Table of Contents

A. Head Circumference Procedure Observation Erasmus MC

The following is a written account of the procedure for taking the head circumference of a preterm infant at the Erasmus MC NICU. Due to privacy concerns, no images or audio could be recorded. The entire procedure took about 5 minutes. The events are presented in chronological order. The two nurses performing the measurement will be referred to as Nurse A and Nurse B.

1. Nurse A lifts the blanket covering the incubator, while at the same time nurse B slowly opens the windows blinds of the windows situated next to the incubator. The child is flailing its limbs around in the incubator
2. Both nurses take a seat on a small stool, on each side of the incubator
3. The nurses both open the side access hatches of the incubator on their respective sides
4. Nurse B reaches in and gently cradles the infant in her hands, one hand below the body, the other supporting the head near the neck.
5. Nurse A has a tape measure and reaches into the incubator from her side
6. Nurse A puts the tape measure around the head of the infant and slowly pulls the tape tight.
7. Nurse A pronounces the pronounces the measurement she reads and asks nurse B if she agrees.
8. Nurse B looks at the tape and confirms the measurement.
9. Nurse A removes the tape measure from the infant's head and closes her side of the incubator.
10. Nurse B puts down the infant, rearranges some wiring and tubing, and closes her side of the incubator
11. Nurse A puts the measurement in the digital patient file using the computer next to the incubator.

This concluded my allotted time to observe the procedure. I assume the window blinds were closed and the blanket put back on the incubator, but I did not observe this.

B. E-mail Interview with Erasmus MC NICU Nurse

The following is a list of questions and answers I got from one of the nurses at the Erasmus MC NICU. This interview was supposed to take place in person in March 2020, but was cancelled and changed into an e-mail interview due to the COVID-19 pandemic.

Interviewer

Interviewee

Groei en schedelomtrek

Waarom wordt de groei van prematuren bijgehouden?

Een goede groei geeft een betere outcome

Wat duidt de huidige schedelomtrek meting aan? Bijvoorbeeld; is het alleen voor neurologische ontwikkeling, of wordt het ook gebruikt om lengte te extrapoleren?

Zegt iets over de verhouding. Je kunt een lichamelijke groeiachterstand hebben en behoud van groei schedel (hersenen) en een groeiachterstand die ook effect heeft op de groei van de schedel en daarmee de hersenen

Is de schedelomtrek meting relatief of absoluut. Dat wil zeggen, is het getal dat uit de meting komt op zichzelf belangrijk (geeft het een staat van ontwikkeling aan), of wordt er gekeken naar een ontwikkeling ten opzichte van de laatste meting?

Er wordt gekeken naar de ontwikkeling

Wat is in uw ervaring de precisie van de schedelomtrek meting (bijv. 1mm, 1cm, enz.?)

Over het algemeen halve centimeters

Een mogelijke functie van het ontwerp is het maken van een 3D beeld van het hoofd van de prematuur, waarop direct of later metingen gedaan kunnen worden zonder de prematuur hier verder bij te betrekken. Zou deze functionaliteit naar uw mening toegevoegde waarde hebben?

Positie van Prematuur

Ik heb vernomen dat het hoofd van de prematuur eens in de zoveel tijd verlegd moet worden of ligplekken en schedeldeformatie te voorkomen. Hoe vaak gebeurt dit per dag/ Wat is de interval?

Geen vaststaand interval, bij de verzorging. Meerdere keren per dag

---

Licht

Er is mij verteld dat Erasmus een dag/nacht cyclus voor de prematuren op de afdeling neonatologie creëert. Wat is het ritme van deze cyclus?

Een dag/nacht ritme hebben prematuren nog niet. We proberen zoveel mogelijk rust te creeeren.

Worden metingen en andere interventies alleen tijdens de dag, of ook tijdens de nacht van deze cyclus uitgevoerd?

Tijdens alle diensten, ip 1 x per week

Prematuren krijgen een blauwlicht behandeling tegen geelzucht. Is dit standaard voor alle prematuren?

Nee, afhankelijk van het bilirubinegehalte in het bloed

Hoe vaak krijg een prematuur deze behandeling?

Zie boven

Hoe lang duurt de behandeling ongeveer?

Afhankelijk van verschillende factoren, bilirubine is leidend

De prematuren dragen oogbescherming tijdens de blauwlicht behandeling. Naar uw ervaring, veroorzaakt het opdoen van de bescherming stres bij de prematuur?

Het bloot liggen en daardoor minder ondersteuning geeft stress.

Hoe lang duurt het om de bescherming op te doen bij de prematuur?

Aantal sec.

Is dit een 1 of 2 persoon proces?

Vaak een 1-persoons proces

Couveuse

Hoe vaak wordt de couveuse ongeveer per dag geopend

Geen idee, afhankelijk van toestand patient

Is het belangrijk dit tot een minimum te beperken?

Je in principe wel, maar je probeert ook te zorg niet in 1 keer te doen, maar te verdelen daar bij kijkend wat de patient aan kan en wat persee moet.

Hoe belangrijk is direct zicht op de prematuur in de couveuse

Belangrijk, je kunt dan zien of een kind wakker is op een bepaald moment zodat je de zorg nog beter kunt afstemmen

Sommige couveuses op de afdeling hebben een deken over het glas. Is dit deken belangrijk voor de rust van het kind?

Is voor privacy, voor minder licht in de couveuse. Intra-uterien is het ook niet licht

Dit deken maakt het wellicht moeilijker om het kind visueel in de gaten te houden. Is dit zo, en zo ja, is dit hinderlijk?

Ja, dit belemmert het zicht op de patient. Door het omhoog tillen van de beschermende deken, maak je vaak patient wakker. Beter is om de camera in de gaten te houden.

Meting

U geeft aan dat de relatieve groei wordt gemeten om ontwikkeling van de patiënt bij te houden. Wat is volgens u een significante stap tussen twee metingen die een (gezonde) groei aanduidt (bijv. halve cm, 1cm, enz.)

Dat is van veel factoren afhankelijk, bv orale voeding, speelt er ergens een infectie. Er wordt gekeken of patient zijn/haar eigen groeilijn volgt volgens de Fenton scale

---

Camera

U antwoordde dat als er een deken over de couveuse ligt het beter is om de camera in de gaten te houden dan de deken op te tillen, om zo het kind niet te storen.

Bij mijn bezoek aan de NICU heb ik geen camera's gezien. Heeft elke couveuse zijn eigen camera?

Ja

Waar is deze camera geplaatst (bijv. in de couveuse, tussen de couveuse en de deken, enz.)?

Boven of op zijkant couveuse

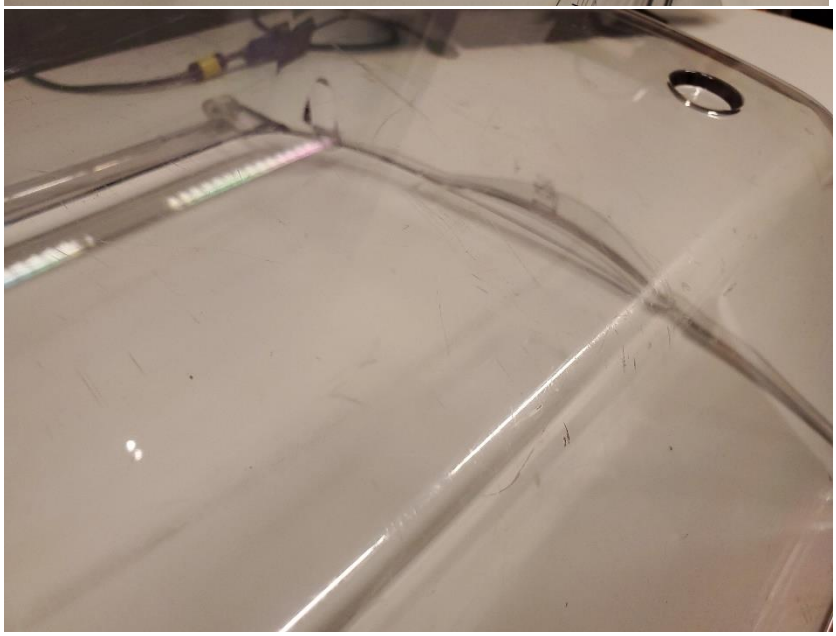
Is deze camera een permanent deel van de opstelling, of wordt deze alleen geplaatst wanneer nodig?

Vaste opstelling

Wordt de camera voor meer doeleinden dan alleen monitoren gebruikt?

Nee

Couveuse



Ik heb hier beschikking over een gebruikte couveuse kap. Deze bevat echter een aantal krassen en schrapen. Als u naar de close-up foto's in de bijlage van de email kijkt, zou u zeggen dat dit een normale hoeveelheid krassen is voor een couveuse kap op de afdeling, of is het meer/minder dan op de afdeling?

Is vergelijkbaar

C. Incubator Market Overview

The point of this analysis is to determine If current incubators share certain design cues. Even though no official standard on incubator design has been published to my knowledge, perhaps a archetype of an incubator can still be created. The geometry of this archetype can then be used to create a generalized design for the product.

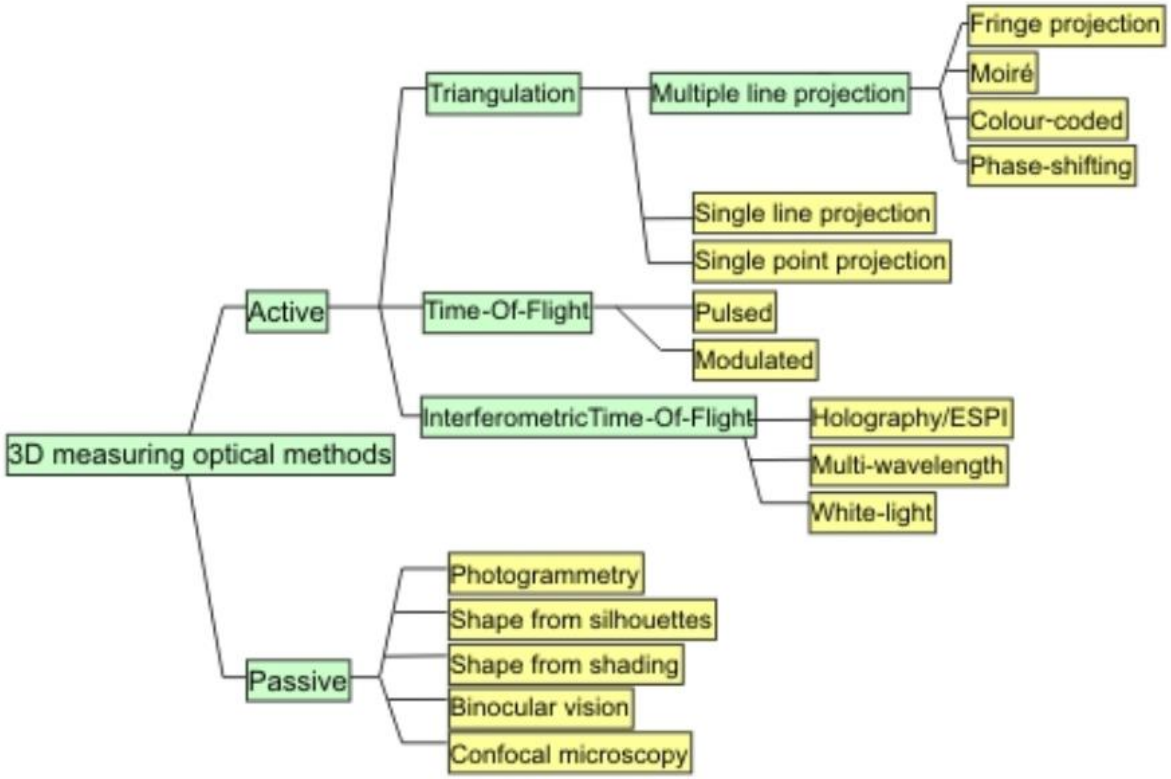
Though proper research was attempted, the market for neonatal incubators is a very specialized one. Almost no advertisement can be found. data on amounts of incubators sold are not available, and brands do not talk about their market share. This makes researching these products challenging. Nonetheless, multiple models were found on the websites of resellers. Images of these incubators were downloaded and put into an image board in order to discover similarities.

I found the following: Most modern freestanding incubators use a design like the Draeger Caleo currently used by Erasmus. This means that the incubator, in additions to the horizontal top and vertical sides, also features two diagonal sides for easy viewing of the infant while standing in the NICU. The only big exceptions are units made for wall placement. These units only feature a single angled pane, with the wall-side of the incubator being completely vertical.

D. Technology Overview

In order to acquire the data necessary for cranial measurements, the product needs to employ a surface scanning technology. Previous chapters discussed a selection of those technologies already used or tested for infant cranial measurement. This chapter will expand on the functioning of those technologies as well as additional options. The goal is to make a selection of one or more technologies that will be used for the ideation and prototyping phases.

Types of acquisition



There are many different ways to acquire a surface scan. These are often divided into the *contact* and *non-contact* category, with the non-contact category being divided into *active* and *passive* acquisition (Figure FIXME) (Ebrahim, 2013).

This division allows us to immediately eliminate certain techniques as candidate. Contact methods, for example, require a physical instrument to interact with the infant in order to acquire data. Not only would touching the infant cause stress, it would also require that the device be placed within the incubator. Thus, only non-contact scanning methods will be discussed.

In addition, since only surface data is needed for measurement, volumetric scanning methods (e.g. MRI, CT), too, will not be considered.

Finally, active scanning methods emit radiation as part of their capture process, while passive scanners can rely on only environmental radiation. Thus, with active methods special consideration must be given to its suitability when scanning through the surface of the incubator.

Overview

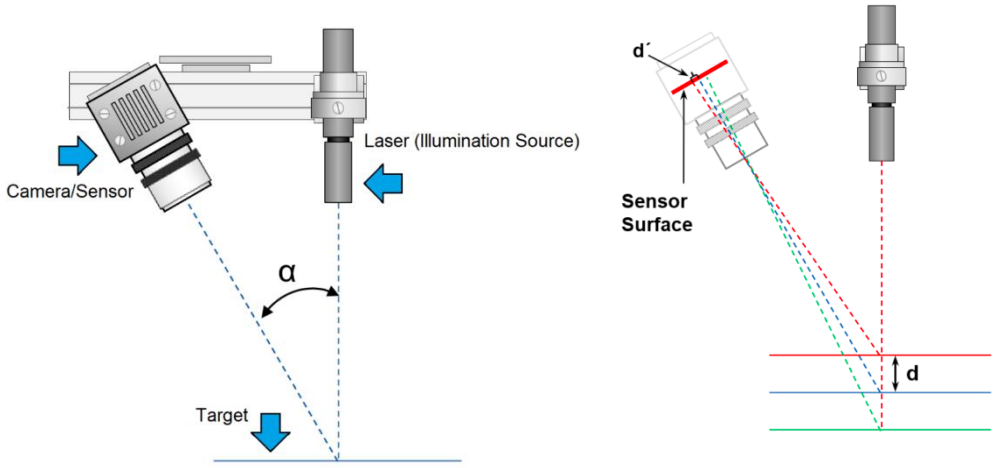
The following is an overview detailing each technique that is considered for the product. In addition to a short description of its functioning, advantages and disadvantages of each technique are discussed.

Laser Triangulation

Laser triangulation is a simple form of 3D scanning, whereby a single laser and a camera are used to acquire depth data along the path of the laser line. The basic principal is as follows:

- A laser and camera are positioned at a known angle α (Figure FIXME).
- Depending on the depth of the object the laser point hits, it's position on the camera sensor changes.
- Using triangulation, this shift in position on the sensor can be translated into an absolute depth of the point (Figure FIXME).

This concept can be expanded upon by projecting a laser line instead of a point using, for example, an oscillating mirror. This then give a depth "slice" of the object that is to be scanned. Moving the laser & camera setup, or the object, can be done to acquire multiple of these slices. Stitching these slices together forms a 3D surface scan of the object.



Laser triangulation is adequately accurate, with a depth accuracy of 0.04mm being claimed by one report (Vukašinović et al., 2010). At the same time, complete systems sell for a relatively low price. Murobo sells a turntable based model (where the to-be-scanned object is rotated instead of moving the laser assembly) for $249,- (*Murobo*, n.d.).

Intrinsic performance variables

- α: The value of α determines both the depth resolution of the setup, and the sensitivity of the setup to occlusion. The depth resolution and sensitivity to occlusion as a function of α are correlated. Thus, as α increases both depth resolution and sensitivity to occlusion increase, and vice versa.

- Laser line thickness: Influences the depth resolution of the system. The thinner the line, the easier the sensor can pick up small variation in the surface's depth.
- Sensor resolution: The higher the resolution of the used image sensor, the more detail it can pick up in the variations of the laser line height, which directly translates to increased depth resolution.

Advantages

Simplicity

This system only requires a laser with a line generator prism, and a regular CMOS camera sensor to function, making the hardware setup relatively simple.

Hardware costs

This system is made up of only a few components, all of which are common, and mass produced, reducing the hardware costs significantly.

Processing requirements

The depth of every point of the laser line corresponds to a shift in vertical position of the line on the camera sensor. This correlation can be solved with simple trigonometry, making the computational requirements to acquire the actual depth of each point on the line relatively low.

Non-visible light source

This setup can be made working with an IR-A laser and a CMOS camera without IR filter. This prevents the infant from enduring stress from visible light being shone upon it.

Disadvantages

Obstruction

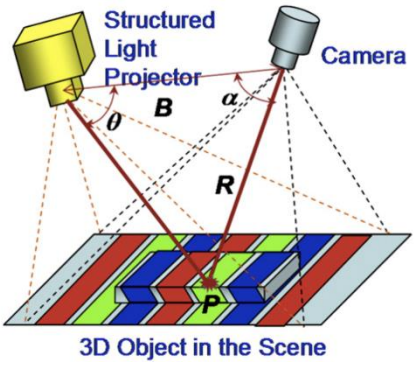
Obstructions like blankets, tubes, or other above-the-infant objects, can cast a shadow when in the path of the projector. If these shadows are cast on the infant, the camera will not be able to gather any depth-data from those areas.

2 Dimensional

This system in its most common, static form can only capture a single line or slice of depth data. This means that the system must be positioned in the correct way by the NICU nurse for it to capture the right slice of the infant's head for a HC measurement, increasing operation complexity and decreasing interobserver precision.

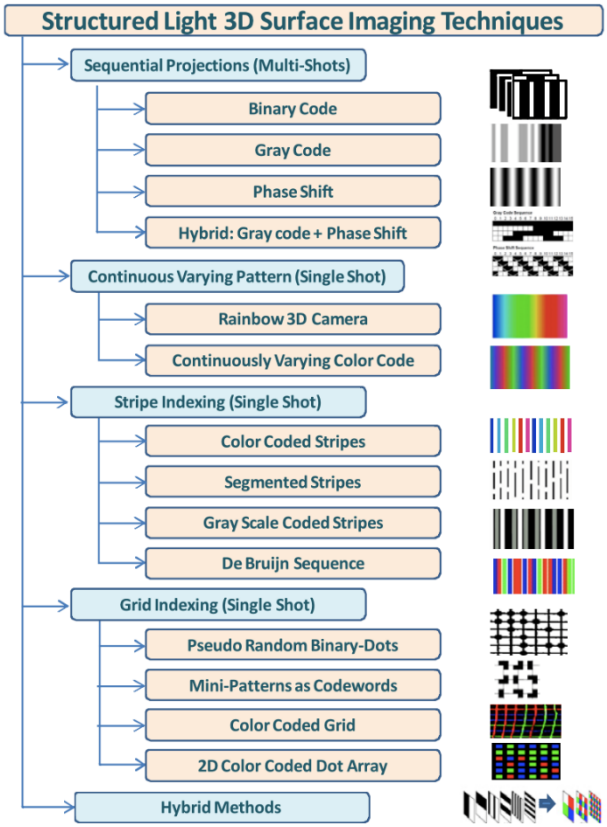
Creating full 3-dimensional scans would require the laser beam to be moved along an additional axis, increasing mechanical complexity.

Structured Light



This scanning technique, like laser triangulation, uses triangulation to determine the depth of a point on the surface on the to-be-scanned object. Where the two techniques differ is that laser triangulation can only acquires one line (or slice) of depth data at any given moment, while structured light scanning allows for the simultaneous acquisition of an entire 3d surface. The basic operation is as follows:

- A light projector, placed at a known angle α and θ to the camera (as in figure FIXME), projects a pattern of sorts (Figure FIXME) on the to-be-scanned surface.
- The camera captures the distortion of this pattern on the surface, which is influenced by the depth of each point of the surface
- Using one of the techniques outlined in figure FIXME, the software identifies each point of the pattern, comparing its shifted position to its original position.
- Triangulation is used to determine the depth value of each point based on the shift from its original position, from the viewpoint of the camera.

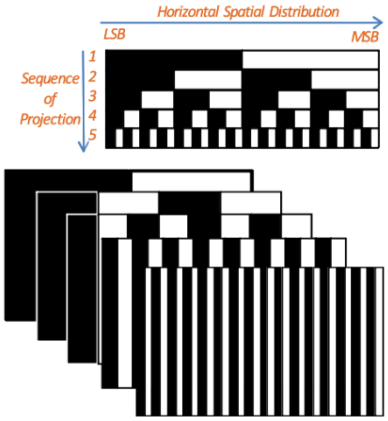


Though all structured light scanners use the same principle of triangulation, various techniques exist for solving the problem of point recognition: For the scanner to determine the depth value of each point it must know the original position of the projected pattern point corresponding to it.

Thus, the scanner must be able to uniquely identify each point of the projected pattern. (Geng, 2011) grouped these techniques into *single-shot* and *multi-shot* methods (Figure FIXME). As the name suggests, single shot methods allow all necessary information to be captured by the camera in a single frame or 'shot', while multi-shot methods require multiple sequential frames to be captured in order for the pattern to be fully identified.

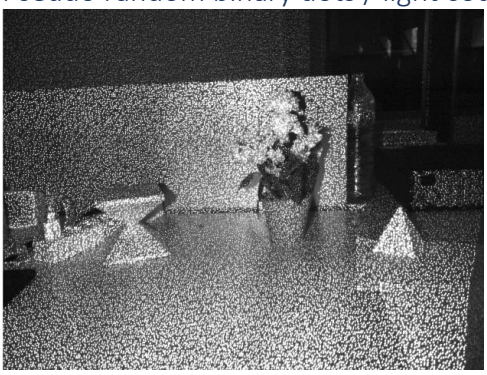
To illustrate the difference between the categories, the following is an overview of two predominant technologies, one of each of the two discussed categories

Gray coding (multi-shot)



With Gray coding, the projection is divided up into vertical or horizontal lines which are either black (no projected light) or white. These represent the binary values 0 and 1 respectively. By projecting and capturing a sequence of frames, these bars can be used to create a unique identifier for each line. Since each frame represents one state, or bit, the number of possibilities is equal to 2^N, where *N* is the number of frames in a sequence. Thus, the more frames, the higher the amount of unique lines that can be identified, increasing the resolution of the scan until the camera sensor's resolution becomes the limiting factor.

Pseudo random binary dots / light coding (single-shot)



This method, employed by the ubiquitous Kinect v1 camera, uses a laser generated pattern of pseudo random dots to identify areas of the pattern. The dots are arranged in such a way that a sub-area of a predetermined size sliding over the pattern would give this sub-area's absolute position in the pattern, regardless of its position (figure FIXME) (Geng, 2011). This is achieved by having the neighbouring dots of every dot in the pattern be in a unique relative position compared to the neighbouring dots of every other dot in the pattern.

At close range, a structure scanner like Occipital's Structure Mk2 has an accuracy of 0.2% of the measured depth (Occipital, 2020a), while costing a total of $449,- (Occipital, 2020b).

Intrinsic performance variables

- α & θ: As with laser scanning, the values of α and θ influence the setup's depth resolution as well as its sensitivity to occlusion. Decreasing α and θ increases both depth resolution and sensitivity to occlusion, and vice versa
- Pattern complexity: Increasing the complexity of the pattern increases the amount of uniquely indexed areas within this pattern, which in turn increases the resolution of the scan. This increase in complexity can take multiple shapes:
    - For single shot methods such as light coding, an increase in complexity would entail a higher resolution grid pattern, meaning more dots per area, which gives more unique sub-areas.
    - For multi-shot methods such as Gray coding, an increase in complexity would entail more frames added to the sequence to increase the amount of possible combinations for a line.
- Sensor resolution: The higher the resolution of the used image sensor, the more detail it can pick up in in the projected pattern, which directly translates to increased depth resolution.

Advantages

Processing requirements

Since simple trigonometry is used to calculate the depth of each pixel, the computational requirements for this method to deliver a point cloud is low, allowing for on-device processing.

Non-visible light source

The two aforementioned indexing techniques can both be performed using an IR-A projector. This not only reduces interference from visible-light sources, but also prevents any light related stress for the infant.

Simplicity

A single structured light camera can capture the depth of all objects in their field-of-view without using moving parts, limiting system complexity.

Disadvantages

Acquisition time (multi-shot)

With multis-shot indexing techniques, whereby multiple images are captured sequentially, the subject must lay perfectly still for the acquisition to be successful. The higher the resolution of the scan needed, the more images must be captured, thus the longer this time will be. Infants must thus be either asleep during acquisition or held still by a caretaker.

Obstruction

Obstructions like blankets, tubes or other above-the-infant object, can cast shadow when in the path of the projector. If these shadows are cast on the infant, the camera will not be able to gather any

depth-data from those areas. This can be solved by using multiple projectors at various positions. However, this increases costs of the assembly. Additionally, multiple projectors would have to make use of a multi-shot indexing method, since static patterns could interfere with one-another.

Multi camera interference

Scanners using this technology use a projected pattern to index the surface. This means that if multiple scanners are used (to get full coverage of a 3D object) their patterns will interfere with each other. This means that a multi-camera setup using this technology must acquire its data one sensor at a time, sequentially.

Time of Flight

If an object travels at a constant speed, it is easy to determine the distance it has travel by timing the duration of the travel: multiplying its speed by the travel time gives the total distance travelled. This principal is applied in Time of Flight (ToF) scanners. These scanners use a projector to send out a pulse of light. Since the speed of light is constant, the time it takes for this light to return to the ToF sensor can then simply be multiplied by the speed of light to get the round-trip distance travelled. Halving this value gives the distance between the sensor and the object. This is known as *direct ToF* (Terabee, n.d.)

Indirect ToF makes use of the phase of the light being sent out by the projector vs the phase of the light being received by the sensor in order to gauge distance travelled (Terabee, n.d.). The projector sends out modulated light at a set frequency. For this example, the amplitude is modulated in a sinusoidal manner at 10MHz. This gives a wavelength of 30m. When the modulated light leaves the projector, its state is known. Depending on the distance the light has travelled before returning to the sensor, the phase will have shifted from its original projected state. Unlike direct ToF where the maximum measuring range is dependent on the intensity of the projector and the light sensitivity of the sensor, indirect ToF's range is determined by the modulation frequency: a 10MHz, 30m wave can only be used to measure distances up to 15m (wavelength divided by 2).

Two major types of ToF systems can be distinguished: LIDAR systems, and ToF cameras.

LIDAR

LIDAR (a portmanteau of LIght and raDAR) uses a pulsing laser and simple single point ToF sensor to scan the depth of a surface. Since the laser only sends out a singular beam, this system requires continuous mechanical movement, moving the beam across the whole surface in order to capture a full 3D scan.

Recent close-range LIDAR systems such as Intel's L515 have a stated depth accuracy of <5mm (Intel, 2019). This unit is set to sell for $349,- (Intel, 2020).

ToF Camera

A time of flight camera uses a 2-dimensional sensor and projector. Instead of a single laser point, multiple points of the surface are acquired at the same time. This means that unlike LIDAR, no mechanical system is needed to move the assembly, as long as the to-be-scanned surface fits within the conical field of view (FoV) of the sensor.

A study trying to improve the accuracy of ToF cameras through software reached a depth-accuracy of 4.6mm within its full range (He et al., 2017), which is inadequate for the intended application. However, the paper does not mention if the used point cloud is the result of a single acquisition of the Kinect, or if an average of multiple frames are used. If only a single acquisition was used, accuracy might be improved by instead averaging the depth of the point cloud points acquired over multiple sequential frames. Microsoft priced its newest ToF camera, a follow-up to the Kinect v2, at $399,- (Microsoft, 2020).

Intrinsic performance variables

- Clock resolution: The depth resolution of ToF based systems in dependent on the resolution of the clock. The smaller the time unit, the more smaller the steps between depth units (distance = constant speed / time).
- Sensor & projector resolution (ToF camera): The higher the resolution of the used image sensor and light projector, the more detail can pick up in in the projected pattern, which directly translates to increased surface scan resolution.
- Polling rate (LIDAR): Influences the speed of acquisition. The higher the polling rate, the faster the laser may move over the surface for the same resolution, decreasing acquisition time which aides in capturing dynamic objects.

Advantages

Low processing requirements

With the speed of light being constant, the depth for each pixel of the camera can be easily determined through a simple multiplication. This means that the immediate output of the sensor can be used as a point cloud, thus reducing computation cost a minimum.

Non-visible light source

LIDAR systems and ToF cameras use IR-A for their projectors. This not only reduces interference from visible-light sources, but also prevents any light related stress for the infant.

Simplicity

A single ToF camera can capture the depth of all objects in their field-of-view without using moving parts, limiting system complexity.

Fast acquisition (ToF camera)

With ToF cameras the entire frame is captured at once. Because of this the subject of the scan (in this case the infant) does not have to lay still for more than a fraction of a second.

Disadvantages

Occlusion

As is the case with structured light systems, obstructions like blankets, tubes or other above-the-infant object, can cast shadow when in the path of the projector. If these shadows are cast on the infant, the camera will not be able to gather any depth-data from those areas.

Hardware costs

LIDAR and ToF cameras capable of scanning close range objects can be expensive compared to techniques like photogrammetry or some forms of structured light scanning.

Depth accuracy

The depth accuracy of a ToF camera is determined by the precision of its clock. Since the speed of light is quite quick, the maximum accuracy on movable hardware is lower than other mentioned techniques. In fact, it is too low to be considered for this product, since HC measurements would be of lower accuracy than the current tape-based HC measurements.

Resolution

ToF camera sensors are of relatively low resolution compared to the average CMOS RGB sensor. For example, a common affordable CMOS RGB like the Raspberry pie camera has a 8 MP resolution (Raspberry Pi, 2016), while a modern ToF camera like the Kinect Azure, has a resolution of 1MP (Microsoft, 2020). In addition to this, since these cameras often have a considerable minimum distance they work from and wide-angle field of view, only a fraction of this resolution would be used to resolve the surface of the infant's head.

Range

Both LIDAR and ToF cameras are used mostly to capture environments, rather than close-by objects. This is because their technology lends them better for the former, with a large potential capture distance and relatively low depth precision compared to other mentioned techniques.

Photogrammetry

component-wise, photogrammetry is the simplest of the methods. This technique only requires standard CMOS sensors to capture RGB images of the to-be-scanned surface, from multiple angles. All 3D data is generated through software. Feature recognition is used to determine the position of each camera, after which multiple algorithms, amongst which is triangulation, are used to determine texture and geometry of the surface.

This makes photogrammetry an almost completely software-based solution. The advantage of this is that a single hardware setup may last for multiple generations, since increases in scan quality are generally achieved through software optimizations. However, since all the heavy lifting is done in software, this technique is the most computationally intensive of all technologies discussed in this chapter. For illustration, Vectory3's Curatio scanner takes 20 minutes to deliver a 3D model, with off-site processing.

A study using the Curatio prototype reached an accuracy of 1.5mm with close-range photogrammetry (Smakman, 2014).

Near-IR Photogrammetry

Though Photogrammetry is usually performed using RGB cameras and light in the visible spectrum, it is possible to use cameras with an IR filter and IR light source to capture the subject. The advantage of this would be the ability to increase illumination of the infant using the IR light source to allow for better capture of the images, without disturbing the child with visible light.

A possible disadvantage of this technique is the reduced data per photo available for the algorithm to resolve the to-be-scanned surface: No colour data is available, possibly reducing contrast between parts of the image. Additionally, the resulting grayscale images would have a lower bit-depth than their colour counterparts (8bpp vs 24bpp, respectively).

However, one study comparing a near IR photogrammetry scan with a RGB scan using the same setup concluded that there is no difference in accuracy between the two, both reaching <1% deviation in measurement (Edelman & Aalders, 2018). This could thus be a viable option for the product.

Intrinsic performance variables

- Number of cameras: Influences object scan detail. Increasing the number of (correctly placed) cameras allows the reconstruction software to more accurately and with more detail reconstruct the to-be-scanned object. Note that returns are diminished as the number of cameras increases.
- Sensor resolution: The higher the resolution of the used image sensor, the more detail it can pick up increasing the overall detail of the produced model.

Advantages

Hardware costs

Photogrammetry makes use of unmodified RGB CMOS cameras. Since it is a passive 3D scanning technique, no emitters of any kind are needed. Though additional lighting may have to be added if the environment requires it, this too is standard part with no special requirements.

Occlusion

While obstruction is still possible by placing objects between the camera and the subject there is no projector component in this system, eliminating additional possibilities of large non-scannable shadows being cast on the subject. Furthermore, since multiple viewpoints are a requirement for acquisition, objects that are in the way of one viewpoint can be compensated for by the access of other viewpoints.

Vectory3 experience

An advantage that is not inherent to photogrammetry itself is the experience Vectory3 has in creating, producing and implementing products with this technology. Scanners like their Curatio already make successful use of photogrammetry, and a pipeline has already been set-up to process acquired images offsite and return a finished mesh to the client. Additionally, this pipeline is a keystone in Vectory3's pay-per-scan business model, where clients pay for use of the device.

Disadvantages

Processing requirements

Out of the discussed techniques, photogrammetry has the highest computational requirements. Camera position, image stitching, surface detection and more all have to be done in software after acquisition of the initial images. One study using photogrammetry for a head scan had a processing time of 49 minutes between the image acquisition and mesh output when using a desktop computer (Santander et al., 2020).

Hardware complexity

Though the cameras themselves are common parts, multiple are needed for one shot acquisition from multiple angles, increasing the complexity of the product's design and construction.

Light sensitivity

Photogrammetry, being a passive acquisition technique, uses environmental light to acquire its images. This means that, even when a dedicated light source is used, performance is partially dependent on changes in environmental lighting conditions.

Conclusion

Method	**Structured Light**	**Photogrammetry**	**Laser triangulation**
Depth Accuracy	0.6mm	1.5mm	0.36mm
Advantages & Disadvantages	*Advantages* + Low processing requirements + Non-visible light-source + Simple hardware + Costs *Disadvantages* – Multi-camera interference – Occlusion sensitivity	*Advantages* + Hardware costs + Occlusion sensitivity + Company experience + Costs *Disadvantages* – Environmental light sensitivity – Hardware complexity – High processing requirements	*Advantages* + Low processing requirements + Non-visible light-source + Simple hardware (When line scanning) + Costs *Disadvantages* – Complex hardware (When surface scanning) – Occlusion sensitivity – Set-up complexity (when line scanning)

Method	**Time of flight**
Depth Accuracy	4.6mm
Advantages & Disadvantages	*Advantages* + Low processing requirements + Non-visible light-source + Simple hardware + Low acquisition time *Disadvantages* – Depth accuracy – Occlusion sensitivity – Resolution – Range – Costs

Having looked at common technologies for 3D scanning, a decision will now be made on what technologies to use for the ideation and prototyping phase. The following is a brief overview of the decision argumentation for each technology.

Laser line triangulation

Laser line triangulation allows for adequate accuracy of the scan. Additionally, the technology does not require great computational power to deliver a timely result. However, human action is needed to place the laser line in the correct position of the head, which introduces a factor of human error into the measurement. This manual placement would also require the use of visible laser light, which can disturb the infant. This problem could be alleviated with a mechanical system that moves the scanning assembly, creating a 3D surface. However, introducing mechanical systems complicates the product, increases the amount of failure points, and potentially increases noise production, which is to be kept at a minimum.

Because of these disadvantages, this technology will not be explored further

Structured light

Structured light scanning allows for adequate accuracy of the scan. Like laser triangulation, the processing of depth information requires little computational power, though the indexing of the pattern required by this technology does increase complexity. Since this technology can make use of IR-A light for its projector, the infant should not be disturbed by the acquisition. Prices for existing technologies are acceptable, with a 0.1mm accuracy Structure scanner for €449.

This technology thus seems suitable for this application. However, since little information was found a unit must be acquired for testing this technology through the hood of the incubator, before ideation.

LIDAR

Though this technology can be used with IR-A light, thus reducing the impact on the infant, the mechanical system required to move the assembly increases product complexity, failure modes, and noise production. In addition, this technology does not have adequate depth resolution (<5mm) for a HC measurement that is equal to or more accurate than the tape-based HC measurement. Furthermore, like other active 3D scanning systems, tests would need to be performed to check the applicability of the technology when scanning through a curved, imperfectly transparent surface like that of the incubator.

This technology will thus not be explored any further.

ToF camera

Though these cameras remove the mechanical component of LIDAR systems, accuracy stays below the required amount for an improvement upon current HC measuring techniques (4.6mm depth accuracy). Additionally, like other active 3D scanning systems, tests would need to be performed to check the applicability of the technology when scanning through a curved, imperfectly transparent surface like that of the incubator.

Therefore, this technology will not be explored any further.

Photogrammetry

Though the accuracy of photogrammetry is dependent on the configuration, Vectory3 has reached accuracies of 0.15mm with their Curatio hand scanner, which is adequate for the proposed application. Furthermore, the system requires no moving parts and the components are relatively inexpensive (standard CMOS cameras).

Downsides are the product complexity due to the multiple cameras needed at multiple angles. The required computation time, too, is higher compared with all previously mentioned technologies. Vectory3 currently needs 20 minutes to process a Curatio scan off-site, which is before any measuring of the finished model. This would significantly impact the current procedure used for circumference measurement, whereby the result is immediately known to the NICU employee performing the measurement.

A faster alternative to basic photogrammetry, which uses the same basic principle of stereoscopy, but combines it with an IR dot projector for creating texture on the subject, can be found in the Intel D4xx series of depth sensing modules. These modules increase cost, but mitigate hardware setup complexity by integrating much of the electronics in a self-contained module, reduce processing time to mere milliseconds per frame thanks to a custom ASIC in the modules, and reduce the systems sensitivity to environmental light by the use of the integrated IR dot projector. This technology will therefore be chosen to represent the photogrammetry solution.

E. Using the Prototype

For the evaluation of the final prototype, it is important that other users are able to use the device. Therefore, this chapter serves as a step-by-step manual as well as a description of the device's functioning.

This guide assumes that the incubator has already been setup and the infant is placed inside. It also requires the following software to be installed on the host computer (the exact version of the software may not match, but is given as reference in case any changes are made after the writing of the guide):

Intel RealSense Viewer (2.39.0)

Meshlab (2020.09)

ParaView (5.8.1)

Additionally, the following two files are needed to follow the guide:

D415_Setup.json

Edge Trim.mlx

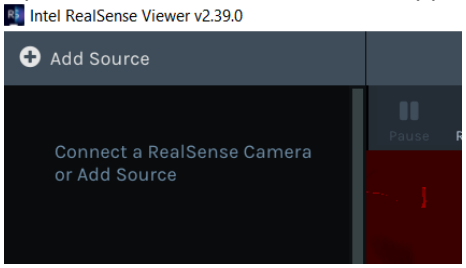
Hardware setup

1. Grab the device by the grab handles and lower it onto the hood of the incubator, with the device roughly aligned with the head of the infant

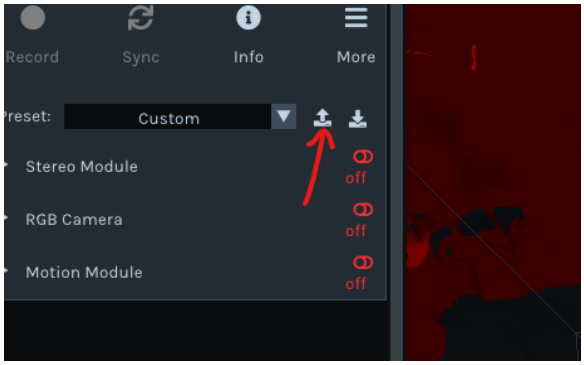
2. Plug the power connector into the device, then the wall plug.

3. Connect the USB cable to a USB 3.1 port on your computer

4. Open the Intel RealSense Viewer application

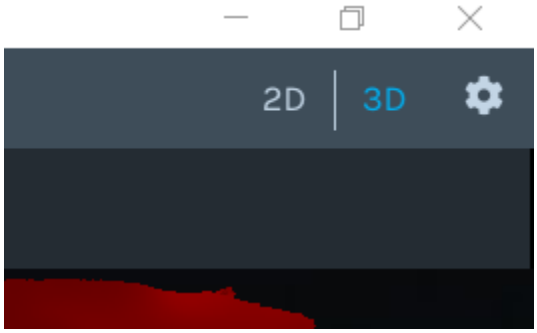


5. Use the “Add Source” drop-sown menu in the upper left corner to add all three D415 cameras

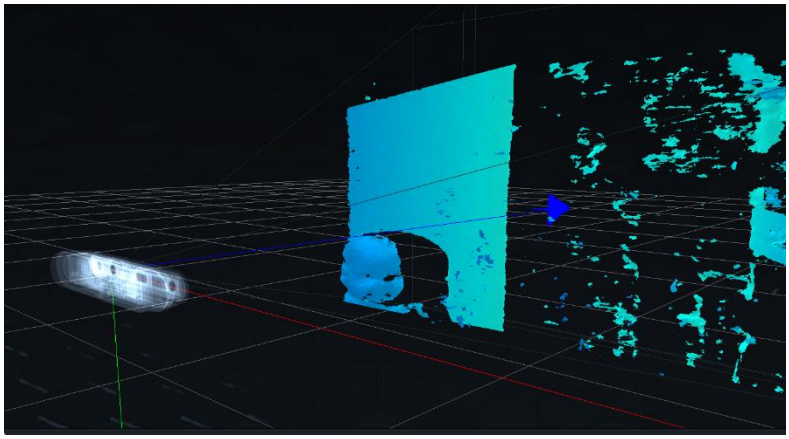


6. Using the “load pre-configured stereo module settings” button, load the included configuration file “D415_Setup.json” for each of the three cameras. In case this file is not provided, its contents can be found in Appendix P.

7. Now toggle the switch for the stereo module for one of the side cameras.



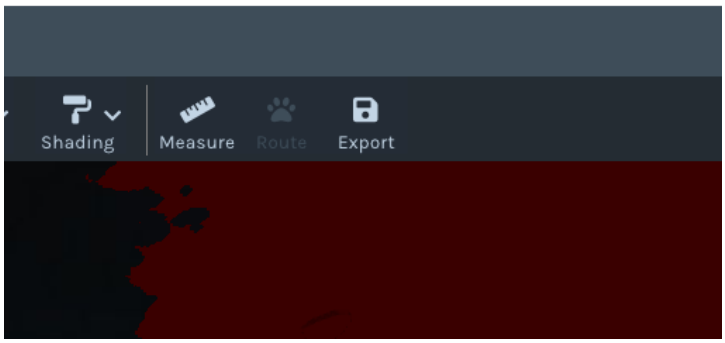
8. Make sure the viewport is set to 3D in the top right corner of the application.



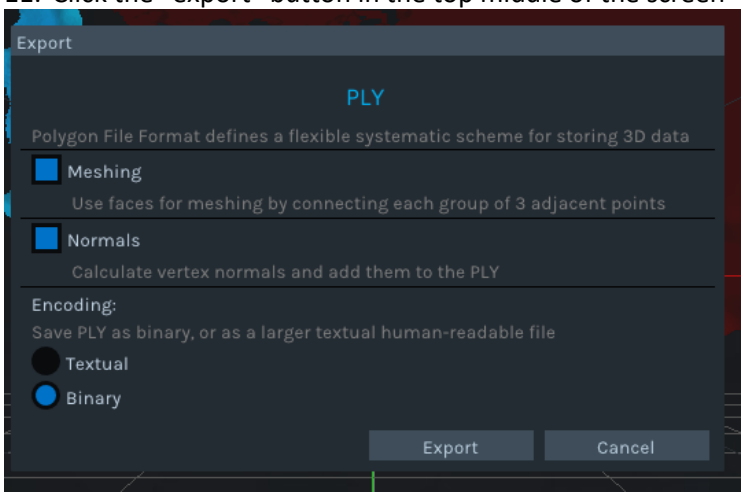
9. While watching the screen, grab the handles of the device and move it forwards or back until the chin of the infant's head is just in the field of view of the camera.

Acquisition

10. Make sure only one camera is active at a time



11. Click the "export" button in the top middle of the screen



12. In the export dialogue, make sure "Meshing" and "Normals" are selected.

13. Save the output file to a convenient location with a recognizable name denoting which of the cameras took the acquisitions, as well as the current rotation of the head of the infant (e.g. "headUp leftCam.ply")

14. Repeat steps 10 through 13 for each of the three cameras, always making sure that only one is active at any given time.

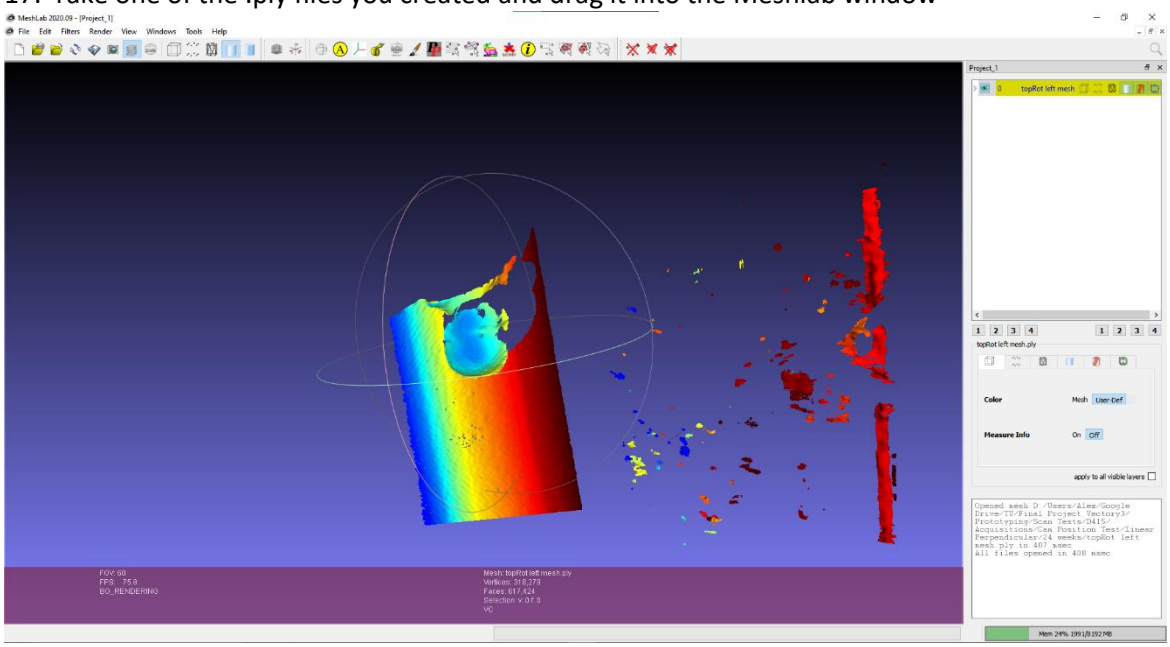
Head Rotation

15. Steps 10 through 14 need to be performed for three orientations of the infant's head: Once while looking up, once while looking to the left, once while looking to the right. This ensures that the entire head can be recreated later on. Make sure that the scanner is still placed correctly after each movement of the infant's head. You should end up with 9 .ply files.

Mesh cutting

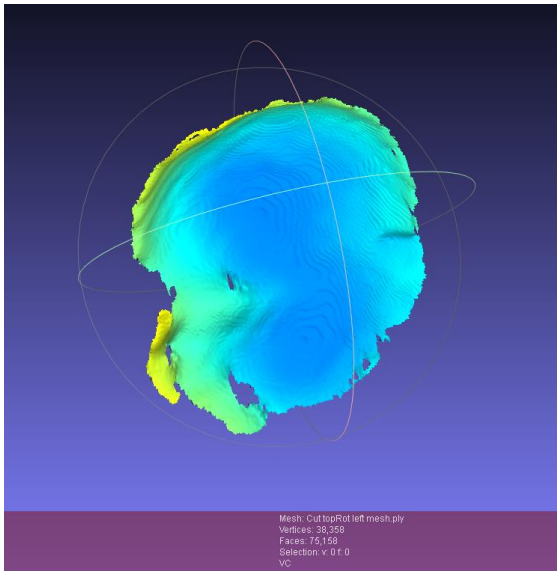
16. Open Meshlab

17. Take one of the .ply files you created and drag it into the Meshlab window



18. Use the middle mouse button to place the head of the infant in the middle of the navigation sphere. Rotate with left mouse button.

19. Select the "select vertices" button in the top toolbar of the application



20. Drag a box around the irrelevant geometry (everything outside of the head) and press CTRL+DELETE to delete the selection. Do this until only the head is left.

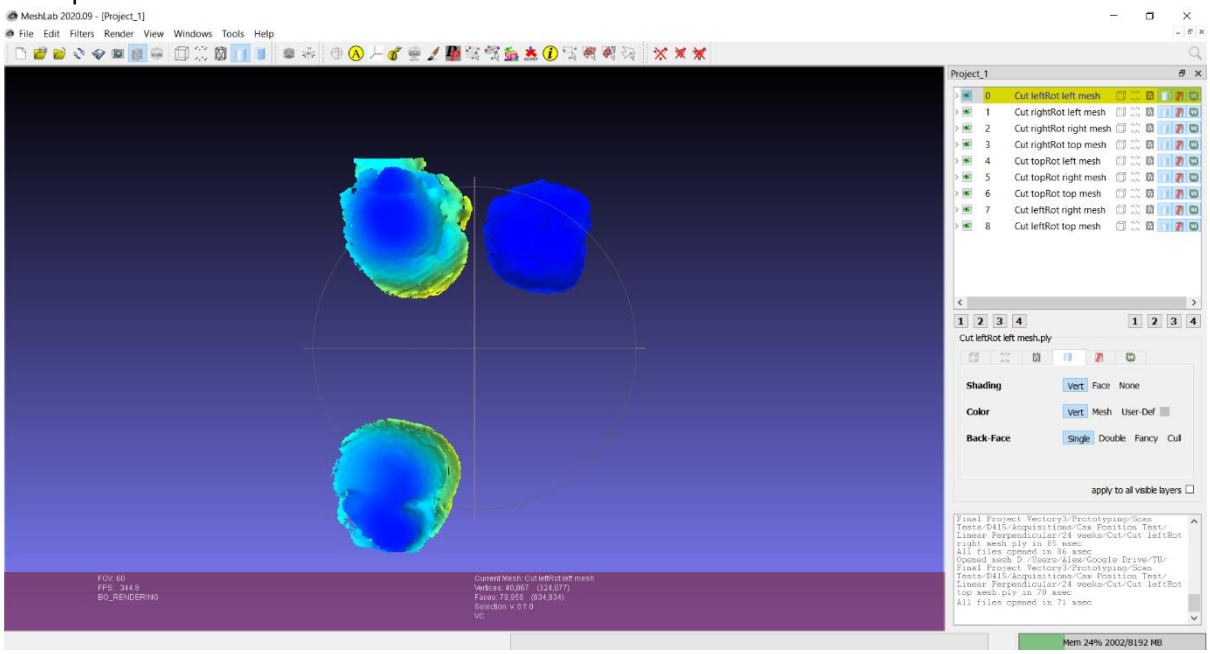
21. Go to File>Export Mesh…

22. Close MeshLab

23. Perform steps 16 through 22 for all 9 .ply files

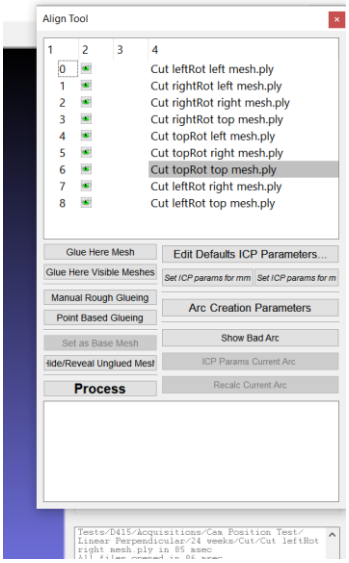
Mesh alignment

24. Open MeshLab



25. Drag all 9 .ply files into the MeshLab window

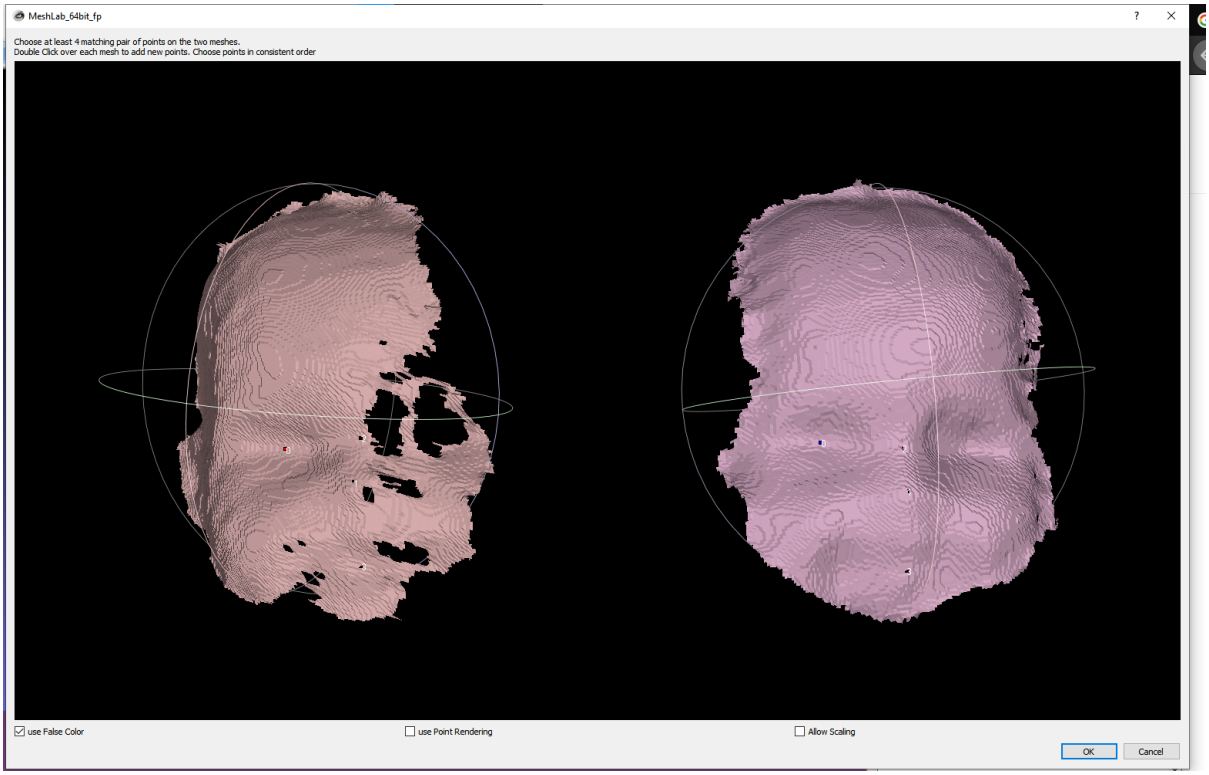
26. In the top toolbar, press the “Align” button.



27. In the align dialogue, select the top camera view of the infant head looking up, and press “Glue Here Mesh”.

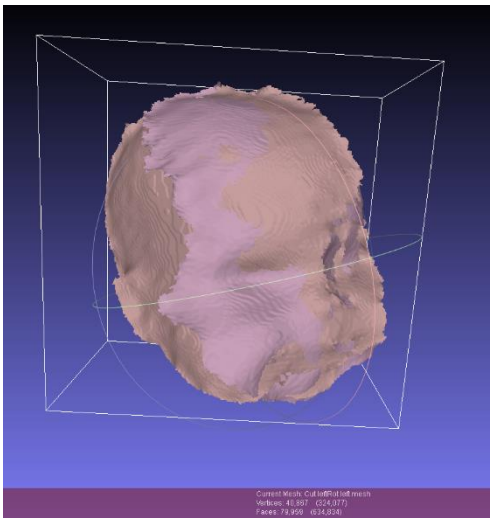
28. Now select a different mesh with as much overlap with the previous mesh as possible, (for example, in this case the left camera of the head looking left would have the most overlap, as well as the right camera of the head looking right).

29. Press “Point Based Glueing”



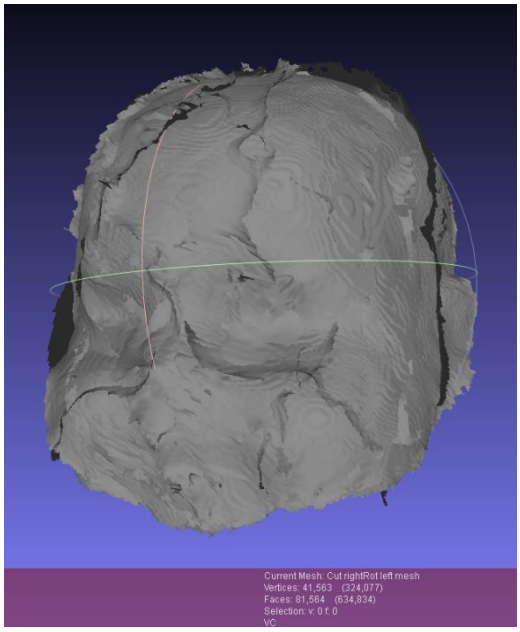
30. In the gluing dialogue, select matching points on both meshes by double clicking on them. Make sure the order of the numbers matches between meshes.

31. Press “OK”.



32. Check if the alignment is realistic. If not, press “Unglue Mesh” then restart at step 28. If that does not work you must manually place the mesh by using the “Manual Rough Glueing” button. [TIP: You can toggle the eyeball icons next to the meshes to temporarily hide them.]

33. In the Align dialogue, press **“Process**”. The meshes will start moving towards each other. Keep pressing **“Process**” until the movement either stops or becomes unnoticeable.

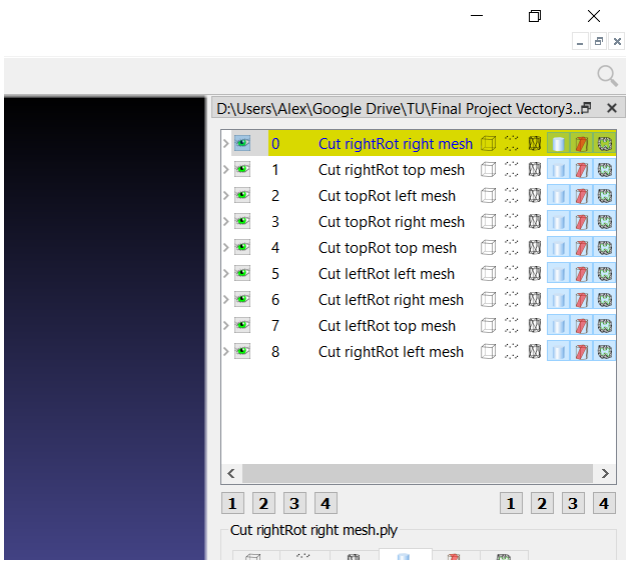


34. Repeat steps 28 through 33 until all 9 meshes are aligned.

35. Go to “File>Save Project As…” to save the alignment as an .mlp file.

36. Close the “Align” window.

Mesh trimming



37. Select a mesh (selection highlighted yellow) using the selection window on the right of the application.

38. Go to Filters>Show current script

39. Press “Open Script” and load the included “Edge Trim.mlx” file

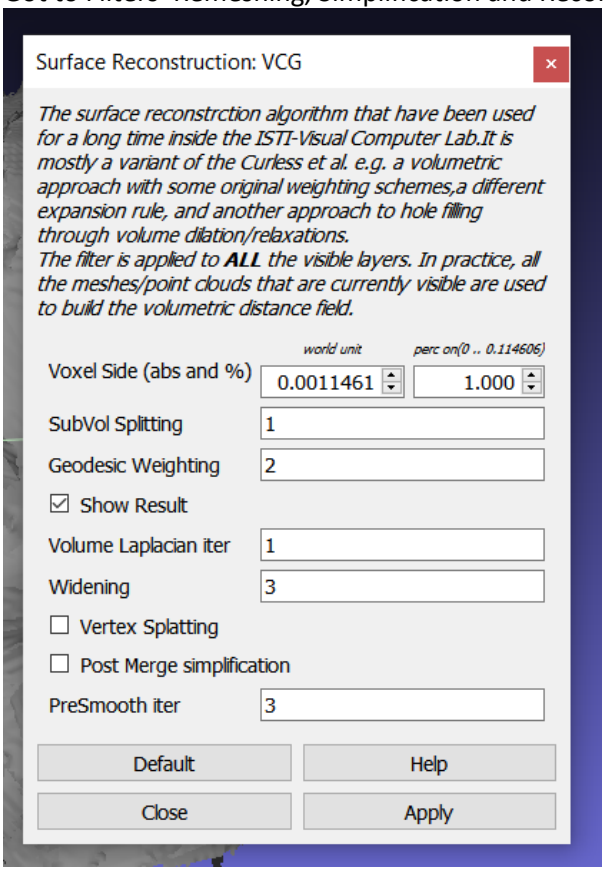
40. Press “Apply Script”

41. Go to File>Export Mesh…

42. Repeat steps 37 through 41 for all 9 .ply files.

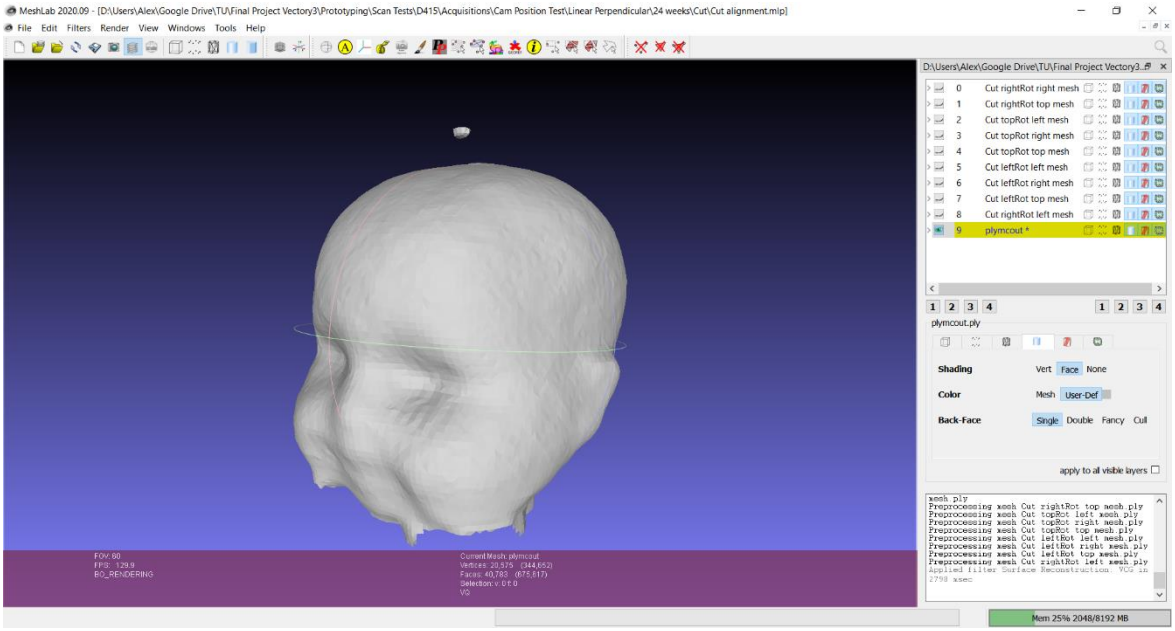
Remeshing

43. Got to Filters>Remeshing, Simplification and Reconstruction>Surface Reconstruction: VCG



44. In the VCG dialogue, copy the above settings.

45. Press “Apply” and close the window



46. A new item “plymcout” has been added to the selector on the right. Disable the view of all other meshes and select the “plymcout” mesh

47. Using the vertex selection as detailed in steps 19 and 20, select any floating or otherwise unwanted geometry (if applicable) and delete it using CTRL+DELETE.

48. Go to File>Export Mesh As

49. Give this mesh a name suitable for the final output and press “Save”

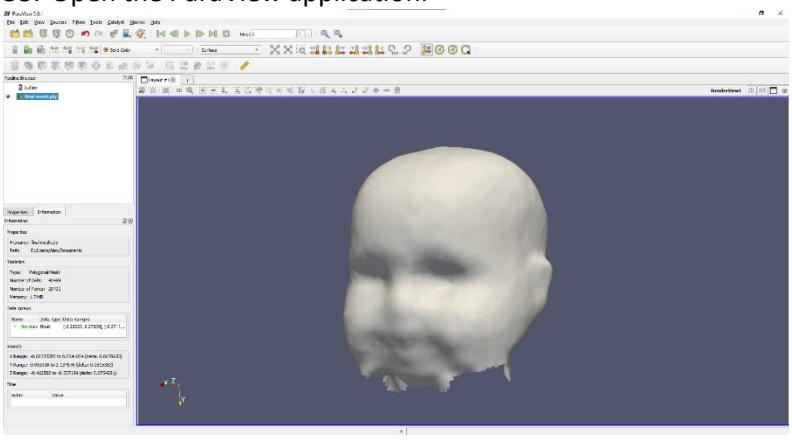
50. In the “Saving Options” dialogue, make sure “Quality” and “Normals” are checked

51. Press “OK”

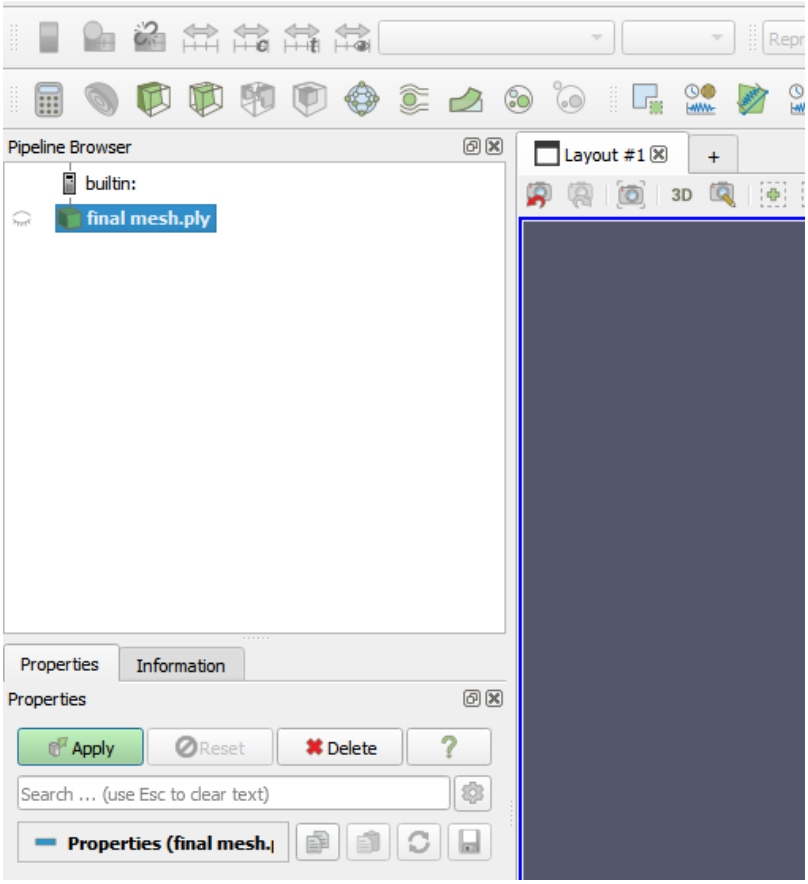
52. Close MeshLab

Measuring Circumference

53. Open the ParaView application.

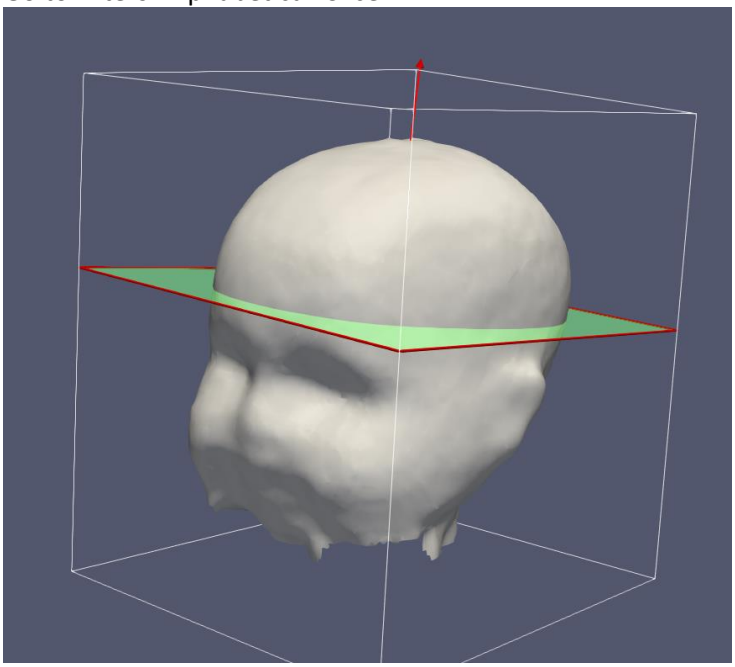


54. Drag the remeshed head .ply file into the window

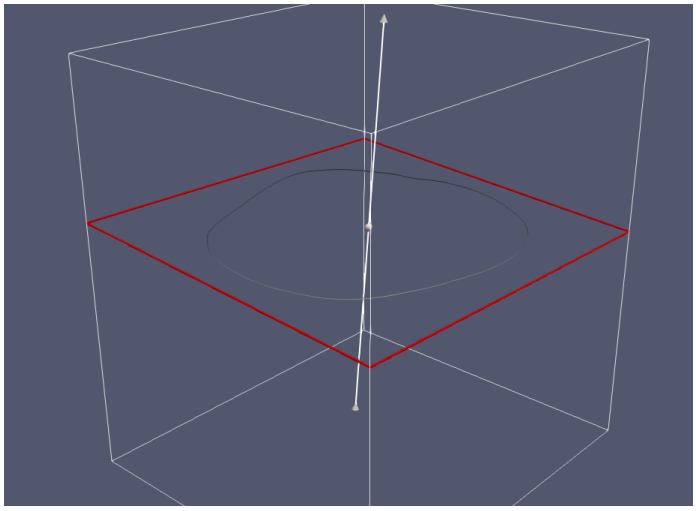


55. Press the green “Apply” button under the “Pipeline Browser” on the left side of the screen, in the “properties” tab, to make the mesh visible.

56. Go to Filters>Alphabetical>Slice



57. Use the arrow through the plane to orient the plane and grab the plane itself to adjust its height in order to place the plane where you want to measure the head circumference.



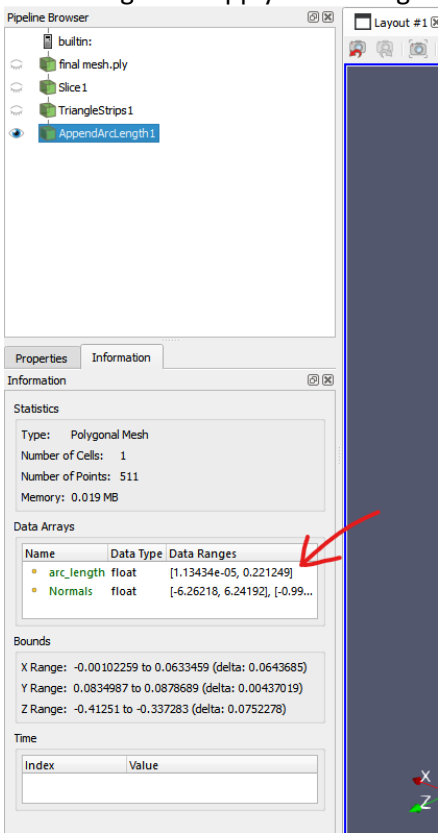
58. Press the green “Apply” button again

59. Go to Filters>Alphabetical>Triangle strips

60. Press the green “Apply” button again

61. Go to Filters>Alphabetical>Append Arc Length

62. Press the green “Apply” button again



63. The head circumference can be found in the left pane under the information tab, then the “Data Arrays” section. It is the second value of the variable “arc_length”, with its value in meters

F. Context Rig

Since testing in the NICU at Erasmus MC is not possible, using all the previously collected data a test bench is set-up that allows for the simulation of most relevant aspects of the NICU. This rig permits for rapid testing and prototyping of ideas and concepts, which should prevent overlooked practical problems from arising later in the concept and embodiment phase.

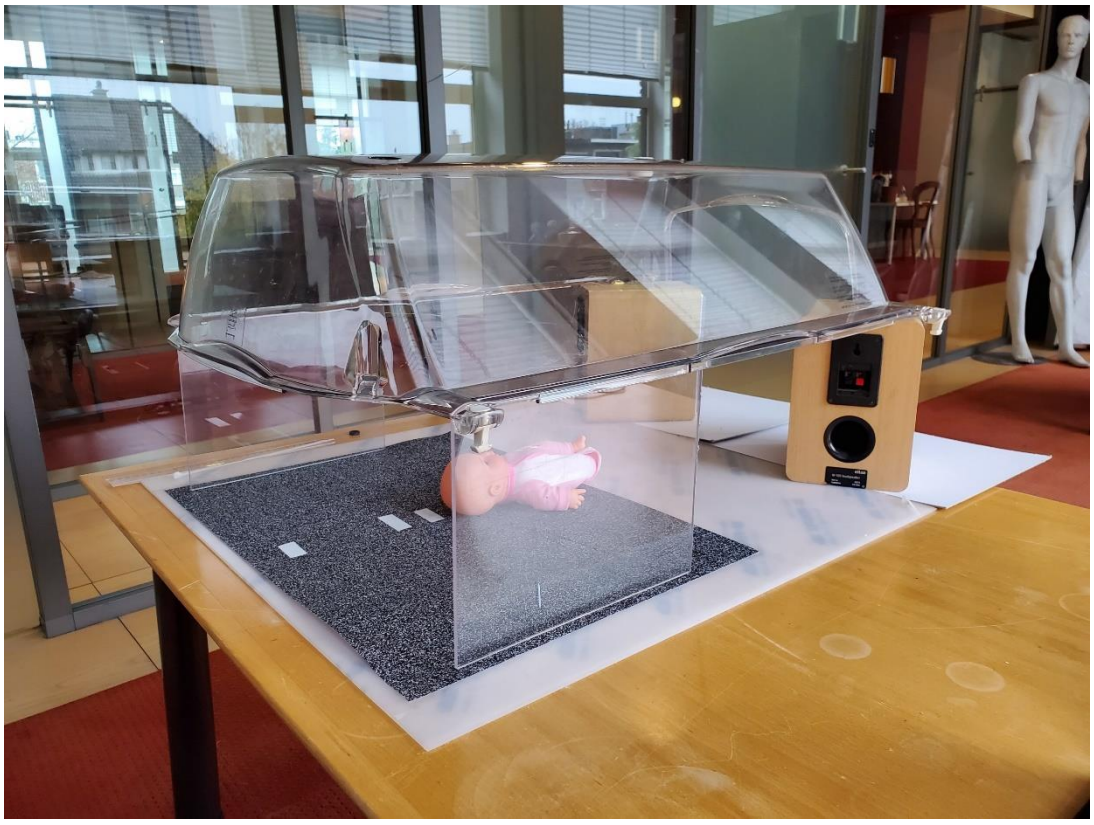
NICU

The first step is recreating the relevant aspects of the NICU. Since it was previously determined that space would not be an issue, only the lighting situation will be considered. In order to recreate multiple lighting conditions, a room of the Vectory3 office featuring two layers of finely adjustable blinds was chosen as the NICU. A quick test with the light meter shows that it is possible adjust the light intensity in the room to the 55.4lux found in the Erasmus MC NICU (figure FIXME, figure FIXME). On a sunny day, a maximum light intensity of 667lux was reached with all blinds open (figure FIXME, figure FIXME), allowing for testing with the 600lux recommended limit. Reducing the light to 0 lux requires a tarp or similar cover be put over the setup, like in the NICU.

Additionally, the table is height adjustable, allowing for quick test regarding ergonomics such as reachability.

Incubator

The most complicated part to replicate is the incubator environment. Erasmus MC lent me a decommissioned hood of one of their current Caleo incubators, for me to build the test rig around (figure FIXME). The scuffed, curved, transparent PC of this hood allows for the testing of the integrity of 3D scans made with various techniques through a realistic non-perfect surface.



In order to simulate the transparent walls of the incubator, 2 flat pieces of plexiglass, 200mm high are glued together and used as sides of the incubator. Since only the view for the scanner must be simulated these plates only have to cover half of each long side of the incubator. The short sides will not be used by the product since incubator designs exist where these ends are made of opaque material.

In initial testing a white sheet is used as a mattress stand-in, featuring the same texture and colour as the actual mattress, allowing for a realistic contrasting background for the scanner. This sheet is replaced by a random noise patterned surface later, which was used for the depth accuracy test of the different D-series cameras.

Infant

Several baby dolls were acquired from Intertoys (figure FIXME). These dolls features a semi-realistic skin texture and colour, allowing for representative testing of the scanner. The circumference of the head of the small doll is 22cm, which corresponds to the lower limit of preterm infants that are to be scanned using this product (24 weeks) (Olsen et al., 2010). The larger doll features a circumference of 26cm (30 weeks). Finally, the largest doll features a circumference of 33cm (37 weeks) the upper possible limit of this device being used. More importantly, this last doll features a darker complexion, allowing the scanner to be tested with multiple ethnicities in mind. All dolls allow the limbs and head of the doll to be rotated to simulate multiple postures found in actual incubators.

Conclusion


Though some liberties had to be taken, the final rig represents the actual situation to a degree where concept prototypes can be validated on it confidently. One area of caution with this rig are the lighting conditions. Though the actual light intensity can be managed to represent the one in the Erasmus MC NICU, the light colour cannot. As can be seen in figures FIXME and FIXME, the blinds used to darken the room have a red colouration, filtering the light and allowing more red light in then other colours.

G. Obtaining Head Circumference

Head circumference of preterm infants is a measurement used to approximate cranial volume, which indicates neurological development of the child (Cheong et al., 2008). Since the product will be based on a 3D scanner, it would be possible to approximate this volume more closely than the 1-dimensional HC measurement can through the analyses of the volume of the model. However, since the current standardized growth curve, the Fenton scale, uses HC as an input and not cranial volume to determine the development of the preterm infant, hospitals are better served with a HC value then the more precise cranial volume. Because of this HC will be the output of the product.

The simplest way to achieve this HC measurement is to have a clear view of the entire circumference of the head. However, as has been described in previous chapters, this is not possible. This chapter describes and compares different techniques that could be used to obtain the HC measurement without having a full round view of the infant's head, using partial 3D models. The method that will be used needs to be determined before product design begins, since it determines what parts of the head needs to be scanned, influencing the layout of the product.

Mirroring

The most straightforward method of obtaining the HC without full head scan is by only scanning one half of the head, and mirror that half to create one whole head model which can be measured (or taking a partial HC using one half and doubling that value). This method requires that the half visible to the scanner lies on an axis of symmetry: If this is not the case (e.g. only the front half (face) of the head is visible) mirroring it will give a wildly inaccurate result for the HC. Therefore, only a side-view of the head can be used for this method.

Advantages

Single acquisition

Only one frame has to be acquired for the HC to be calculated.

Simple processing

The partial HC value obtained from the half-head measurement can simply be doubled to obtain the full HC

Disadvantages

Requires good head orientation

For the mirroring to give an acceptable HC result, the full half of the head must be visible to the scanner. Inaccuracies caused missing geometry on the edges because of obstruction from view are doubled when mirrored.

Multi-scan reconstruction

A method which allows for a closer approximation of the true HC is multi-scan reconstruction. This technique builds on the requirement for preterm infants to have their head repositioned (read: turned) by caretakers multiple times a day to prevent head deformations. This causes a different side of the head to be facing the scanner every time the head is repositioned. Instead of one single scan, multiple scans over time are made and the resulting partial models stitched together to form a (mostly) complete head.

Advantages

Most accurate

Since the actual geometry of the head is used to determine the HC this technique has highest possible accuracy out of the discussed methods.

Robust

Since the model is made-up out of several acquisitions where overlap is possible, no single acquisition has to be perfect. This also allows for obscured areas (for example by tubing) to be filled in by additional acquisitions over time.

Disadvantages

Multi-frame acquisition time

Unlike current tape-based HC measurements where the result is instant, this method requires multiple acquisitions with the wating time between these acquisitions depending on the schedule of the head repositioning of the infant/NICU.

Complex alignment

Since multiple scans from multiple angles over time are to be combined, the alignment and stitching of these scans might prove to be difficult.

Correlated measurements

Using a large dataset of head and facial measurements, a correlation might be found between one or more measurements that are visible to the scanner on a single side of the head, which allows for the HC to be approximated. This would remove the need for a direct HC approximation and could reduce the number of sensors needed if only facial features are required for an acceptable approximation.

Advantages

Less geometry needed

Since the measurements which are correlated to HC are all made on the face-side of the head, no additional cranium geometry (and thus, acquisition) is needed to determine the HC.

Simpler hardware requirements

With the geometry of only the facial area of the head necessary, the scanning hardware could be reduced to only a single sensor facing the infant.

Disadvantages

Insufficient accuracy

Unfortunately, a backwards multiple regression analysis of a dataset of 300 new-born infants (Goto, 2019) found that the best possible correlation between head circumference and other head measurements (Head Height, Height of Chin (SUM - GN), Nose width (AL-AL), Head Breadth, Face length (G-GN), Nose length (SL- SN)) is not accurate enough to be used in a medical setting (R^2 0.602, Std. error 13.28mm).

Feature recognition

Some of the measurements require precise selections of areas on the face. This would most likely have to be done by a human operator, decreasing accuracy due to human error.

Conclusion

Mirroring

Though adequate results should be possible using this method, a near perfect half of the head needs to be scanned for the result to be accurate enough. Since this perfect scan cannot be guaranteed due to the imperfect environment of the preterm infant, this technique is disqualified from implementation.

Multi-scan reconstruction

Multi scan reconstruction combines a robust reconstruction method with high possible accuracy. This means that the technique is better suited for the sometimes-chaotic interior of the incubator. Though scan times are longer than with current and the alternatively proposed methods, the scanner could be designed in such a way that no human interaction is needed during acquisition, eliminating any wating by NICU staff. These advantages and possibilities make this the best choice for this product.

Correlated measurements

Though this technique is promising in regard to the simplicity of acquisition, the accuracy is too low to be used as replacement for the current tape-based HC measurement. This disqualifies this technique from further implementation.

H. Camera Orientation

Though it is established that 3 cameras are the optimal amount for capturing the relevant surface of the infant's head with adequate robustness, the placement of these three cameras is not immediately obvious. Therefore a test setup was made to determine which of three ideated camera positions and orientations would give the best acquisitions. The 24 weeks infant doll was scanned with each setup, after which the three output meshes were compared to the Artec Eva mesh using Cloud Compare.

The Layouts

Three camera layouts were devised, each with their own theoretical strengths. These three were as follows:

Linear Perpendicular

This setup has all three cameras aligned in a semi-circle above the head of the infant. The cameras are not angled towards the infant, but instead placed flat on the incubator panes.

The idea with this setup is that the short distance from the head will give a high resolved detail due to the higher pixel count used for the infant's head. Additionally, because the cameras are placed flat against the incubator panes, no environmental light can cause distortion or other artifacts in the scans.

Linear Angled

This setup still has all three cameras aligned in a semi-circle. However, instead of the setup being positioned above the head of the infant, the setup is placed as far back on the incubator as is possible. Furthermore, instead of being laid flat against the incubator, the cameras are angled towards the infant's head.

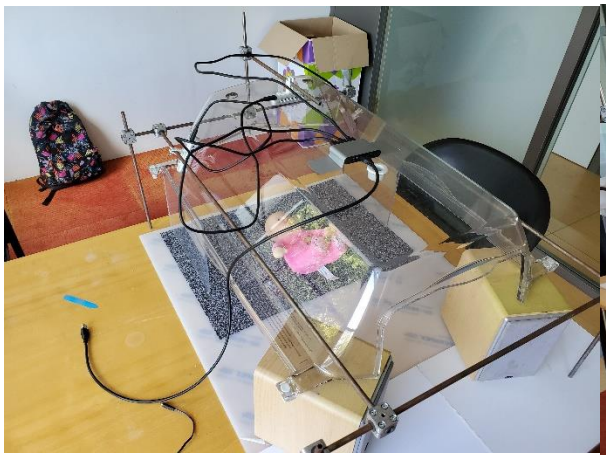
This setup should give a better view of the top of the child's head to the cameras which might increase the accuracy in that area, which is important for any future cranial volume measurements.

Offset Angled

This setup is a hybrid between the Linear Angled and Linear Perpendicular setups. The side cameras are setup like those of the Linear perpendicular setup, meaning that they are positioned practically above the infant's head. These cameras are also placed flat against the incubator panes. The top camera meanwhile is setup like that of the Linear Angled setup, with the camera placed as far back on the incubator as possible while being angled towards the head of the child.

The thought with this setup is that it delivers both the high resolved detail of the Linear Perpendicular setup, as well as capturing more of the top of the head of the infant like the Linear Angled setup.

Test Rig

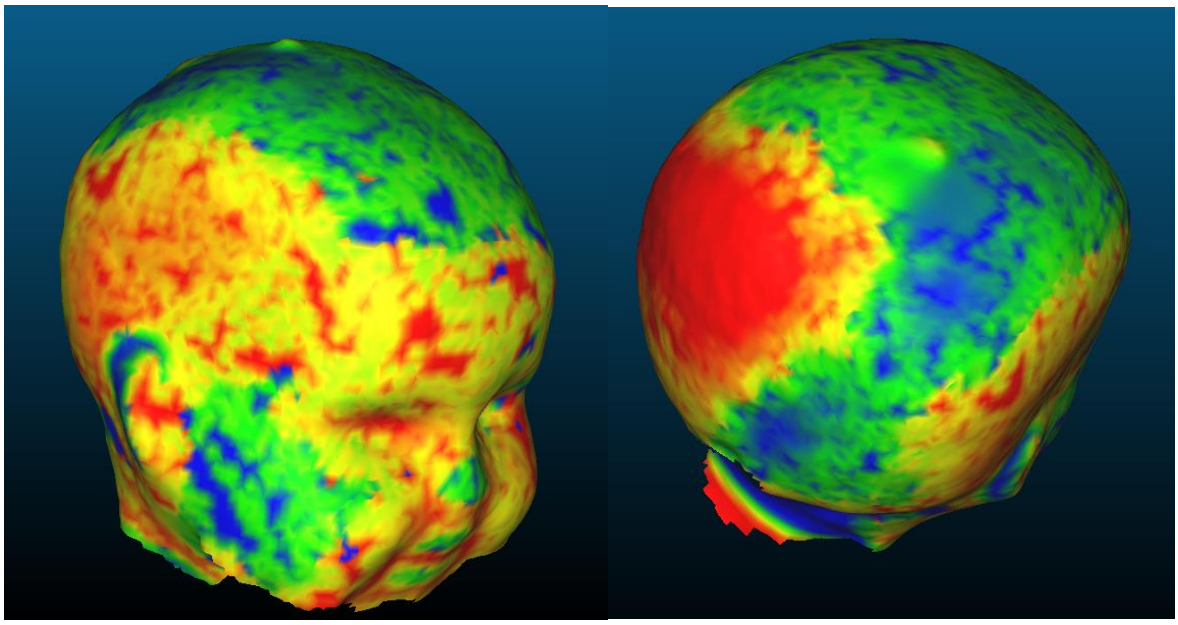



For the test a special setup was built to allow for easy switching between the camera layouts. This setup consisted of steel bars held together by clamps. The cameras were held to these rails with 3D printed mounting hardware.


For the setups where the cameras were not flat against the incubator hood, additional measures were takes to keep out both environmental light, and light generated by the built-in dot-projector, in the shape of covering cloths for environmental light, and cardboard separators which keep the IR light from being reflected back into the lens by the incubator hood.

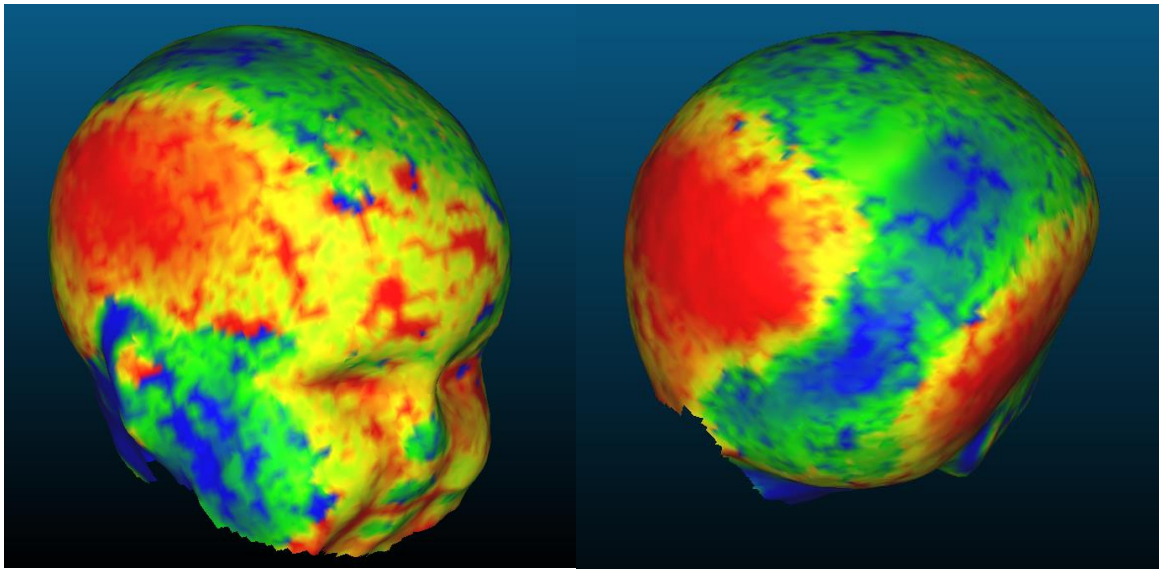
Results

Linear Perpendicular



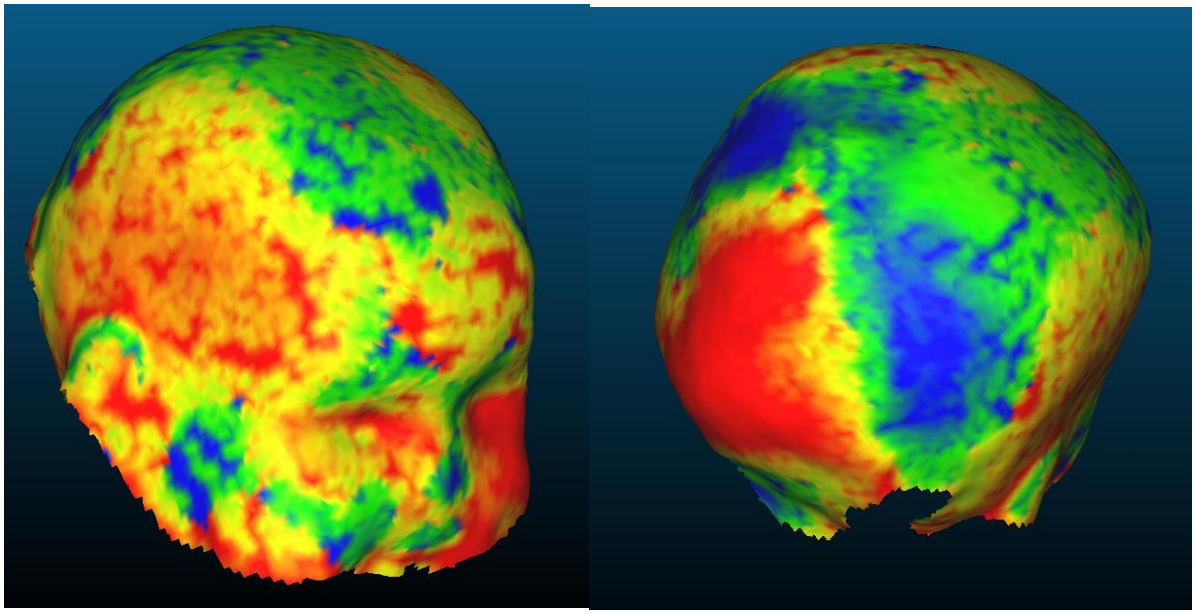
The linear perpendicular setup performed best in this test. Resolved detail is highest and the accuracy too, slightly higher than that of the offset angled setup.

Offset Angled



As can be seen, the offset angled setup performed very close to the linear perpendicular setup. However, resolved detail in the face is reduced, and deviations on the sides of the head are larger than with the linear perpendicular layout.

Linear Angled



This layout performed by far the worst. Resolved detail is significantly lower than with the other layouts, with the face seeming squashed and undefined. Furthermore, large deformations are visible on the back of the head.

Conclusion

The best performing, and thus chosen layout is the linear perpendicular layout. This layout has the most resolved detail an lowest deviation from the Artec model. It is clearly more advantageous to have the closer, and thus higher resolution and depth accuracy, than a larger distance with a better view of a certain part of the head, but at the cost of the overall scan quality.

I. Config file D415

The following contains the contents of the D415_setup.json file:


```
{
    "aux-param-autoexposure-setpoint": "400",
    "aux-param-colorcorrection1": "0.129883",
    "aux-param-colorcorrection10": "-0.441406",
    "aux-param-colorcorrection11": "-0.441406",
    "aux-param-colorcorrection12": "-0.0390625",
    "aux-param-colorcorrection2": "0.399414",
    "aux-param-colorcorrection3": "0.399414",
    "aux-param-colorcorrection4": "-0.0693359",
    "aux-param-colorcorrection5": "-0.198242",
    "aux-param-colorcorrection6": "-0.40332",
    "aux-param-colorcorrection7": "-0.40332",
    "aux-param-colorcorrection8": "1.00586",
    "aux-param-colorcorrection9": "0.921875",
    "aux-param-depthclampmax": "45000",
    "aux-param-depthclampmin": "0",
    "aux-param-disparityshift": "110",
    "controls-autoexposure-auto": "True",
    "controls-autoexposure-manual": "33000",
    "controls-color-autoexposure-auto": "True",
    "controls-color-autoexposure-manual": "156",
    "controls-color-backlight-compensation": "0",
    "controls-color-brightness": "0",
    "controls-color-contrast": "50",
    "controls-color-gain": "64",
    "controls-color-gamma": "300",
    "controls-color-hue": "0",
    "controls-color-power-line-frequency": "3",
```

"controls-color-saturation": "64",

"controls-color-sharpness": "50",

"controls-color-white-balance-auto": "True",

"controls-color-white-balance-manual": "4600",

"controls-depth-gain": "16",

"controls-depth-white-balance-auto": "True",

"controls-laserpower": "180",

"controls-laserstate": "on",

"ignoreSAD": "0",

"param-amplitude-factor": "0",

"param-autoexposure-setpoint": "400",

"param-censusenablereg-udiameter": "9",

"param-censusenablereg-vdiameter": "9",

"param-censususize": "9",

"param-censusvsize": "9",

"param-depthclampmax": "45000",

"param-depthclampmin": "0",

"param-depthunits": "10",

"param-disableraucolor": "0",

"param-disablesadcolor": "0",

"param-disablesadnormalize": "0",

"param-disablesloleftcolor": "0",

"param-disableslorightcolor": "0",

"param-disparitymode": "0",

"param-disparityshift": "110",

"param-lambdaad": "800",

"param-lambdacensus": "26",

"param-leftrightthreshold": "24",

"param-maxscorethreshb": "2047",

"param-medianthreshold": "500",

"param-minscorethresha": "1",

"param-neighborthresh": "7",

"param-raumine": "1",

"param-rauminn": "1",

"param-rauminnssum": "3",

"param-raumins": "1",

"param-rauminw": "1",

"param-rauminwesum": "3",

"param-regioncolorthresholdb": "0.0499022",

"param-regioncolorthresholdg": "0.0499022",

"param-regioncolorthresholdr": "0.0499022",

"param-regionshrinku": "3",

"param-regionshrinkv": "1",

"param-robbinsmonrodecrement": "10",

"param-robbinsmonroincrement": "10",

"param-rsmdiffthreshold": "4",

"param-rsmrauslodiffthreshold": "1",

"param-rsmremovethreshold": "0.375",

"param-scanlineedgetaub": "72",

"param-scanlineedgetaug": "72",

"param-scanlineedgetaur": "72",

"param-scanlinep1": "60",

"param-scanlinep1onediscon": "105",

"param-scanlinep1twodiscon": "70",

"param-scanlinep2": "342",

"param-scanlinep2onediscon": "190",

"param-scanlinep2twodiscon": "130",

"param-secondpeakdelta": "325",

"param-texturecountthresh": "0",

"param-texturedifferencethresh": "0",

"param-usersm": "1",

"param-zunits": "10",

```
    "stream-depth-format": "Z16",
    "stream-fps": "30",
    "stream-height": "720",
    "stream-width": "1280"
}
```

J. Mood boards

This appendix features the mood boards used to determine the aesthetic design of the product. Three mood boards were created. One depicting NICU equipment, one depicting hospital scanning equipment, and one containing professional 3D scanning equipment.

NICU Equipment Board

Medical Scanner Board









3D Scanner Board

K. Mesh Processing Responses

The following pages contain all individual responses to the mesh processing test questionnaire.

Mesh Processing Test

Thank you for participating in the mesh processing test.

In this test, you will be asked to perform multiple steps in the process of reconstructing a 3D scan of an infant's head, for the purpose of taking a measurement of the child's head circumference.

The test will be subdivided into 5 parts: Cutting the mesh, aligning the mesh, cleaning the mesh, re-meshing, and measuring the mesh.

Each part will be accompanied by an instructional video. Questions will be asked about the clarity of the instructions, as well as the ease of the process.

Do not worry about not being able to complete a part. Each part has its own files, so missing one does not affect the others.

Before beginning the test, please download the zip-file using the link below. This zip file contains the necessary programs, as well as the meshes that need to be processed.

https://drive.google.com/uc?export=download&id=12jwjNSfSakkmWSwopE_wBpH4vfFH9kKC

Once downloaded, please unzip the file in an easy to find location. The "Mesh Processing Test" folder contains a folder named "Programs". This "Programs" folder contains two directories, one for MacOS, and one for Windows. Please open the folder corresponding to your computer and install the two programs (MeshLab & ParaView) within.

You may now proceed to the next section

Note: Though email addresses are recorded (for matching file uploads to form responses) data is anonymized before publishing.

Participant info

The following are a few questions aimed at better understanding your experience with 3D software.

What (if any) 3D software have you used before?

- [x] Meshlab
- [x] ParaView
- [ ] CloudCompare
- [x] Solidworks
- [x] Autocad
- [ ] Fusion360
- [x] Blender
- [ ] Rhino
- [x] Cinema4D
- [ ] Other: .....

How would you describe your skill-level in Meshlab? *

	1	2	3	4	5	6	7	
Never used it	○	○	○	○	◉	○	○	Expert

How would you describe your skill-level in ParaView? *

	1	2	3	4	5	6	7	
Never used it	○	○	○	○	◉	○	○	Expert

How would you describe your skill-level with 3D software in general? *

	1	2	3	4	5	6	7	
Never use it	○	○	○	○	○	○	◉	Expert

1. Cutting the mesh

Please watch the instructional video below once before following the steps.

https://youtu.be/G-aGkxKr3ls

After watching once, you may begin following the instructions in the video.

Please time your progress!

Perform these instructions for all three files (Top, Left, Right) in the folder. You may re-watch (parts of) the video at any time during this process.

After completing the task and saving the results, please answer the questions below:

ERRATA:
It has been brought to my attention that on some computers MeshLab will not accept files being dragged into the window. If that is the case for you, please watch the video below, which details an alternative file import method

https://youtu.be/tr8KDFjVnPs

How many minutes did it take to complete this step? *

4

How clear where the instructions given in the video? *

	1	2	3	4	5	6	7	
Very unclear	○	○	○	○	○	○	◉	Very clear

Please motivate your score *

Easy to follow

How difficult was this task? *

	1	2	3	4	5	6	7	
Very easy	◉	○	○	○	○	○	○	Very difficult

Please motivate your score *

No issues, straighforward

What parts of the instructional do you think can be improved? How? *

The tutorial does not spend a lot of time on how to choose what parts of the head to keep and what to delete.
I prefer to listen to tutorials instead of reading on screen text, as I can then do the steps without looking at the video.

What parts of the instructional video did you think were good? Why? *

The tutorial shows where you can find the right buttons. This saves time and effort as the menus are a little complex.

2. Aligning the mesh

Please watch the instructional video below once before following the steps.

https://youtu.be/GA7Vtoq07bs

After watching once, you may begin following the instructions in the video. You may re-watch (parts of) the video at any time during this process.

Please time your progress!

After completing the task and saving the results, please answer the questions below:

ERRATA:
It has been brought to my attention that on some computers MeshLab will not accept files being dragged into the window. If that is the case for you, please watch the video below, which details an alternative file import method

https://youtu.be/Ll4r1D8-S-o

How many minutes did it take to complete this step? *

3

How clear where the instructions given in the video? *

	1	2	3	4	5	6	7	
Very unclear	○	○	○	○	○	○	◉	Very clear

Please motivate your score *

Very clear no hickups

How difficult was this task? *

	1	2	3	4	5	6	7	
Very easy	◉	○	○	○	○	○	○	Very difficult

Please motivate your score *

Striaghtforward

What parts of the instructional do you think can be improved? How? *

I missed the part where it said to double click in the point based alignment.

What parts of the instructional video did you think were good? Why? *

Everything else was clear

3. Cleaning the mesh

Please watch the instructional video below once before following the steps.

https://youtu.be/ZKzdxAPU3W4

After watching once, you may begin following the instructions in the video. You may re-watch (parts of) the video at any time during this process.

Please time your progress!

After completing the task and saving the results, please answer the questions below:

ERRATA:
It has been brought to my attention that on some computers MeshLab will not accept files being dragged into the window. If that is the case for you, please watch the video below, which details an alternative file import method

https://youtu.be/ATpbkHY7YXs

How many minutes did it take to complete this step? *

1

How clear where the instructions given in the video? *

	1	2	3	4	5	6	7	
Very unclear	○	○	○	○	○	○	◉	Very clear

Please motivate your score *

Clear steps

How difficult was this task? *

	1	2	3	4	5	6	7	
Very easy	◉	○	○	○	○	○	○	Very difficult

Please motivate your score *

Straightforward steps

What parts of the instructional do you think can be improved? How? *

NA

What parts of the instructional video did you think were good? Why? *

NA

4. Remeshing

Please watch the instructional video below once before following the steps.

https://youtu.be/UUbchFMgBdc

After watching once, you may begin following the instructions in the video. You may re-watch (parts of) the video at any time during this process.

Please time your progress!

After completing the task and saving the results, please answer the questions below:

ERRATA:
It has been brought to my attention that on some computers MeshLab will not accept files being dragged into the window. If that is the case for you, please watch the video below, which details an alternative file import method

https://youtu.be/QOXBS7_7sko

How many minutes did it take to complete this step? *

0.5

How clear where the instructions given in the video? *

	1	2	3	4	5	6	7	
Very unclear	○	○	○	○	○	○	◉	Very clear

Please motivate your score *

Clear steps and explanation

How difficult was this task? *

	1	2	3	4	5	6	7	
Very easy	◉	○	○	○	○	○	○	Very difficult

Please motivate your score *

Straightforward

What parts of the instructional do you think can be improved? How? *

NA

What parts of the instructional video did you think were good? Why? *

NA

5. Measuring

Please watch the instructional video below once before following the steps.

https://youtu.be/EqsjGsxCtjA

After watching once, you may begin following the instructions in the video. You may re-watch (parts of) the video at any time during this process.

Please time your progress!

After completing the task and saving the results, please answer the questions below:

How many minutes did it take to complete this step? *

1

Please enter the value of the head circumference you measured. *

0.221686

How clear where the instructions given in the video? *

	1	2	3	4	5	6	7	
Very unclear	○	○	○	○	○	○	◉	Very clear

Please motivate your score *

Clear steps

How difficult was this task? *

	1	2	3	4	5	6	7	
Very easy	◉	○	○	○	○	○	○	Very difficult

Please motivate your score *

Straightforward

What parts of the instructional do you think can be improved? How? *

NA

What parts of the instructional video did you think were good? Why? *

Speed of the video is good.

Results

Please go to the "Mesh Processing Test" folder.

In Windows, right-click the "Mesh" folder. Then select "Send to", then "Compressed (zipped folder)".

In MacOS, right-click or two-finger click the "Mesh" folder. Then select "Compress "Mesh""

This creates a "Mesh.zip" file of the folder. Please use the form below to upload this "Mesh.zip" file

Please upload "Mesh.zip" using the form below *

[redacted]

Any final remarks?

Very clear instructions overall, anyone who uses a computer on a regular basis should be able to do this.

Mesh Processing Test

Thank you for participating in the mesh processing test.

In this test, you will be asked to perform multiple steps in the process of reconstructing a 3D scan of an infant's head, for the purpose of taking a measurement of the child's head circumference.

The test will be subdivided into 5 parts: Cutting the mesh, aligning the mesh, cleaning the mesh, re-meshing, and measuring the mesh.

Each part will be accompanied by an instructional video. Questions will be asked about the clarity of the instructions, as well as the ease of the process.

Do not worry about not being able to complete a part. Each part has its own files, so missing one does not affect the others.

Before beginning the test, please download the zip-file using the link below. This zip file contains the necessary programs, as well as the meshes that need to be processed.

https://drive.google.com/uc?export=download&id=12jwjNSfSakkmWSwopE_wBpH4vfFH9kKC

Once downloaded, please unzip the file in an easy to find location. The "Mesh Processing Test" folder contains a folder named "Programs". This "Programs" folder contains two directories, one for MacOS, and one for Windows. Please open the folder corresponding to your computer and install the two programs (MeshLab & ParaView) within.

You may now proceed to the next section

Note: Though email addresses are recorded (for matching file uploads to form responses) data is anonymized before publishing.

Participant info

The following are a few questions aimed at better understanding your experience with 3D software.

What (if any) 3D software have you used before?

- [ ] Meshlab
- [ ] ParaView
- [ ] CloudCompare
- [x] Solidworks
- [ ] Autocad
- [x] Fusion360
- [x] Blender
- [ ] Rhino
- [ ] Cinema4D
- [ ] Other: .....

How would you describe your skill-level in Meshlab? *

	1	2	3	4	5	6	7	
Never used it	◉	○	○	○	○	○	○	Expert

How would you describe your skill-level in ParaView? *

	1	2	3	4	5	6	7	
Never used it	◉	○	○	○	○	○	○	Expert

How would you describe your skill-level with 3D software in general? *

	1	2	3	4	5	6	7	
Never use it	○	○	○	○	◉	○	○	Expert

1. Cutting the mesh

Please watch the instructional video below once before following the steps.

https://youtu.be/G-aGkxKr3ls

After watching once, you may begin following the instructions in the video.

Please time your progress!

Perform these instructions for all three files (Top, Left, Right) in the folder. You may re-watch (parts of) the video at any time during this process.

After completing the task and saving the results, please answer the questions below:

ERRATA:
It has been brought to my attention that on some computers MeshLab will not accept files being dragged into the window. If that is the case for you, please watch the video below, which details an alternative file import method

https://youtu.be/tr8KDFjVnPs

How many minutes did it take to complete this step? *

10

How clear where the instructions given in the video? *

	1	2	3	4	5	6	7	
Very unclear	○	○	○	○	○	○	◉	Very clear

Please motivate your score *

It said you had watch the whole video first but that wasn't really needed as the instruction were very easy to follow. I also did not need the video for the second and third model.

How difficult was this task? *

	1	2	3	4	5	6	7	
Very easy	◉	○	○	○	○	○	○	Very difficult

Please motivate your score *

Very straight forward. You have to remember which options to choose. Most button are in the menu bar so they are easy to find. Only the invert option is buried a bit into the menus but is also very easy find when you have done it multiple times

What parts of the instructional do you think can be improved? How? *

Say if you don't have a middle mouse button, I have a macbook and an apple mouse which both don't have one, that you can use the command button. Don't say you have to watch the whole video because now I thought some planning needed to be done. But the tasks are so straight forward that it is hard to mess up. Maybe change the font and font color so it does not class horribly. I understand you choose the opposite color to the purple background but maybe put a black bar underneath white letters like on youtube.

What parts of the instructional video did you think were good? Why? *

Every part, it explained everything well. Although it was a bit slow for my I can understand that that is very useful for less experienced user and I could just skip trough it faster.

2. Aligning the mesh

Please watch the instructional video below once before following the steps.

https://youtu.be/GA7Vtoq07bs

After watching once, you may begin following the instructions in the video. You may re-watch (parts of) the video at any time during this process.

Please time your progress!

After completing the task and saving the results, please answer the questions below:

ERRATA:
It has been brought to my attention that on some computers MeshLab will not accept files being dragged into the window. If that is the case for you, please watch the video below, which details an alternative file import method

https://youtu.be/Ll4r1D8-S-o

How many minutes did it take to complete this step? *

25

How clear where the instructions given in the video? *

	1	2	3	4	5	6	7	
Very unclear	○	○	◉	○	○	○	○	Very clear

Please motivate your score *

The steps were well explained. But you had to pick the precise points from the video otherwise the mesh would not align at all. I wanted to choose my own point is why it took me so long. It would be nice to know why you place certain points somewhere because it does apparently matter. Also t was not explained hoe to delete your comparison points which would be nice to know as well when someone makes a mistake. Also when I messed up my aligned because I wanted to try it myself the model was broken because it just placed the last model further and further away from my doel when i tried to align it

How difficult was this task? *

	1	2	3	4	5	6	7	
Very easy	○	○	○	○	○	◉	○	Very difficult

Please motivate your score *

See previous answer. But the main point is that I did not know where to place my poi's

What parts of the instructional do you think can be improved? How? *

See previous answers

What parts of the instructional video did you think were good? Why? *

I think all the other steps were clearly explained and very easy to follow. Only the alignment went wrong a lot.

3. Cleaning the mesh

Please watch the instructional video below once before following the steps.

https://youtu.be/ZKzdxAPU3W4

After watching once, you may begin following the instructions in the video. You may re-watch (parts of) the video at any time during this process.

Please time your progress!

After completing the task and saving the results, please answer the questions below:

ERRATA:
It has been brought to my attention that on some computers MeshLab will not accept files being dragged into the window. If that is the case for you, please watch the video below, which details an alternative file import method

https://youtu.be/ATpbkHY7YXs

How many minutes did it take to complete this step? *

6

How clear where the instructions given in the video? *

	1	2	3	4	5	6	7	
Very unclear	○	○	○	○	○	○	◉	Very clear

Please motivate your score *

Easy to follow. I took a bit longer but that was just because I forgot which mesh I cleaned first.

How difficult was this task? *

	1	2	3	4	5	6	7	
Very easy	◉	○	○	○	○	○	○	Very difficult

Please motivate your score *

Just easy to follow an everything went alright

What parts of the instructional do you think can be improved? How? *

The save all files function is not visible on the mac so I did not know for sure I did everything right when saving the file.

What parts of the instructional video did you think were good? Why? *

All of them. Just easy to follow.

4. Remeshing

Please watch the instructional video below once before following the steps.

https://youtu.be/UUbchFMgBdc

After watching once, you may begin following the instructions in the video. You may re-watch (parts of) the video at any time during this process.

Please time your progress!

After completing the task and saving the results, please answer the questions below:

ERRATA:
It has been brought to my attention that on some computers MeshLab will not accept files being dragged into the window. If that is the case for you, please watch the video below, which details an alternative file import method

https://youtu.be/QOXBS7_7sko

How many minutes did it take to complete this step? *

4

How clear where the instructions given in the video? *

	1	2	3	4	5	6	7	
Very unclear	○	○	○	○	○	○	◉	Very clear

Please motivate your score *

You were guided step by step and it was easy to follow even on 1.5 speed

How difficult was this task? *

	1	2	3	4	5	6	7	
Very easy	◉	○	○	○	○	○	○	Very difficult

Please motivate your score *

the explanation was very good which made the task very easy.

What parts of the instructional do you think can be improved? How? *

Small part is that my selected models do not become yellow when I select them. Maybe that is just my version or my operating system, Apple.

What parts of the instructional video did you think were good? Why? *

Every part, they were very clear

5. Measuring

Please watch the instructional video below once before following the steps.

https://youtu.be/EqsjGsxCtjA

After watching once, you may begin following the instructions in the video. You may re-watch (parts of) the video at any time during this process.

Please time your progress!

After completing the task and saving the results, please answer the questions below:

How many minutes did it take to complete this step? *

8

Please enter the value of the head circumference you measured. *

0.22124

How clear where the instructions given in the video? *

	1	2	3	4	5	6	7	
Very unclear	○	○	○	○	◉	○	○	Very clear

Please motivate your score *

The step were clear but I did not understand why the plane was placed in a certain way. From what I saw in the video is that you have to also take the tilt of the model into account but the text did not say that. The other steps were very clear

How difficult was this task? *

	1	2	3	4	5	6	7	
Very easy	◉	○	○	○	○	○	○	Very difficult

Please motivate your score *

It was ecxplained well and the task itself was straight forward.

What parts of the instructional do you think can be improved? How? *

Point out what you need to do with the angle of the head. I also found it useful to use the numbers to level the plain you use to slice the model and than just that afterwards a bit.

What parts of the instructional video did you think were good? Why? *

Every other part then what needs to be improved.

Results

Please go to the "Mesh Processing Test" folder.

In Windows, right-click the "Mesh" folder. Then select "Send to", then "Compressed (zipped folder)".

In MacOS, right-click or two-finger click the "Mesh" folder. Then select "Compress "Mesh""

This creates a "Mesh.zip" file of the folder. Please use the form below to upload this "Mesh.zip" file

[redacted].zip" using the form below *

Any final remarks?

Nice explanation!

Mesh Processing Test

Thank you for participating in the mesh processing test.

In this test, you will be asked to perform multiple steps in the process of reconstructing a 3D scan of an infant's head, for the purpose of taking a measurement of the child's head circumference.

The test will be subdivided into 5 parts: Cutting the mesh, aligning the mesh, cleaning the mesh, re-meshing, and measuring the mesh.

Each part will be accompanied by an instructional video. Questions will be asked about the clarity of the instructions, as well as the ease of the process.

Do not worry about not being able to complete a part. Each part has its own files, so missing one does not affect the others.

Before beginning the test, please download the zip-file using the link below. This zip file contains the necessary programs, as well as the meshes that need to be processed.

https://drive.google.com/uc?export=download&id=12jwjNSfSakkmWSwopE_wBpH4vfFH9kKC

Once downloaded, please unzip the file in an easy to find location. The "Mesh Processing Test" folder contains a folder named "Programs". This "Programs" folder contains two directories, one for MacOS, and one for Windows. Please open the folder corresponding to your computer and install the two programs (MeshLab & ParaView) within.

You may now proceed to the next section

Note: Though email addresses are recorded (for matching file uploads to form responses) data is anonymized before publishing.

Participant info

The following are a few questions aimed at better understanding your experience with 3D software.

What (if any) 3D software have you used before?

- [ ] Meshlab
- [ ] ParaView
- [ ] CloudCompare
- [ ] Solidworks
- [ ] Autocad
- [ ] Fusion360
- [ ] Blender
- [ ] Rhino
- [ ] Cinema4D
- [x] Other: None

How would you describe your skill-level in Meshlab? *

	1	2	3	4	5	6	7	
Never used it	◉	○	○	○	○	○	○	Expert

How would you describe your skill-level in ParaView? *

	1	2	3	4	5	6	7	
Never used it	◉	○	○	○	○	○	○	Expert

How would you describe your skill-level with 3D software in general? *

	1	2	3	4	5	6	7	
Never use it	◉	○	○	○	○	○	○	Expert

1. Cutting the mesh

Please watch the instructional video below once before following the steps.

https://youtu.be/G-aGkxKr3ls

After watching once, you may begin following the instructions in the video.

Please time your progress!

Perform these instructions for all three files (Top, Left, Right) in the folder. You may re-watch (parts of) the video at any time during this process.

After completing the task and saving the results, please answer the questions below:

ERRATA:
It has been brought to my attention that on some computers MeshLab will not accept files being dragged into the window. If that is the case for you, please watch the video below, which details an alternative file import method

https://youtu.be/tr8KDFjVnPs

How many minutes did it take to complete this step? *

8

How clear where the instructions given in the video? *

	1	2	3	4	5	6	7	
Very unclear	○	○	○	○	○	◉	○	Very clear

Please motivate your score *

The text aligned with the actions performed on screen and these actions weren't performed too quickly for an amateur to lose track. I think having voice commentary would have made it even more easy to follow, which is why I'm giving it a 6 instead of a 7.

How difficult was this task? *

	1	2	3	4	5	6	7	
Very easy	○	◉	○	○	○	○	○	Very difficult

Please motivate your score *

As per the instructions, I only had to learn 5 or so actions and had to repeat them 3 times, which wasn't very hard.

What parts of the instructional do you think can be improved? How? *

As said before, I think simple audio commentary might be helpful.

What parts of the instructional video did you think were good? Why? *

The fact that the person using the mouse was performing the actions very slowly made it very easy to copy them myself. The instructional text at the bottom of the video was also very succinct.

2. Aligning the mesh

Please watch the instructional video below once before following the steps.

https://youtu.be/GA7Vtoq07bs

After watching once, you may begin following the instructions in the video. You may re-watch (parts of) the video at any time during this process.

Please time your progress!

After completing the task and saving the results, please answer the questions below:

ERRATA:
It has been brought to my attention that on some computers MeshLab will not accept files being dragged into the window. If that is the case for you, please watch the video below, which details an alternative file import method

https://youtu.be/Ll4r1D8-S-o

How many minutes did it take to complete this step? *

17

How clear where the instructions given in the video? *

	1	2	3	4	5	6	7	
Very unclear	○	○	○	○	○	◉	○	Very clear

Please motivate your score *

Instructions were very clear. Again, with audio I think it would have been a 7.

How difficult was this task? *

	1	2	3	4	5	6	7	
Very easy	○	○	○	○	○	◉	○	Very difficult

Please motivate your score *

Unlike the video, my beautiful baby heads wouldn't align very well. Pressing the Process button only seemed to misalign them further so I eventually simply restarted the task.

What parts of the instructional do you think can be improved? How? *

Add some sweet and sultry commentary

What parts of the instructional video did you think were good? Why? *

Instructions were again very clear, and the slow and deliberate mouse movements were easy to follow.

3. Cleaning the mesh

Please watch the instructional video below once before following the steps.

https://youtu.be/ZKzdxAPU3W4

After watching once, you may begin following the instructions in the video. You may re-watch (parts of) the video at any time during this process.

Please time your progress!

After completing the task and saving the results, please answer the questions below:

ERRATA:
It has been brought to my attention that on some computers MeshLab will not accept files being dragged into the window. If that is the case for you, please watch the video below, which details an alternative file import method

https://youtu.be/ATpbkHY7YXs

How many minutes did it take to complete this step? *

3

How clear where the instructions given in the video? *

	1	2	3	4	5	6	7	
Very unclear	○	○	○	○	○	◉	○	Very clear

Please motivate your score *

As clear as in previous tests.

How difficult was this task? *

	1	2	3	4	5	6	7	
Very easy	◉	○	○	○	○	○	○	Very difficult

Please motivate your score *

The computer did all the work for me. This time it took perhaps 3 button presses to clean up each of the 3 parts.

What parts of the instructional do you think can be improved? How? *

Audio commentary

What parts of the instructional video did you think were good? Why? *

The instructions and mouse movements.

4. Remeshing

Please watch the instructional video below once before following the steps.

https://youtu.be/UUbchFMgBdc

After watching once, you may begin following the instructions in the video. You may re-watch (parts of) the video at any time during this process.

Please time your progress!

After completing the task and saving the results, please answer the questions below:

ERRATA:
It has been brought to my attention that on some computers MeshLab will not accept files being dragged into the window. If that is the case for you, please watch the video below, which details an alternative file import method

https://youtu.be/QOXBS7_7sko

How many minutes did it take to complete this step? *

3

How clear where the instructions given in the video? *

	1	2	3	4	5	6	7	
Very unclear	○	○	○	○	○	◉	○	Very clear

Please motivate your score *

Identical to previous instructional videos: Clear written instructions, aided by a video that aligned to what was being said in those instructions.

How difficult was this task? *

	1	2	3	4	5	6	7	
Very easy	◉	○	○	○	○	○	○	Very difficult

Please motivate your score *

The task itself was very easy to perform with the help of the instructions.

What parts of the instructional do you think can be improved? How? *

Audio instructions

What parts of the instructional video did you think were good? Why? *

The clear written instructions and the slow mouse movements.

5. Measuring

Please watch the instructional video below once before following the steps.

https://youtu.be/EqsjGsxCtjA

After watching once, you may begin following the instructions in the video. You may re-watch (parts of) the video at any time during this process.

Please time your progress!

After completing the task and saving the results, please answer the questions below:

How many minutes did it take to complete this step? *

7

Please enter the value of the head circumference you measured. *

0.221877

How clear where the instructions given in the video? *

	1	2	3	4	5	6	7	
Very unclear	○	○	○	○	○	◉	○	Very clear

Please motivate your score *

Clear written instructions and solid mousework (slow, deliberate movement and not too fast with the clicks so that the viewer can see what you're clicking)

How difficult was this task? *

	1	2	3	4	5	6	7	
Very easy	○	○	◉	○	○	○	○	Very difficult

Please motivate your score *

I found moving and aligning the slicing tool a bit difficult.

What parts of the instructional do you think can be improved? How? *

Adding audio commentary would be helpful

What parts of the instructional video did you think were good? Why? *

The written instructions and mouse movements.

Results

Please go to the "Mesh Processing Test" folder.

In Windows, right-click the "Mesh" folder. Then select "Send to", then "Compressed (zipped folder)".

In MacOS, right-click or two-finger click the "Mesh" folder. Then select "Compress "Mesh""

This creates a "Mesh.zip" file of the folder. Please use the form below to upload this "Mesh.zip" file

P[redacted].zip" using the form below *

Any final remarks?

Mesh Processing Test

Thank you for participating in the mesh processing test.

In this test, you will be asked to perform multiple steps in the process of reconstructing a 3D scan of an infant's head, for the purpose of taking a measurement of the child's head circumference.

The test will be subdivided into 5 parts: Cutting the mesh, aligning the mesh, cleaning the mesh, re-meshing, and measuring the mesh.

Each part will be accompanied by an instructional video. Questions will be asked about the clarity of the instructions, as well as the ease of the process.

Do not worry about not being able to complete a part. Each part has its own files, so missing one does not affect the others.

Before beginning the test, please download the zip-file using the link below. This zip file contains the necessary programs, as well as the meshes that need to be processed.

https://drive.google.com/uc?export=download&id=12jwjNSfSakkmWSwopE_wBpH4vfFH9kKC

Once downloaded, please unzip the file in an easy to find location. The "Mesh Processing Test" folder contains a folder named "Programs". This "Programs" folder contains two directories, one for MacOS, and one for Windows. Please open the folder corresponding to your computer and install the two programs (MeshLab & ParaView) within.

You may now proceed to the next section

Note: Though email addresses are recorded (for matching file uploads to form responses) data is anonymized before publishing.

Participant info

The following are a few questions aimed at better understanding your experience with 3D software.

What (if any) 3D software have you used before?

- [x] Meshlab
- [ ] ParaView
- [ ] CloudCompare
- [x] Solidworks
- [x] Autocad
- [x] Fusion360
- [x] Blender
- [ ] Rhino
- [ ] Cinema4D
- [ ] Other: .....

How would you describe your skill-level in Meshlab? *

	1	2	3	4	5	6	7	
Never used it	○	◉	○	○	○	○	○	Expert

How would you describe your skill-level in ParaView? *

	1	2	3	4	5	6	7	
Never used it	◉	○	○	○	○	○	○	Expert

How would you describe your skill-level with 3D software in general? *

	1	2	3	4	5	6	7	
Never use it	○	○	○	◉	○	○	○	Expert

1. Cutting the mesh

Please watch the instructional video below once before following the steps.

https://youtu.be/G-aGkxKr3ls

After watching once, you may begin following the instructions in the video.

Please time your progress!

Perform these instructions for all three files (Top, Left, Right) in the folder. You may re-watch (parts of) the video at any time during this process.

After completing the task and saving the results, please answer the questions below:

ERRATA:
It has been brought to my attention that on some computers MeshLab will not accept files being dragged into the window. If that is the case for you, please watch the video below, which details an alternative file import method

https://youtu.be/tr8KDFjVnPs

How many minutes did it take to complete this step? *

10

How clear where the instructions given in the video? *

	1	2	3	4	5	6	7	
Very unclear	○	○	○	○	○	◉	○	Very clear

Please motivate your score *

All was clear, didn't know how much of the features in the neck to cut away.

How difficult was this task? *

	1	2	3	4	5	6	7	
Very easy	○	◉	○	○	○	○	○	Very difficult

Please motivate your score *

The task was easy and unambiguous, a little tedious and repetitive. No support for Linux was supplied but the Meshlab AppImage worked flawlessly.

What parts of the instructional do you think can be improved? How? *

More in depth info about how much of the 3D scan artifacts should be cut away.

What parts of the instructional video did you think were good? Why? *

The speed of the video and subtitles were good, it was easy to scroll through the video at your own pace.

2. Aligning the mesh

Please watch the instructional video below once before following the steps.

https://youtu.be/GA7Vtoq07bs

After watching once, you may begin following the instructions in the video. You may re-watch (parts of) the video at any time during this process.

Please time your progress!

After completing the task and saving the results, please answer the questions below:

ERRATA:
It has been brought to my attention that on some computers MeshLab will not accept files being dragged into the window. If that is the case for you, please watch the video below, which details an alternative file import method

https://youtu.be/Ll4r1D8-S-o

How many minutes did it take to complete this step? *

12

How clear where the instructions given in the video? *

	1	2	3	4	5	6	7	
Very unclear	○	○	○	○	○	○	◉	Very clear

Please motivate your score *

Very clear what to do, I had no doubts or questions whatsoever

How difficult was this task? *

	1	2	3	4	5	6	7	
Very easy	◉	○	○	○	○	○	○	Very difficult

Please motivate your score *

Very easy because the task was short and repetitive.

What parts of the instructional do you think can be improved? How? *

Explaining that selecting the points doesn't require critical precision before processing.

What parts of the instructional video did you think were good? Why? *

Good that you show the repeat step to show that it is in fact the same.

3. Cleaning the mesh

Please watch the instructional video below once before following the steps.

https://youtu.be/ZKzdxAPU3W4

After watching once, you may begin following the instructions in the video. You may re-watch (parts of) the video at any time during this process.

Please time your progress!

After completing the task and saving the results, please answer the questions below:

ERRATA:
It has been brought to my attention that on some computers MeshLab will not accept files being dragged into the window. If that is the case for you, please watch the video below, which details an alternative file import method

https://youtu.be/ATpbkHY7YXs

How many minutes did it take to complete this step? *

7

How clear where the instructions given in the video? *

	1	2	3	4	5	6	7	
Very unclear	○	○	○	○	○	○	◉	Very clear

Please motivate your score *

Super clear, nothing to add

How difficult was this task? *

	1	2	3	4	5	6	7	
Very easy	◉	○	○	○	○	○	○	Very difficult

Please motivate your score *

very easy and short

What parts of the instructional do you think can be improved? How? *

Nothing

What parts of the instructional video did you think were good? Why? *

Clarity of the instructional text makes it very quick to skip through

4. Remeshing

Please watch the instructional video below once before following the steps.

https://youtu.be/UUbchFMgBdc

After watching once, you may begin following the instructions in the video. You may re-watch (parts of) the video at any time during this process.

Please time your progress!

After completing the task and saving the results, please answer the questions below:

ERRATA:
It has been brought to my attention that on some computers MeshLab will not accept files being dragged into the window. If that is the case for you, please watch the video below, which details an alternative file import method

https://youtu.be/QOXBS7_7sko

How many minutes did it take to complete this step? *

5

How clear where the instructions given in the video? *

	1	2	3	4	5	6	7	
Very unclear	○	○	○	○	○	○	◉	Very clear

Please motivate your score *

Clear and concise

How difficult was this task? *

	1	2	3	4	5	6	7	
Very easy	◉	○	○	○	○	○	○	Very difficult

Please motivate your score *

Super simple task

What parts of the instructional do you think can be improved? How? *

None

What parts of the instructional video did you think were good? Why? *

The duration was nice and short

5. Measuring

Please watch the instructional video below once before following the steps.

https://youtu.be/EqsjGsxCtjA

After watching once, you may begin following the instructions in the video. You may re-watch (parts of) the video at any time during this process.

Please time your progress!

After completing the task and saving the results, please answer the questions below:

How many minutes did it take to complete this step? *

15

Please enter the value of the head circumference you measured. *

0.22135

How clear where the instructions given in the video? *

	1	2	3	4	5	6	7	
Very unclear	○	○	○	○	○	◉	○	Very clear

Please motivate your score *

The interface was more complex and foreign than that of MeshLab

How difficult was this task? *

	1	2	3	4	5	6	7	
Very easy	○	◉	○	○	○	○	○	Very difficult

Please motivate your score *

It was very easy still

What parts of the instructional do you think can be improved? How? *

Tell me why the last couple of filters are applied and what they do, I felt like an NPC

What parts of the instructional video did you think were good? Why? *

Clear as always

Results

Please go to the "Mesh Processing Test" folder.

In Windows, right-click the "Mesh" folder. Then select "Send to", then "Compressed (zipped folder)".

In MacOS, right-click or two-finger click the "Mesh" folder. Then select "Compress "Mesh""

This creates a "Mesh.zip" file of the folder. Please use the form below to upload this "Mesh.zip" file

Please upload "Mesh.zip" using the form below *

[redacted]

Any final remarks?

Nice work with the scanner and I salute you for using open source software.

Mesh Processing Test

Thank you for participating in the mesh processing test.

In this test, you will be asked to perform multiple steps in the process of reconstructing a 3D scan of an infant's head, for the purpose of taking a measurement of the child's head circumference.

The test will be subdivided into 5 parts: Cutting the mesh, aligning the mesh, cleaning the mesh, re-meshing, and measuring the mesh.

Each part will be accompanied by an instructional video. Questions will be asked about the clarity of the instructions, as well as the ease of the process.

Do not worry about not being able to complete a part. Each part has its own files, so missing one does not affect the others.

Before beginning the test, please download the zip-file using the link below. This zip file contains the necessary programs, as well as the meshes that need to be processed.

https://drive.google.com/uc?export=download&id=12jwjNSfSakkmWSwopE_wBpH4vfFH9kKC

Once downloaded, please unzip the file in an easy to find location. The "Mesh Processing Test" folder contains a folder named "Programs". This "Programs" folder contains two directories, one for MacOS, and one for Windows. Please open the folder corresponding to your computer and install the two programs (MeshLab & ParaView) within.

You may now proceed to the next section

Note: Though email addresses are recorded (for matching file uploads to form responses) data is anonymized before publishing.

Participant info

The following are a few questions aimed at better understanding your experience with 3D software.

What (if any) 3D software have you used before?

- [ ] Meshlab
- [ ] ParaView
- [ ] CloudCompare
- [x] Solidworks
- [ ] Autocad
- [ ] Fusion360
- [x] Blender
- [ ] Rhino
- [ ] Cinema4D
- [ ] Other: .....

How would you describe your skill-level in Meshlab? *

	1	2	3	4	5	6	7	
Never used it	◉	○	○	○	○	○	○	Expert

How would you describe your skill-level in ParaView? *

	1	2	3	4	5	6	7	
Never used it	◉	○	○	○	○	○	○	Expert

How would you describe your skill-level with 3D software in general? *

	1	2	3	4	5	6	7	
Never use it	○	○	○	○	◉	○	○	Expert

1. Cutting the mesh

Please watch the instructional video below once before following the steps.

https://youtu.be/G-aGkxKr3ls

After watching once, you may begin following the instructions in the video.

Please time your progress!

Perform these instructions for all three files (Top, Left, Right) in the folder. You may re-watch (parts of) the video at any time during this process.

After completing the task and saving the results, please answer the questions below:

ERRATA:
It has been brought to my attention that on some computers MeshLab will not accept files being dragged into the window. If that is the case for you, please watch the video below, which details an alternative file import method

https://youtu.be/tr8KDFjVnPs

How many minutes did it take to complete this step? *

4

How clear where the instructions given in the video? *

	1	2	3	4	5	6	7	
Very unclear	○	○	○	○	○	○	◉	Very clear

Please motivate your score *

Clear instructions, no problems encountered while performing the task

How difficult was this task? *

	1	2	3	4	5	6	7	
Very easy	○	◉	○	○	○	○	○	Very difficult

Please motivate your score *

Not difficult at all.

What parts of the instructional do you think can be improved? How? *

I expected also sound. In general, when I'm following atutorial, I let it play in the background and listen to the tutor while following along simultaneously.

What parts of the instructional video did you think were good? Why? *

Everything else was good, there were not any unclear things.

2. Aligning the mesh

Please watch the instructional video below once before following the steps.

https://youtu.be/GA7Vtoq07bs

After watching once, you may begin following the instructions in the video. You may re-watch (parts of) the video at any time during this process.

Please time your progress!

After completing the task and saving the results, please answer the questions below:

ERRATA:
It has been brought to my attention that on some computers MeshLab will not accept files being dragged into the window. If that is the case for you, please watch the video below, which details an alternative file import method

https://youtu.be/Ll4r1D8-S-o

How many minutes did it take to complete this step? *

2.20

How clear where the instructions given in the video? *

	1	2	3	4	5	6	7	
Very unclear	○	○	○	○	○	○	◉	Very clear

Please motivate your score *

No issues encountered

How difficult was this task? *

	1	2	3	4	5	6	7	
Very easy	○	○	◉	○	○	○	○	Very difficult

Please motivate your score *

The only (slight) difficulty was carefully selecting the corresponding points on two to be aligned meshes. The rest was easy.

What parts of the instructional do you think can be improved? How? *

Maybe the sound again. Also because I was trying to read the subtitles and looking at your cursor in the tutorial at the same time

What parts of the instructional video did you think were good? Why? *

All remaining parts of the video were very clear.

3. Cleaning the mesh

Please watch the instructional video below once before following the steps.

https://youtu.be/ZKzdxAPU3W4

After watching once, you may begin following the instructions in the video. You may re-watch (parts of) the video at any time during this process.

Please time your progress!

After completing the task and saving the results, please answer the questions below:

ERRATA:
It has been brought to my attention that on some computers MeshLab will not accept files being dragged into the

window. If that is the case for you, please watch the video below, which details an alternative file import method

https://youtu.be/ATpbkHY7YXs

How many minutes did it take to complete this step? *

1.03

How clear where the instructions given in the video? *

	1	2	3	4	5	6	7	
Very unclear	○	○	○	○	○	○	◉	Very clear

Please motivate your score *

Very straightforward actions to perform the task

How difficult was this task? *

	1	2	3	4	5	6	7	
Very easy	◉	○	○	○	○	○	○	Very difficult

Please motivate your score *

It was just clicking at the right buttons, not carefully aligning meshes or selecting vertices.

What parts of the instructional do you think can be improved? How? *

Nothing

What parts of the instructional video did you think were good? Why? *

It was all very clear.

4. Remeshing

Please watch the instructional video below once before following the steps.

https://youtu.be/UUbchFMgBdc

After watching once, you may begin following the instructions in the video. You may re-watch (parts of) the video at any time during this process.

Please time your progress!

After completing the task and saving the results, please answer the questions below:

ERRATA:
It has been brought to my attention that on some computers MeshLab will not accept files being dragged into the window. If that is the case for you, please watch the video below, which details an alternative file import method

https://youtu.be/QOXBS7_7sko

How many minutes did it take to complete this step? *

0.57

How clear where the instructions given in the video? *

	1	2	3	4	5	6	7	
Very unclear	○	○	○	○	○	○	◉	Very clear

Please motivate your score *

No issues

How difficult was this task? *

	1	2	3	4	5	6	7	
Very easy	○	◉	○	○	○	○	○	Very difficult

Please motivate your score *

Not difficult if you can find the right filter right away. Still, I had to look at the video again to make sure that the values of the filter were correct, so that took an extra 10-15 seconds. Furthermore, the task was easy.

What parts of the instructional do you think can be improved? How? *

Maybe saying that the default values in the filter are already the ones you need to use. But these default values might change when a user uses meshlab for more purposes, so not certain if this is the right way to go.

What parts of the instructional video did you think were good? Why? *

The rest was all good

5. Measuring

Please watch the instructional video below once before following the steps.

https://youtu.be/EqsjGsxCtjA

After watching once, you may begin following the instructions in the video. You may re-watch (parts of) the video at any time during this process.

Please time your progress!

After completing the task and saving the results, please answer the questions below:

How many minutes did it take to complete this step? *

1.20

Please enter the value of the head circumference you measured. *

0.221632

How clear where the instructions given in the video? *

	1	2	3	4	5	6	7	
Very unclear	○	○	○	○	○	○	◉	Very clear

Please motivate your score *

All clear.

How difficult was this task? *

	1	2	3	4	5	6	7	
Very easy	○	○	◉	○	○	○	○	Very difficult

Please motivate your score *

Positioning the slicing plane was a bit of a hassle, but I managed to get it right. The rest was easy.

What parts of the instructional do you think can be improved? How? *

Nothing

What parts of the instructional video did you think were good? Why? *

Everything was clear.

Results

Please go to the "Mesh Processing Test" folder.

In Windows, right-click the "Mesh" folder. Then select "Send to", then "Compressed (zipped folder)".

In MacOS, right-click or two-finger click the "Mesh" folder. Then select "Compress "Mesh""

This creates a "Mesh.zip" file of the folder. Please use the form below to upload this "Mesh.zip" file

Please upload "Mesh.zip" using the form below *

Any final remarks?

I found that on MacOS I could not save projects (when I clicked save project I could click through the saving dialog, but then no file was created afterwards). Hence, I switched to Windows and had no further issues.

Mesh Processing Test

Thank you for participating in the mesh processing test.

In this test, you will be asked to perform multiple steps in the process of reconstructing a 3D scan of an infant's head, for the purpose of taking a measurement of the child's head circumference.

The test will be subdivided into 5 parts: Cutting the mesh, aligning the mesh, cleaning the mesh, re-meshing, and measuring the mesh.

Each part will be accompanied by an instructional video. Questions will be asked about the clarity of the instructions, as well as the ease of the process.

Do not worry about not being able to complete a part. Each part has its own files, so missing one does not affect the others.

Before beginning the test, please download the zip-file using the link below. This zip file contains the necessary programs, as well as the meshes that need to be processed.

https://drive.google.com/uc?export=download&id=12jwjNSfSakkmWSwopE_wBpH4vfFH9kKC

Once downloaded, please unzip the file in an easy to find location. The "Mesh Processing Test" folder contains a folder named "Programs". This "Programs" folder contains two directories, one for MacOS, and one for Windows. Please open the folder corresponding to your computer and install the two programs (MeshLab & ParaView) within.

You may now proceed to the next section

Note: Though email addresses are recorded (for matching file uploads to form responses) data is anonymized before publishing.

Participant info

The following are a few questions aimed at better understanding your experience with 3D software.

What (if any) 3D software have you used before?

- [ ] Meshlab
- [x] ParaView
- [ ] CloudCompare
- [x] Solidworks
- [ ] Autocad
- [ ] Fusion360
- [ ] Blender
- [ ] Rhino
- [ ] Cinema4D
- [ ] Other: .....

How would you describe your skill-level in Meshlab? *

	1	2	3	4	5	6	7	
Never used it	◉	○	○	○	○	○	○	Expert

How would you describe your skill-level in ParaView? *

	1	2	3	4	5	6	7	
Never used it	○	◉	○	○	○	○	○	Expert

How would you describe your skill-level with 3D software in general? *

	1	2	3	4	5	6	7	
Never use it	○	○	○	○	◉	○	○	Expert

1. Cutting the mesh

Please watch the instructional video below once before following the steps.

https://youtu.be/G-aGkxKr3ls

After watching once, you may begin following the instructions in the video.

Please time your progress!

Perform these instructions for all three files (Top, Left, Right) in the folder. You may re-watch (parts of) the video at any time during this process.

After completing the task and saving the results, please answer the questions below:

ERRATA:
It has been brought to my attention that on some computers MeshLab will not accept files being dragged into the window. If that is the case for you, please watch the video below, which details an alternative file import method

https://youtu.be/tr8KDFjVnPs

How many minutes did it take to complete this step? *

12

How clear where the instructions given in the video? *

	1	2	3	4	5	6	7	
Very unclear	○	○	○	○	○	◉	○	Very clear

Please motivate your score *

It was clear what to do, where to find the tools. I would have prefereered a voice over, just so that I could play the video while doing some of the steps.

How difficult was this task? *

	1	2	3	4	5	6	7	
Very easy	○	◉	○	○	○	○	○	Very difficult

Please motivate your score *

Once you know where to find the tools, the task didn't require a lot of active thinking afterwards.

What parts of the instructional do you think can be improved? How? *

So an extra voice over would be nice, especially for rewatching.

What parts of the instructional video did you think were good? Why? *

All the small steps were explained, like in which menu you can find certain tools. That makes me feel not like an idiot

2. Aligning the mesh

Please watch the instructional video below once before following the steps.

https://youtu.be/GA7Vtoq07bs

After watching once, you may begin following the instructions in the video. You may re-watch (parts of) the video at any time during this process.

Please time your progress!

After completing the task and saving the results, please answer the questions below:

ERRATA:
It has been brought to my attention that on some computers MeshLab will not accept files being dragged into the window. If that is the case for you, please watch the video below, which details an alternative file import method

https://youtu.be/Ll4r1D8-S-o

How many minutes did it take to complete this step? *

8

How clear where the instructions given in the video? *

	1	2	3	4	5	6	7	
Very unclear	○	○	○	○	◉	○	○	Very clear

Please motivate your score *

Again, the explanation was very well done, I was only missing tips on what points where the best to allign.

How difficult was this task? *

	1	2	3	4	5	6	7	
Very easy	○	○	○	◉	○	○	○	Very difficult

Please motivate your score *

It required some intense looking at the screen, but it was not active thinking

What parts of the instructional do you think can be improved? How? *

Again, voice over, and the tips on what points are the best to allign

What parts of the instructional video did you think were good? Why? *

I am really digging the small steps in between

3. Cleaning the mesh

Please watch the instructional video below once before following the steps.

https://youtu.be/ZKzdxAPU3W4

After watching once, you may begin following the instructions in the video. You may re-watch (parts of) the video at any time during this process.

Please time your progress!

After completing the task and saving the results, please answer the questions below:

ERRATA:
It has been brought to my attention that on some computers MeshLab will not accept files being dragged into the window. If that is the case for you, please watch the video below, which details an alternative file import method

https://youtu.be/ATpbkHY7YXs

How many minutes did it take to complete this step? *

4

How clear where the instructions given in the video? *

	1	2	3	4	5	6	7	
Very unclear	○	○	○	○	○	○	◉	Very clear

Please motivate your score *

It was simple clicking around, and it was helpful that it was explained why you had to do certain steps

How difficult was this task? *

	1	2	3	4	5	6	7	
Very easy	◉	○	○	○	○	○	○	Very difficult

Please motivate your score *

It was simple clicking around

What parts of the instructional do you think can be improved? How? *

(voice over) but nothing really else

What parts of the instructional video did you think were good? Why? *

The explaining small steps and the reasoning behind them, it makes it easy to follow while also feeling like you're learning

4. Remeshing

Please watch the instructional video below once before following the steps.

https://youtu.be/UUbchFMgBdc

After watching once, you may begin following the instructions in the video. You may re-watch (parts of) the video at any time during this process.

Please time your progress!

After completing the task and saving the results, please answer the questions below:

ERRATA:
It has been brought to my attention that on some computers MeshLab will not accept files being dragged into the window. If that is the case for you, please watch the video below, which details an alternative file import method

https://youtu.be/QOXBS7_7sko

How many minutes did it take to complete this step? *

3

How clear where the instructions given in the video? *

	1	2	3	4	5	6	7	
Very unclear	○	○	○	○	○	○	◉	Very clear

Please motivate your score *

Simple clicking, same as the last question

How difficult was this task? *

	1	2	3	4	5	6	7	
Very easy	◉	○	○	○	○	○	○	Very difficult

Please motivate your score *

Finding the filter was the only "hard" thing to do in this task

What parts of the instructional do you think can be improved? How? *

(voice over maybe) But nothing I can think of right now

What parts of the instructional video did you think were good? Why? *

The whole thing :)

5. Measuring

Please watch the instructional video below once before following the steps.

https://youtu.be/EqsjGsxCtjA

After watching once, you may begin following the instructions in the video. You may re-watch (parts of) the video at any time during this process.

Please time your progress!

After completing the task and saving the results, please answer the questions below:

How many minutes did it take to complete this step? *

4.30

Please enter the value of the head circumference you measured. *

0.221216

How clear where the instructions given in the video? *

	1	2	3	4	5	6	7	
Very unclear	○	○	○	○	○	◉	○	Very clear

Please motivate your score *

It again showed where everything is, but here I was missing the reasoning behind the filters

How difficult was this task? *

	1	2	3	4	5	6	7	
Very easy	◉	○	○	○	○	○	○	Very difficult

Please motivate your score *

It went very smooth, no complaints where

What parts of the instructional do you think can be improved? How? *

Some extra reasoning behind the filters

What parts of the instructional video did you think were good? Why? *

All of it, it was really clear :)

Results

Please go to the "Mesh Processing Test" folder.

In Windows, right-click the "Mesh" folder. Then select "Send to", then "Compressed (zipped folder)".

In MacOS, right-click or two-finger click the "Mesh" folder. Then select "Compress "Mesh""

This creates a "Mesh.zip" file of the folder. Please use the form below to upload this "Mesh.zip" file

Please upload "Mesh.zip" using the form below *

[redacted]

Any final remarks?

I really like the videos and the project :)

Mesh Processing Test

Thank you for participating in the mesh processing test.

In this test, you will be asked to perform multiple steps in the process of reconstructing a 3D scan of an infant's head, for the purpose of taking a measurement of the child's head circumference.

The test will be subdivided into 5 parts: Cutting the mesh, aligning the mesh, cleaning the mesh, re-meshing, and measuring the mesh.

Each part will be accompanied by an instructional video. Questions will be asked about the clarity of the instructions, as well as the ease of the process.

Do not worry about not being able to complete a part. Each part has its own files, so missing one does not affect the others.

Before beginning the test, please download the zip-file using the link below. This zip file contains the necessary programs, as well as the meshes that need to be processed.

https://drive.google.com/uc?export=download&id=12jwjNSfSakkmWSwopE_wBpH4vfFH9kKC

Once downloaded, please unzip the file in an easy to find location. The "Mesh Processing Test" folder contains a folder named "Programs". This "Programs" folder contains two directories, one for MacOS, and one for Windows. Please open the folder corresponding to your computer and install the two programs (MeshLab & ParaView) within.

You may now proceed to the next section

Note: Though email addresses are recorded (for matching file uploads to form responses) data is anonymized before publishing.

Participant info

The following are a few questions aimed at better understanding your experience with 3D software.

What (if any) 3D software have you used before?

- [x] Meshlab
- [ ] ParaView
- [ ] CloudCompare
- [x] Solidworks
- [ ] Autocad
- [ ] Fusion360
- [ ] Blender
- [ ] Rhino
- [ ] Cinema4D
- [ ] Other: .....

How would you describe your skill-level in Meshlab? *

	1	2	3	4	5	6	7	
Never used it	○	◉	○	○	○	○	○	Expert

How would you describe your skill-level in ParaView? *

	1	2	3	4	5	6	7	
Never used it	◉	○	○	○	○	○	○	Expert

How would you describe your skill-level with 3D software in general? *

	1	2	3	4	5	6	7	
Never use it	○	○	○	○	○	◉	○	Expert

1. Cutting the mesh

Please watch the instructional video below once before following the steps.

https://youtu.be/G-aGkxKr3ls

After watching once, you may begin following the instructions in the video.

Please time your progress!

Perform these instructions for all three files (Top, Left, Right) in the folder. You may re-watch (parts of) the video at any time during this process.

After completing the task and saving the results, please answer the questions below:

ERRATA:
It has been brought to my attention that on some computers MeshLab will not accept files being dragged into the window. If that is the case for you, please watch the video below, which details an alternative file import method

https://youtu.be/tr8KDFjVnPs

How many minutes did it take to complete this step? *

12

How clear where the instructions given in the video? *

	1	2	3	4	5	6	7	
Very unclear	○	○	○	○	○	○	◉	Very clear

Please motivate your score *

I could find all relevant tools in the app

How difficult was this task? *

	1	2	3	4	5	6	7	
Very easy	○	○	○	○	○	◉	○	Very difficult

Please motivate your score *

difficult to rotate the mesh to get the right orientation to cut with the retangle; not sure what/how much to cut of the edges

What parts of the instructional do you think can be improved? How? *

more tips on how you can rotate/ navigate the part; more tips on what to cut of the edges

What parts of the instructional video did you think were good? Why? *

to use invert selection, that is a big step to delete most of the unwanted part; that you can switch between invert and just select and delete later on.

2. Aligning the mesh

Please watch the instructional video below once before following the steps.

https://youtu.be/GA7Vtoq07bs

After watching once, you may begin following the instructions in the video. You may re-watch (parts of) the video at any time during this process.

Please time your progress!

After completing the task and saving the results, please answer the questions below:

ERRATA:
It has been brought to my attention that on some computers MeshLab will not accept files being dragged into the window. If that is the case for you, please watch the video below, which details an alternative file import method

https://youtu.be/Ll4r1D8-S-o

How many minutes did it take to complete this step? *

11

How clear where the instructions given in the video? *

	1	2	3	4	5	6	7	
Very unclear	○	○	○	○	○	○	◉	Very clear

Please motivate your score *

easy to find the tools in the app

How difficult was this task? *

	1	2	3	4	5	6	7	
Very easy	○	○	○	○	○	○	◉	Very difficult

Please motivate your score *

first set: it did not work at first attempt. although it seemed that i selected corresponding points, it glued it at a differnt position. second set: did not work at all, had to do 3 attempts, first 2 did not gave an overlapping glue. third attempt (5 points selected) give overlapping glue, but not correctly

What parts of the instructional do you think can be improved? How? *

how to correct when first attempt give no overlapping glue. may be an alternative way to glue. not sure if there is sound in the video (i expected a voice over), so maybe some background music or voice over.

What parts of the instructional video did you think were good? Why? *

in general instructions were clearly visualized

3. Cleaning the mesh

Please watch the instructional video below once before following the steps.

https://youtu.be/ZKzdxAPU3W4

After watching once, you may begin following the instructions in the video. You may re-watch (parts of) the video at any time during this process.

Please time your progress!

After completing the task and saving the results, please answer the questions below:

ERRATA:
It has been brought to my attention that on some computers MeshLab will not accept files being dragged into the window. If that is the case for you, please watch the video below, which details an alternative file import method

https://youtu.be/ATpbkHY7YXs

How many minutes did it take to complete this step? *

3

How clear where the instructions given in the video? *

	1	2	3	4	5	6	7	
Very unclear	○	○	○	○	○	◉	○	Very clear

Please motivate your score *

all was clear

How difficult was this task? *

	1	2	3	4	5	6	7	
Very easy	○	○	○	○	○	◉	○	Very difficult

Please motivate your score *

The script did not give a good result!!!! each mesh got a weird long extra ridge attached. Do not know how to correct this. Not clear that script will effect the selected mesh, even when it is unvisible

What parts of the instructional do you think can be improved? How? *

make clear that script effect the selected mesh

What parts of the instructional video did you think were good? Why? *

steps clearly visualized

4. Remeshing

Please watch the instructional video below once before following the steps.

https://youtu.be/UUbchFMgBdc

After watching once, you may begin following the instructions in the video. You may re-watch (parts of) the video at any time during this process.

Please time your progress!

After completing the task and saving the results, please answer the questions below:

ERRATA:
It has been brought to my attention that on some computers MeshLab will not accept files being dragged into the window. If that is the case for you, please watch the video below, which details an alternative file import method

https://youtu.be/QOXBS7_7sko

How many minutes did it take to complete this step? *

4

How clear where the instructions given in the video? *

	1	2	3	4	5	6	7	
Very unclear	○	○	○	○	○	◉	○	Very clear

Please motivate your score *

difficult to find the right tool in a long list

How difficult was this task? *

	1	2	3	4	5	6	7	
Very easy	◉	○	○	○	○	○	○	Very difficult

Please motivate your score *

no problems

What parts of the instructional do you think can be improved? How? *

to zoom in on the long list

What parts of the instructional video did you think were good? Why? *

in general all was clear

5. Measuring

Please watch the instructional video below once before following the steps.

https://youtu.be/EqsjGsxCtjA

After watching once, you may begin following the instructions in the video. You may re-watch (parts of) the video at any time during this process.

Please time your progress!

After completing the task and saving the results, please answer the questions below:

How many minutes did it take to complete this step? *

3

Please enter the value of the head circumference you measured. *

0.221

How clear where the instructions given in the video? *

	1	2	3	4	5	6	7	
Very unclear	○	○	○	○	○	○	◉	Very clear

Please motivate your score *

all clear. but the user interface and amount of steps are making this not intuitieve

How difficult was this task? *

	1	2	3	4	5	6	7	
Very easy	○	○	○	◉	○	○	○	Very difficult

Please motivate your score *

user interface and amount of steps are making this not intuitive

What parts of the instructional do you think can be improved? How? *

instruction is okay, but it is very unclear what one is doing. Also the second number in the array is the arc length, very easy to forget that, or make a mistake etc.

What parts of the instructional video did you think were good? Why? *

steps were clearly visualized

Results

Please go to the "Mesh Processing Test" folder.

In Windows, right-click the "Mesh" folder. Then select "Send to", then "Compressed (zipped folder)".

In MacOS, right-click or two-finger click the "Mesh" folder. Then select "Compress "Mesh""

This creates a "Mesh.zip" file of the folder. Please use the form below to upload this "Mesh.zip" file

Please upload "Mesh.zip" using the form below *

Any final remarks?

this can only work with unexperienced users when nothing goes wrong. In my case, glueing didnt went well, and after that its make no sense to continue. Also the cleaning up gave weird extra ridges in all meshes, again, if one does not know how to correct this, it is difficult / makes no sense to continue.
NOTE: I had to use meshlab v2016 (which had all tools needed), because I could not install v2020 because of enterprise-laptop restrictions.
the setup of this survey is very good!

Mesh Processing Test

Thank you for participating in the mesh processing test.

In this test, you will be asked to perform multiple steps in the process of reconstructing a 3D scan of an infant's head, for the purpose of taking a measurement of the child's head circumference.

The test will be subdivided into 5 parts: Cutting the mesh, aligning the mesh, cleaning the mesh, re-meshing, and measuring the mesh.

Each part will be accompanied by an instructional video. Questions will be asked about the clarity of the instructions, as well as the ease of the process.

Do not worry about not being able to complete a part. Each part has its own files, so missing one does not affect the others.

Before beginning the test, please download the zip-file using the link below. This zip file contains the necessary programs, as well as the meshes that need to be processed.

https://drive.google.com/uc?export=download&id=12jwjNSfSakkmWSwopE_wBpH4vfFH9kKC

Once downloaded, please unzip the file in an easy to find location. The "Mesh Processing Test" folder contains a folder named "Programs". This "Programs" folder contains two directories, one for MacOS, and one for Windows. Please open the folder corresponding to your computer and install the two programs (MeshLab & ParaView) within.

You may now proceed to the next section

Note: Though email addresses are recorded (for matching file uploads to form responses) data is anonymized before publishing.

Participant info

The following are a few questions aimed at better understanding your experience with 3D software.

What (if any) 3D software have you used before?

- [x] Meshlab
- [ ] ParaView
- [ ] CloudCompare
- [x] Solidworks
- [ ] Autocad
- [ ] Fusion360
- [ ] Blender
- [ ] Rhino
- [ ] Cinema4D
- [ ] Other: .....

How would you describe your skill-level in Meshlab? *

	1	2	3	4	5	6	7	
Never used it	○	◉	○	○	○	○	○	Expert

How would you describe your skill-level in ParaView? *

	1	2	3	4	5	6	7	
Never used it	◉	○	○	○	○	○	○	Expert

How would you describe your skill-level with 3D software in general? *

	1	2	3	4	5	6	7	
Never use it	○	◉	○	○	○	○	○	Expert

1. Cutting the mesh

Please watch the instructional video below once before following the steps.

https://youtu.be/G-aGkxKr3ls

After watching once, you may begin following the instructions in the video.

Please time your progress!

Perform these instructions for all three files (Top, Left, Right) in the folder. You may re-watch (parts of) the video at any time during this process.

After completing the task and saving the results, please answer the questions below:

ERRATA:
It has been brought to my attention that on some computers MeshLab will not accept files being dragged into the window. If that is the case for you, please watch the video below, which details an alternative file import method

https://youtu.be/tr8KDFjVnPs

How many minutes did it take to complete this step? *

7

How clear where the instructions given in the video? *

	1	2	3	4	5	6	7	
Very unclear	○	○	○	○	○	◉	○	Very clear

Please motivate your score *

clear except what the boundaries of 'to select zone' is (color reference?)

How difficult was this task? *

	1	2	3	4	5	6	7	
Very easy	○	○	○	○	○	○	◉	Very difficult

Please motivate your score *

intuitive

What parts of the instructional do you think can be improved? How? *

pointing at the colour in the representation as the limit of 'to select object'

What parts of the instructional video did you think were good? Why? *

step by step

2. Aligning the mesh

Please watch the instructional video below once before following the steps.

https://youtu.be/GA7Vtoq07bs

After watching once, you may begin following the instructions in the video. You may re-watch (parts of) the video at any time during this process.

Please time your progress!

After completing the task and saving the results, please answer the questions below:

ERRATA:
It has been brought to my attention that on some computers MeshLab will not accept files being dragged into the window. If that is the case for you, please watch the video below, which details an alternative file import method

https://youtu.be/Ll4r1D8-S-o

How many minutes did it take to complete this step? *

12

How clear where the instructions given in the video? *

	1	2	3	4	5	6	7	
Very unclear	○	○	○	○	○	○	◉	Very clear

Please motivate your score *

all clear

How difficult was this task? *

	1	2	3	4	5	6	7	
Very easy	◉	○	○	○	○	○	○	Very difficult

Please motivate your score *

intuitive

What parts of the instructional do you think can be improved? How? *

none

What parts of the instructional video did you think were good? Why? *

the tempo

3. Cleaning the mesh

Please watch the instructional video below once before following the steps.

https://youtu.be/ZKzdxAPU3W4

After watching once, you may begin following the instructions in the video. You may re-watch (parts of) the video at any time during this process.

Please time your progress!

After completing the task and saving the results, please answer the questions below:

ERRATA:
It has been brought to my attention that on some computers MeshLab will not accept files being dragged into the window. If that is the case for you, please watch the video below, which details an alternative file import method

https://youtu.be/ATpbkHY7YXs

How many minutes did it take to complete this step? *

5

How clear where the instructions given in the video? *

	1	2	3	4	5	6	7	
Very unclear	○	○	○	○	○	○	◉	Very clear

Please motivate your score *

easy

How difficult was this task? *

	1	2	3	4	5	6	7	
Very easy	◉	○	○	○	○	○	○	Very difficult

Please motivate your score *

easy

What parts of the instructional do you think can be improved? How? *

none

What parts of the instructional video did you think were good? Why? *

tempo

4. Remeshing

Please watch the instructional video below once before following the steps.

https://youtu.be/UUbchFMgBdc

After watching once, you may begin following the instructions in the video. You may re-watch (parts of) the video at any time during this process.

Please time your progress!

After completing the task and saving the results, please answer the questions below:

ERRATA:
It has been brought to my attention that on some computers MeshLab will not accept files being dragged into the window. If that is the case for you, please watch the video below, which details an alternative file import method

https://youtu.be/QOXBS7_7sko

How many minutes did it take to complete this step? *

4

How clear where the instructions given in the video? *

	1	2	3	4	5	6	7	
Very unclear	○	○	○	○	○	○	◉	Very clear

Please motivate your score *

clear

How difficult was this task? *

	1	2	3	4	5	6	7	
Very easy	◉	○	○	○	○	○	○	Very difficult

Please motivate your score *

intuitive

What parts of the instructional do you think can be improved? How? *

none

What parts of the instructional video did you think were good? Why? *

tempo

5. Measuring

Please watch the instructional video below once before following the steps.

https://youtu.be/EqsjGsxCtjA

After watching once, you may begin following the instructions in the video. You may re-watch (parts of) the video at any time during this process.

Please time your progress!

After completing the task and saving the results, please answer the questions below:

How many minutes did it take to complete this step? *

7

Please enter the value of the head circumference you measured. *

0.22176

How clear where the instructions given in the video? *

	1	2	3	4	5	6	7	
Very unclear	○	○	○	○	○	○	◉	Very clear

Please motivate your score *

clear

How difficult was this task? *

	1	2	3	4	5	6	7	
Very easy	○	○	◉	○	○	○	○	Very difficult

Please motivate your score *

difficult to select

What parts of the instructional do you think can be improved? How? *

none

What parts of the instructional video did you think were good? Why? *

tempo

Results

Please go to the "Mesh Processing Test" folder.

In Windows, right-click the "Mesh" folder. Then select "Send to", then "Compressed (zipped folder)".

In MacOS, right-click or two-finger click the "Mesh" folder. Then select "Compress "Mesh""

This creates a "Mesh.zip" file of the folder. Please use the form below to upload this "Mesh.zip" file

Please upload "Mesh.zip" using the form below *

[redacted]

Any final remarks?

bravo

Mesh Processing Test

Thank you for participating in the mesh processing test.

In this test, you will be asked to perform multiple steps in the process of reconstructing a 3D scan of an infant's head, for the purpose of taking a measurement of the child's head circumference.

The test will be subdivided into 5 parts: Cutting the mesh, aligning the mesh, cleaning the mesh, re-meshing, and measuring the mesh.

Each part will be accompanied by an instructional video. Questions will be asked about the clarity of the instructions, as well as the ease of the process.

Do not worry about not being able to complete a part. Each part has its own files, so missing one does not affect the others.

Before beginning the test, please download the zip-file using the link below. This zip file contains the necessary programs, as well as the meshes that need to be processed.

https://drive.google.com/uc?export=download&id=12jwjNSfSakkmWSwopE_wBpH4vfFH9kKC

Once downloaded, please unzip the file in an easy to find location. The "Mesh Processing Test" folder contains a folder named "Programs". This "Programs" folder contains two directories, one for MacOS, and one for Windows. Please open the folder corresponding to your computer and install the two programs (MeshLab & ParaView) within.

You may now proceed to the next section

Note: Though email addresses are recorded (for matching file uploads to form responses) data is anonymized before publishing.

Participant info

The following are a few questions aimed at better understanding your experience with 3D software.

What (if any) 3D software have you used before?

- [x] Meshlab
- [ ] ParaView
- [ ] CloudCompare
- [ ] Solidworks
- [ ] Autocad
- [ ] Fusion360
- [x] Blender
- [ ] Rhino
- [ ] Cinema4D
- [ ] Other: .....

How would you describe your skill-level in Meshlab? *

	1	2	3	4	5	6	7	
Never used it	○	○	○	○	◉	○	○	Expert

How would you describe your skill-level in ParaView? *

	1	2	3	4	5	6	7	
Never used it	◉	○	○	○	○	○	○	Expert

How would you describe your skill-level with 3D software in general? *

	1	2	3	4	5	6	7	
Never use it	○	○	◉	○	○	○	○	Expert

1. Cutting the mesh

Please watch the instructional video below once before following the steps.

https://youtu.be/G-aGkxKr3ls

After watching once, you may begin following the instructions in the video.

Please time your progress!

Perform these instructions for all three files (Top, Left, Right) in the folder. You may re-watch (parts of) the video at any time during this process.

After completing the task and saving the results, please answer the questions below:

ERRATA:
It has been brought to my attention that on some computers MeshLab will not accept files being dragged into the window. If that is the case for you, please watch the video below, which details an alternative file import method

https://youtu.be/tr8KDFjVnPs

How many minutes did it take to complete this step? *

4

How clear where the instructions given in the video? *

	1	2	3	4	5	6	7	
Very unclear	○	○	○	○	○	○	◉	Very clear

Please motivate your score *

it was simple

How difficult was this task? *

	1	2	3	4	5	6	7	
Very easy	◉	○	○	○	○	○	○	Very difficult

Please motivate your score *

just select and delete

What parts of the instructional do you think can be improved? How? *

where it shows how to select verts it should also show you can add and subtract from your selection with ctrl and shift

What parts of the instructional video did you think were good? Why? *

invert selection shortcut, saves time

2. Aligning the mesh

Please watch the instructional video below once before following the steps.

https://youtu.be/GA7Vtoq07bs

After watching once, you may begin following the instructions in the video. You may re-watch (parts of) the video at any time during this process.

Please time your progress!

After completing the task and saving the results, please answer the questions below:

ERRATA:
It has been brought to my attention that on some computers MeshLab will not accept files being dragged into the window. If that is the case for you, please watch the video below, which details an alternative file import method

https://youtu.be/Ll4r1D8-S-o

How many minutes did it take to complete this step? *

2

How clear where the instructions given in the video? *

	1	2	3	4	5	6	7	
Very unclear	○	○	○	○	○	○	◉	Very clear

Please motivate your score *

very clear

How difficult was this task? *

	1	2	3	4	5	6	7	
Very easy	◉	○	○	○	○	○	○	Very difficult

Please motivate your score *

not much to it

What parts of the instructional do you think can be improved? How? *

show why top mesh was chosen instead of other mesh

What parts of the instructional video did you think were good? Why? *

the rest of it

3. Cleaning the mesh

Please watch the instructional video below once before following the steps.

https://youtu.be/ZKzdxAPU3W4

After watching once, you may begin following the instructions in the video. You may re-watch (parts of) the video at any time during this process.

Please time your progress!

After completing the task and saving the results, please answer the questions below:

ERRATA:
It has been brought to my attention that on some computers MeshLab will not accept files being dragged into the window. If that is the case for you, please watch the video below, which details an alternative file import method

https://youtu.be/ATpbkHY7YXs

How many minutes did it take to complete this step? *

0.8

How clear where the instructions given in the video? *

	1	2	3	4	5	6	7	
Very unclear	○	○	○	○	○	○	◉	Very clear

Please motivate your score *

simple steps

How difficult was this task? *

	1	2	3	4	5	6	7	
Very easy	◉	○	○	○	○	○	○	Very difficult

Please motivate your score *

only 2 steps

What parts of the instructional do you think can be improved? How? *

none

What parts of the instructional video did you think were good? Why? *

all

4. Remeshing

Please watch the instructional video below once before following the steps.

https://youtu.be/UUbchFMgBdc

After watching once, you may begin following the instructions in the video. You may re-watch (parts of) the video at any time during this process.

Please time your progress!

After completing the task and saving the results, please answer the questions below:

ERRATA:
It has been brought to my attention that on some computers MeshLab will not accept files being dragged into the window. If that is the case for you, please watch the video below, which details an alternative file import method

https://youtu.be/QOXBS7_7sko

How many minutes did it take to complete this step? *

0.4

How clear where the instructions given in the video? *

	1	2	3	4	5	6	7	
Very unclear	○	○	○	○	○	○	◉	Very clear

Please motivate your score *

simple

How difficult was this task? *

	1	2	3	4	5	6	7	
Very easy	◉	○	○	○	○	○	○	Very difficult

Please motivate your score *

press a button

What parts of the instructional do you think can be improved? How? *

to make it really idiot proof. "make sure "plymcout" is the active mesh (yellow)" could be "make sure "plymcout" is the active mesh by selecting it"

What parts of the instructional video did you think were good? Why? *

the rest was good

5. Measuring

Please watch the instructional video below once before following the steps.

https://youtu.be/EqsjGsxCtjA

After watching once, you may begin following the instructions in the video. You may re-watch (parts of) the video at any time during this process.

Please time your progress!

After completing the task and saving the results, please answer the questions below:

How many minutes did it take to complete this step? *

1

Please enter the value of the head circumference you measured. *

0.22121

How clear where the instructions given in the video? *

	1	2	3	4	5	6	7	
Very unclear	○	○	○	○	○	○	◉	Very clear

Please motivate your score *

easy to see

How difficult was this task? *

	1	2	3	4	5	6	7	
Very easy	○	◉	○	○	○	○	○	Very difficult

Please motivate your score *

few more steps than the other ones

What parts of the instructional do you think can be improved? How? *

when making a slice, you could add that by pressing "Y Normal" in the Plane Parameters, it aligns the plane horizontally for you. That will save time

What parts of the instructional video did you think were good? Why? *

the rest was good

Results

Please go to the "Mesh Processing Test" folder.

In Windows, right-click the "Mesh" folder. Then select "Send to", then "Compressed (zipped folder)".

In MacOS, right-click or two-finger click the "Mesh" folder. Then select "Compress "Mesh""

This creates a "Mesh.zip" file of the folder. Please use the form below to upload this "Mesh.zip" file

Please upload "Mesh.zip" using the form below *

Any final remarks?

you said yellow when it was green, that's gonna be a cringe from me, son

Mesh Processing Test

Thank you for participating in the mesh processing test.

In this test, you will be asked to perform multiple steps in the process of reconstructing a 3D scan of an infant's head, for the purpose of taking a measurement of the child's head circumference.

The test will be subdivided into 5 parts: Cutting the mesh, aligning the mesh, cleaning the mesh, re-meshing, and measuring the mesh.

Each part will be accompanied by an instructional video. Questions will be asked about the clarity of the instructions, as well as the ease of the process.

Do not worry about not being able to complete a part. Each part has its own files, so missing one does not affect the others.

Before beginning the test, please download the zip-file using the link below. This zip file contains the necessary programs, as well as the meshes that need to be processed.

https://drive.google.com/uc?export=download&id=12jwjNSfSakkmWSwopE_wBpH4vfFH9kKC

Once downloaded, please unzip the file in an easy to find location. The "Mesh Processing Test" folder contains a folder named "Programs". This "Programs" folder contains two directories, one for MacOS, and one for Windows. Please open the folder corresponding to your computer and install the two programs (MeshLab & ParaView) within.

You may now proceed to the next section

Note: Though email addresses are recorded (for matching file uploads to form responses) data is anonymized before publishing.

Participant info

The following are a few questions aimed at better understanding your experience with 3D software.

What (if any) 3D software have you used before?

- [x] Meshlab
- [ ] ParaView
- [ ] CloudCompare
- [ ] Solidworks
- [x] Autocad
- [x] Fusion360
- [ ] Blender
- [ ] Rhino
- [ ] Cinema4D
- [ ] Other: .....

How would you describe your skill-level in Meshlab? *

	1	2	3	4	5	6	7	
Never used it	○	◉	○	○	○	○	○	Expert

How would you describe your skill-level in ParaView? *

	1	2	3	4	5	6	7	
Never used it	◉	○	○	○	○	○	○	Expert

How would you describe your skill-level with 3D software in general? *

	1	2	3	4	5	6	7	
Never use it	○	○	○	◉	○	○	○	Expert

1. Cutting the mesh

Please watch the instructional video below once before following the steps.

https://youtu.be/G-aGkxKr3ls

After watching once, you may begin following the instructions in the video.

Please time your progress!

Perform these instructions for all three files (Top, Left, Right) in the folder. You may re-watch (parts of) the video at any time during this process.

After completing the task and saving the results, please answer the questions below:

ERRATA:
It has been brought to my attention that on some computers MeshLab will not accept files being dragged into the window. If that is the case for you, please watch the video below, which details an alternative file import method

https://youtu.be/tr8KDFjVnPs

How many minutes did it take to complete this step? *

10

How clear where the instructions given in the video? *

	1	2	3	4	5	6	7	
Very unclear	○	○	○	○	◉	○	○	Very clear

Please motivate your score *

The instruction where very clear. I could follow every step. But I think the explanation is a little bit too long. For example in the beginning there was a whole process to select the vertices and invert them via the dropdown menu, but after you showed a short cut. After that the video showed how you also could just select the vertices and delete the selection. I did the cutting of the Top mesh with the instruction on the video but after that for the Left and Right I only used the select vertices and delete it as a whole. I think this was much faster. The reasoning for the 10min was because I did the whole process of the video over the Top mesh. But after I got the hang of it the Left and Right took less then 30s each.

How difficult was this task? *

	1	2	3	4	5	6	7	
Very easy	◉	○	○	○	○	○	○	Very difficult

Please motivate your score *

The task was not difficult it was straight forward. After the first one you will get a hang of it and this will take you less then 30s per mesh to cut it.

What parts of the instructional do you think can be improved? How? *

I believe the part where you showed the invert of vertices. I think cutting the image should only be selecting vertices and deleting it. I do not see any benefits as of now when seeing the mesh of Top, Left and Right why one would need the "invert vertices". The video will also be much shorter when you only show the Select Vertices and deleting it.

What parts of the instructional video did you think were good? Why? *

The speed at which the video was very good. I could follow everything. And nearing the end that there where short cuts was also very good.

2. Aligning the mesh

Please watch the instructional video below once before following the steps.

https://youtu.be/GA7Vtoq07bs

After watching once, you may begin following the instructions in the video. You may re-watch (parts of) the video at any time during this process.

Please time your progress!

After completing the task and saving the results, please answer the questions below:

ERRATA:
It has been brought to my attention that on some computers MeshLab will not accept files being dragged into the window. If that is the case for you, please watch the video below, which details an alternative file import method

https://youtu.be/Ll4r1D8-S-o

How many minutes did it take to complete this step? *

4.19

How clear where the instructions given in the video? *

	1	2	3	4	5	6	7	
Very unclear	○	○	○	○	○	○	◉	Very clear

Please motivate your score *

I watch the video one time only and could do the whole process.

How difficult was this task? *

	1	2	3	4	5	6	7	
Very easy	◉	○	○	○	○	○	○	Very difficult

Please motivate your score *

It was not very difficult. But when aligning the Top and Left I first got this error: "Failure. There are no overlapping meshes? No candidate alignment arcs. Nothing Done." After that I closed Meshlab and re did the process and it worked. Don't know why i got this message, maybe the points I took were not that great?

What parts of the instructional do you think can be improved? How? *

I like the video how it is. It is very straightforward. Everything the video showed me I got it immediately. Everything showed in the video was also the things I did for the alignment.

What parts of the instructional video did you think were good? Why? *

See previous answer.

3. Cleaning the mesh

Please watch the instructional video below once before following the steps.

https://youtu.be/ZKzdxAPU3W4

After watching once, you may begin following the instructions in the video. You may re-watch (parts of) the video at any time during this process.

Please time your progress!

After completing the task and saving the results, please answer the questions below:

ERRATA:
It has been brought to my attention that on some computers MeshLab will not accept files being dragged into the window. If that is the case for you, please watch the video below, which details an alternative file import method

https://youtu.be/ATpbkHY7YXs

How many minutes did it take to complete this step? *

1.20

How clear where the instructions given in the video? *

	1	2	3	4	5	6	7	
Very unclear	○	○	○	○	○	○	◉	Very clear

Please motivate your score *

instructions where very clear. I didn't had to do much so everything went well.

How difficult was this task? *

	1	2	3	4	5	6	7	
Very easy	◉	○	○	○	○	○	○	Very difficult

Please motivate your score *

Everything was done by the cleaning script itself so there was no diffilculty.

What parts of the instructional do you think can be improved? How? *

The instructional could be made a little bit faster. There is not much to do so I believe the video could be shorter. I also watch the video the first time and got it to work.

What parts of the instructional video did you think were good? Why? *

The instructions where very clear. Everything you showed made sense and could duplicate it easily.

4. Remeshing

Please watch the instructional video below once before following the steps.

https://youtu.be/UUbchFMgBdc

After watching once, you may begin following the instructions in the video. You may re-watch (parts of) the video at any time during this process.

Please time your progress!

After completing the task and saving the results, please answer the questions below:

ERRATA:
It has been brought to my attention that on some computers MeshLab will not accept files being dragged into the window. If that is the case for you, please watch the video below, which details an alternative file import method

https://youtu.be/QOXBS7_7sko

How many minutes did it take to complete this step? *

2.02

How clear where the instructions given in the video? *

	1	2	3	4	5	6	7	
Very unclear	○	○	○	○	○	○	◉	Very clear

Please motivate your score *

Instruction where very clear. I watch the video a second time when you select the filter. There are so many options.

How difficult was this task? *

	1	2	3	4	5	6	7	
Very easy	◉	○	○	○	○	○	○	Very difficult

Please motivate your score *

Not very difficult. Meshlab did everything for you.

What parts of the instructional do you think can be improved? How? *

You could maybe make in clearer in the text what filter you should select. But after doing it the first time. I do not believe that I will make an mistake.

What parts of the instructional video did you think were good? Why? *

I could the follow the instructional video and also did not find it to slow or too fast.

5. Measuring

Please watch the instructional video below once before following the steps.

https://youtu.be/EqsjGsxCtjA

After watching once, you may begin following the instructions in the video. You may re-watch (parts of) the video at any time during this process.

Please time your progress!

After completing the task and saving the results, please answer the questions below:

How many minutes did it take to complete this step? *

4.15

Please enter the value of the head circumference you measured. *

0.221234

How clear where the instructions given in the video? *

	1	2	3	4	5	6	7	
Very unclear	○	○	○	○	○	○	◉	Very clear

Please motivate your score *

Everything was clear.

How difficult was this task? *

	1	2	3	4	5	6	7	
Very easy	○	◉	○	○	○	○	○	Very difficult

Please motivate your score *

I had difficulty using the slicing filter. Moving it to the circumference was the biggest challenge.

What parts of the instructional do you think can be improved? How? *

Maybe make it clearer how to move the slicing filter for the circumference.

What parts of the instructional video did you think were good? Why? *

Video was very good. I could follow it.

Results

Please go to the "Mesh Processing Test" folder.

In Windows, right-click the "Mesh" folder. Then select "Send to", then "Compressed (zipped folder)".

In MacOS, right-click or two-finger click the "Mesh" folder. Then select "Compress "Mesh""

This creates a "Mesh.zip" file of the folder. Please use the form below to upload this "Mesh.zip" file

P[redacted]zip" using the form below *

[redacted]

Any final remarks?

Very easy and straightforward method to get the whole 3D image of an infant using 3, 3D camera's. I always thought the process would be difficult. But after watching the instructional video's and doing it afterwards It was very easy! Good job!

Mesh Processing Test

Thank you for participating in the mesh processing test.

In this test, you will be asked to perform multiple steps in the process of reconstructing a 3D scan of an infant's head, for the purpose of taking a measurement of the child's head circumference.

The test will be subdivided into 5 parts: Cutting the mesh, aligning the mesh, cleaning the mesh, re-meshing, and measuring the mesh.

Each part will be accompanied by an instructional video. Questions will be asked about the clarity of the instructions, as well as the ease of the process.

Do not worry about not being able to complete a part. Each part has its own files, so missing one does not affect the others.

Before beginning the test, please download the zip-file using the link below. This zip file contains the necessary programs, as well as the meshes that need to be processed.

https://drive.google.com/uc?export=download&id=12jwjNSfSakkmWSwopE_wBpH4vfFH9kKC

Once downloaded, please unzip the file in an easy to find location. The "Mesh Processing Test" folder contains a folder named "Programs". This "Programs" folder contains two directories, one for MacOS, and one for Windows. Please open the folder corresponding to your computer and install the two programs (MeshLab & ParaView) within.

You may now proceed to the next section

Note: Though email addresses are recorded (for matching file uploads to form responses) data is anonymized before publishing.

Participant info

The following are a few questions aimed at better understanding your experience with 3D software.

What (if any) 3D software have you used before?

- [x] Meshlab
- [x] ParaView
- [ ] CloudCompare
- [x] Solidworks
- [x] Autocad
- [x] Fusion360
- [x] Blender
- [x] Rhino
- [ ] Cinema4D
- [ ] Other: .....

How would you describe your skill-level in Meshlab? *

	1	2	3	4	5	6	7	
Never used it	○	◉	○	○	○	○	○	Expert

How would you describe your skill-level in ParaView? *

	1	2	3	4	5	6	7	
Never used it	○	◉	○	○	○	○	○	Expert

How would you describe your skill-level with 3D software in general? *

	1	2	3	4	5	6	7	
Never use it	○	○	○	○	○	○	◉	Expert

1. Cutting the mesh

Please watch the instructional video below once before following the steps.

https://youtu.be/G-aGkxKr3ls

After watching once, you may begin following the instructions in the video.

Please time your progress!

Perform these instructions for all three files (Top, Left, Right) in the folder. You may re-watch (parts of) the video at any time during this process.

After completing the task and saving the results, please answer the questions below:

ERRATA:
It has been brought to my attention that on some computers MeshLab will not accept files being dragged into the window. If that is the case for you, please watch the video below, which details an alternative file import method

https://youtu.be/tr8KDFjVnPs

How many minutes did it take to complete this step? *

20

How clear where the instructions given in the video? *

	1	2	3	4	5	6	7	
Very unclear	○	○	○	○	○	◉	○	Very clear

Please motivate your score *

quik ok, voice instructions will make it easier

How difficult was this task? *

	1	2	3	4	5	6	7	
Very easy	○	◉	○	○	○	○	○	Very difficult

Please motivate your score *

if you are familiar with 3D software and geometry processing, this is a general preprocessing step

What parts of the instructional do you think can be improved? How? *

voice instruction

What parts of the instructional video did you think were good? Why? *

precise descriptions of mouse clicks are very nice

2. Aligning the mesh

Please watch the instructional video below once before following the steps.

https://youtu.be/GA7Vtoq07bs

After watching once, you may begin following the instructions in the video. You may re-watch (parts of) the video at any time during this process.

Please time your progress!

After completing the task and saving the results, please answer the questions below:

ERRATA:
It has been brought to my attention that on some computers MeshLab will not accept files being dragged into the window. If that is the case for you, please watch the video below, which details an alternative file import method

https://youtu.be/Ll4r1D8-S-o

How many minutes did it take to complete this step? *

3

How clear where the instructions given in the video? *

	1	2	3	4	5	6	7	
Very unclear	○	○	○	○	○	◉	○	Very clear

Please motivate your score *

just clear, no voice instruction is a con.

How difficult was this task? *

	1	2	3	4	5	6	7	
Very easy	○	◉	○	○	○	○	○	Very difficult

Please motivate your score *

it is a standard registration process

What parts of the instructional do you think can be improved? How? *

voice instruction will be better as you have to watch two screen for this action. Actually I watch the first part of video in a 1.5 times speed, then clicked the interface without watch the rest (except the output part)

What parts of the instructional video did you think were good? Why? *

the prices location of the button to be clicked

3. Cleaning the mesh

Please watch the instructional video below once before following the steps.

https://youtu.be/ZKzdxAPU3W4

After watching once, you may begin following the instructions in the video. You may re-watch (parts of) the video at any time during this process.

Please time your progress!

After completing the task and saving the results, please answer the questions below:

ERRATA:
It has been brought to my attention that on some computers MeshLab will not accept files being dragged into the

window. If that is the case for you, please watch the video below, which details an alternative file import method

https://youtu.be/ATpbkHY7YXs

How many minutes did it take to complete this step? *

5

How clear where the instructions given in the video? *

	1	2	3	4	5	6	7	
Very unclear	○	○	○	○	○	◉	○	Very clear

Please motivate your score *

Very clear, nice script

How difficult was this task? *

	1	2	3	4	5	6	7	
Very easy	○	◉	○	○	○	○	○	Very difficult

Please motivate your score *

the difficult process is embedded in a script, which makes the task very easy, good job

What parts of the instructional do you think can be improved? How? *

still the voice part, but it is ok. for users who are familiar with mesh processing, it is suggested to watch the video furst, then do the mouse clicks

What parts of the instructional video did you think were good? Why? *

nothing special, it is a good tutorial

4. Remeshing

Please watch the instructional video below once before following the steps.

https://youtu.be/UUbchFMgBdc

After watching once, you may begin following the instructions in the video. You may re-watch (parts of) the video at any time during this process.

Please time your progress!

After completing the task and saving the results, please answer the questions below:

ERRATA:
It has been brought to my attention that on some computers MeshLab will not accept files being dragged into the window. If that is the case for you, please watch the video below, which details an alternative file import method

https://youtu.be/QOXBS7_7sko

How many minutes did it take to complete this step? *

2

How clear where the instructions given in the video? *

	1	2	3	4	5	6	7	
Very unclear	○	○	○	○	◉	○	○	Very clear

Please motivate your score *

Still very clear, but the parameters in VCG was not explained

How difficult was this task? *

	1	2	3	4	5	6	7	
Very easy	○	◉	○	○	○	○	○	Very difficult

Please motivate your score *

it is a standard merging process

What parts of the instructional do you think can be improved? How? *

want a bit more explanation of VCG parameters

What parts of the instructional video did you think were good? Why? *

still , it is quite clear, I watched the video first, then did the mouse click

5. Measuring

Please watch the instructional video below once before following the steps.

https://youtu.be/EqsjGsxCtjA

After watching once, you may begin following the instructions in the video. You may re-watch (parts of) the video at any time during this process.

Please time your progress!

After completing the task and saving the results, please answer the questions below:

How many minutes did it take to complete this step? *

15

Please enter the value of the head circumference you measured. *

0.22

How clear where the instructions given in the video? *

	1	2	3	4	5	6	7	
Very unclear	○	○	○	○	◉	○	○	Very clear

Please motivate your score *

it is clear, again, it took me some time to get acquainted with paraview, two things were not clear enough: 1. if the mesh is not selected, the filter will be dimmed 21. for arc length, what is the meaning of the first value?

How difficult was this task? *

	1	2	3	4	5	6	7	
Very easy	○	○	◉	○	○	○	○	Very difficult

Please motivate your score *

selecting the plane can be tricky as there is no standard

What parts of the instructional do you think can be improved? How? *

as I mentioned, 1. if the mesh is not selected, the filter will be dimmed 21. for arc length, what is the meaning of the first value?

What parts of the instructional video did you think were good? Why? *

quite clear process, with voice will be better

Results

Please go to the "Mesh Processing Test" folder.

In Windows, right-click the "Mesh" folder. Then select "Send to", then "Compressed (zipped folder)".

In MacOS, right-click or two-finger click the "Mesh" folder. Then select "Compress "Mesh""

This creates a "Mesh.zip" file of the folder. Please use the form below to upload this "Mesh.zip" file

Please upload "Mesh.zip" using the form below *

Any final remarks?

I feels that using the mesh I processed will make it more authentic, however, it may introduce more mistakes

Mesh Processing Test

Thank you for participating in the mesh processing test.

In this test, you will be asked to perform multiple steps in the process of reconstructing a 3D scan of an infant's head, for the purpose of taking a measurement of the child's head circumference.

The test will be subdivided into 5 parts: Cutting the mesh, aligning the mesh, cleaning the mesh, re-meshing, and measuring the mesh.

Each part will be accompanied by an instructional video. Questions will be asked about the clarity of the instructions, as well as the ease of the process.

Do not worry about not being able to complete a part. Each part has its own files, so missing one does not affect the others.

Before beginning the test, please download the zip-file using the link below. This zip file contains the necessary programs, as well as the meshes that need to be processed.

https://drive.google.com/uc?export=download&id=12jwjNSfSakkmWSwopE_wBpH4vfFH9kKC

Once downloaded, please unzip the file in an easy to find location. The "Mesh Processing Test" folder contains a folder named "Programs". This "Programs" folder contains two directories, one for MacOS, and one for Windows. Please open the folder corresponding to your computer and install the two programs (MeshLab & ParaView) within.

You may now proceed to the next section

Note: Though email addresses are recorded (for matching file uploads to form responses) data is anonymized before publishing.

Participant info

The following are a few questions aimed at better understanding your experience with 3D software.

What (if any) 3D software have you used before?

- [x] Meshlab
- [x] ParaView
- [ ] CloudCompare
- [x] Solidworks
- [x] Autocad
- [x] Fusion360
- [x] Blender
- [x] Rhino
- [ ] Cinema4D
- [x] Other: DesignX, OpenSCad, Clo3D, MeshMixer, Artec Studio,

How would you describe your skill-level in Meshlab? *

	1	2	3	4	5	6	7	
Never used it	○	○	○	○	○	◉	○	Expert

How would you describe your skill-level in ParaView? *

	1	2	3	4	5	6	7	
Never used it	○	○	○	○	○	◉	○	Expert

How would you describe your skill-level with 3D software in general? *

	1	2	3	4	5	6	7	
Never use it	○	○	○	○	○	◉	○	Expert

1. Cutting the mesh

Please watch the instructional video below once before following the steps.

https://youtu.be/G-aGkxKr3ls

After watching once, you may begin following the instructions in the video.

Please time your progress!

Perform these instructions for all three files (Top, Left, Right) in the folder. You may re-watch (parts of) the video at any time during this process.

After completing the task and saving the results, please answer the questions below:

ERRATA:
It has been brought to my attention that on some computers MeshLab will not accept files being dragged into the window. If that is the case for you, please watch the video below, which details an alternative file import method

https://youtu.be/tr8KDFjVnPs

How many minutes did it take to complete this step? *

5

How clear where the instructions given in the video? *

	1	2	3	4	5	6	7	
Very unclear	○	○	○	○	◉	○	○	Very clear

Please motivate your score *

The steps were slowly demonstrated and it were only a few steps.

How difficult was this task? *

	1	2	3	4	5	6	7	
Very easy	○	○	○	○	◉	○	○	Very difficult

Please motivate your score *

It can be somewhat annoying to rotate the head to the right direction because you only have a rectangular selection tool.

What parts of the instructional do you think can be improved? How? *

It is not entirely clear what part is still considered 'head'. There are also other functions that could help in completing the task faster, e.g. select component.

What parts of the instructional video did you think were good? Why? *

The basic proces was explained well.

2. Aligning the mesh

Please watch the instructional video below once before following the steps.

https://youtu.be/GA7Vtoq07bs

After watching once, you may begin following the instructions in the video. You may re-watch (parts of) the video at any time during this process.

Please time your progress!

After completing the task and saving the results, please answer the questions below:

ERRATA:
It has been brought to my attention that on some computers MeshLab will not accept files being dragged into the window. If that is the case for you, please watch the video below, which details an alternative file import method

https://youtu.be/Ll4r1D8-S-o

How many minutes did it take to complete this step? *

4

How clear where the instructions given in the video? *

	1	2	3	4	5	6	7	
Very unclear	○	○	○	◉	○	○	○	Very clear

Please motivate your score *

The steps in itself were clear, but there are a lot of buttons in the alignment tab and that can be a bit distracting or intimidating when watching such a demo.

How difficult was this task? *

	1	2	3	4	5	6	7	
Very easy	○	○	○	○	○	◉	○	Very difficult

Please motivate your score *

It is not very difficult to execute but the result is not always satisfactory. I went a bit quick with pin pointing markers for the third mesh and the result was that it did not align well. From the instructions I did not learn how to "go back" a step and redo the pin-pointing.

What parts of the instructional do you think can be improved? How? *

It should contain an introduction on what the exact goal of alignment is. The video should try to put the person at ease, as the amount of options in the alignment tab can be overwhelming. The instructional video should provide information on how to go one step back in the alignment or how to redo the alignment for one of the meshes.

What parts of the instructional video did you think were good? Why? *

The pace was good.

3. Cleaning the mesh

Please watch the instructional video below once before following the steps.

https://youtu.be/ZKzdxAPU3W4

After watching once, you may begin following the instructions in the video. You may re-watch (parts of) the video at any time during this process.

Please time your progress!

After completing the task and saving the results, please answer the questions below:

ERRATA:
It has been brought to my attention that on some computers MeshLab will not accept files being dragged into the window. If that is the case for you, please watch the video below, which details an alternative file import method

https://youtu.be/ATpbkHY7YXs

How many minutes did it take to complete this step? *

2

How clear where the instructions given in the video? *

	1	2	3	4	5	6	7	
Very unclear	○	○	○	○	◉	○	○	Very clear

Please motivate your score *

Only a few steps, quite simple to memorise.

How difficult was this task? *

	1	2	3	4	5	6	7	
Very easy	○	◉	○	○	○	○	○	Very difficult

Please motivate your score *

This is just applying a filter so no skills or trials needed.

What parts of the instructional do you think can be improved? How? *

It would be good to mention explicitly that the filter does not get applied to what is visible but to the mesh that is selected. I accidentally applied the script twice on the same mesh because by clicking the visibility eye to hide the mesh, I selected that mesh without noticing. Also I did not have the option "save all meshes". Finally, I think this holds for all Steps: it would be nice to show in the beginning of the video the starting point and the desired result... it gives more context to the operations you need to apply.

What parts of the instructional video did you think were good? Why? *

Again the pace was good and clear process.

4. Remeshing

Please watch the instructional video below once before following the steps.

https://youtu.be/UUbchFMgBdc

After watching once, you may begin following the instructions in the video. You may re-watch (parts of) the video at any time during this process.

Please time your progress!

After completing the task and saving the results, please answer the questions below:

ERRATA:
It has been brought to my attention that on some computers MeshLab will not accept files being dragged into the window. If that is the case for you, please watch the video below, which details an alternative file import method

https://youtu.be/QOXBS7_7sko

How many minutes did it take to complete this step? *

1

How clear where the instructions given in the video? *

	1	2	3	4	5	6	7	
Very unclear	○	○	○	○	◉	○	○	Very clear

Please motivate your score *

Easy to follow and execute.

How difficult was this task? *

	1	2	3	4	5	6	7	
Very easy	○	◉	○	○	○	○	○	Very difficult

Please motivate your score *

Again, no skills required from the user.

What parts of the instructional do you think can be improved? How? *

it was inconvenient to search back in the video to find the settings for comparison with the settings on my PC.

What parts of the instructional video did you think were good? Why? *

Pace

5. Measuring

Please watch the instructional video below once before following the steps.

https://youtu.be/EqsjGsxCtjA

After watching once, you may begin following the instructions in the video. You may re-watch (parts of) the video at any time during this process.

Please time your progress!

After completing the task and saving the results, please answer the questions below:

How many minutes did it take to complete this step? *

3

Please enter the value of the head circumference you measured. *

0.221149

How clear where the instructions given in the video? *

	1	2	3	4	5	6	7	
Very unclear	○	○	○	○	◉	○	○	Very clear

Please motivate your score *

steps were clear, but definition of plane may be ambiguous

How difficult was this task? *

	1	2	3	4	5	6	7	
Very easy	○	○	○	◉	○	○	○	Very difficult

Please motivate your score *

steps are not difficult but I had doubts about the correctness of the plane location

What parts of the instructional do you think can be improved? How? *

elaborate on the definition of circumference. Could be good to let the reader know what the triangle strips filter does.

What parts of the instructional video did you think were good? Why? *

overall

Results

Please go to the "Mesh Processing Test" folder.

In Windows, right-click the "Mesh" folder. Then select "Send to", then "Compressed (zipped folder)".

In MacOS, right-click or two-finger click the "Mesh" folder. Then select "Compress "Mesh""

This creates a "Mesh.zip" file of the folder. Please use the form below to upload this "Mesh.zip" file

Please upload "Mesh.zip" using the form below *

[redacted]

Any final remarks?

The demonstration was done at the right pace. It would however be nice to give the user an overview at the beginning of the tutorial and along the way. This gives the user a sense of purpose and control.

References

Ebrahim, M. A.-B. (2013). 3D Laser Scanners' Techniques Overview. *International Journal of Science and Research*.

Edelman, G. J., & Aalders, M. C. (2018). Photogrammetry using visible, infrared, hyperspectral and thermal imaging of crime scenes. *Forensic Science International*, *292*, 181–189. https://doi.org/10.1016/j.forsciint.2018.09.025

Geng, J. (2011). Structured-light 3D surface imaging: a tutorial. *Advances in Optics and Photonics*, *3*(2), 128. https://doi.org/10.1364/aop.3.000128

He, Y., Liang, B., Zou, Y., He, J., & Yang, J. (2017). Depth Errors Analysis and Correction for Time-of-Flight (ToF) Cameras. *Sensors*, *17*(1), 92. https://doi.org/10.3390/s17010092

Intel. (2019). *LiDAR Camera L515* (Issue December).

Intel. (2020). *LiDAR Camera L515*. https://store.intelrealsense.com/buy-intel-realsense-lidar-camera-l515.html

Microsoft. (2020). *Buy the Azure Kinect developer kit – Microsoft*. https://www.microsoft.com/en-us/p/azure-kinect-dk/8pp5vxmd9nhq?activetab=pivot%3Aoverviewtab

Murobo. (n.d.). Retrieved May 5, 2020, from http://store.murobo.com/atlas-3d-kit/

Occipital. (2020a). *Structure Accuracy*. https://support.structure.io/article/377-how-precise-is-structure-sensor-mark-ii

Occipital. (2020b). *Structure Costs*. https://www.makerpoint.nl/nl/structure-sensor-mark-ii-standalone-100525845.html

Raspberry Pi. (2016). *Camera Module V2 – Raspberry Pi*. https://www.raspberrypi.org/products/camera-module-v2/

Santander, P., Quast, A., Hubbert, J., Horn, S., Meyer-Marcotty, P., Küster, H., & Dieks, J. K. (2020). Three-dimensional head shape acquisition in preterm infants - Translating an orthodontic imaging procedure into neonatal care. *Early Human Development*, *140*, 104908. https://doi.org/10.1016/j.earlhumdev.2019.104908

Smakman, P. (2014). *Curatio: Development of a low-cost, dedicated 3D Hand Scanner*. http://resolver.tudelft.nl/uuid:a4202d21-6174-4994-a6ea-828392836c54

Terabee. (n.d.). *A Brief Introduction to Time-of-Flight Sensing*. Retrieved May 1, 2020, from https://www.terabee.com/a-brief-introduction-to-time-of-flight-sensing-part-2-indirect-tof-sensors/

Vukašinović, N., Korošec, M., & Duhovnik, J. (2010). The influence of surface topology on the accuracy of laser triangulation scanning results. *Strojniski Vestnik/Journal of Mechanical Engineering*.