APPENDICES

Master thesis
Frederik Ueberschär

Design for Interaction
TU Delft
February 2021

APPENDIX 1
Design Brief

APPENDIX 2
Game analysis

APPENDIX 3
Design Cycle 1
Design Cycle 2
Additional Exploration
Final validation cluster & raw data
Testing Consent form

APPENDIX 4
Colab dataset code
Final prototype: Processing & Arduino Code
AI for Experience:
Designing with Generative Adversarial Networks to evoke climate fascination

Master thesis
Design for Interaction

Frederik Ueberschär
February 2021

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APPENDIX 1
IDE Master Graduation

Project team, Procedural checks and personal Project brief

This document contains the agreements made between student and supervisory team about the student's IDE Master Graduation Project. This document can also include the involvement of an external organisation, however, it does not cover any legal employment relationship that the student and the client (might) agree upon. Next to that, this document facilitates the required procedural checks. In this document:

- The student defines the team, what he/she is going to do/deliver and how that will come about.
- SSC E&SA (Shared Service Center, Education & Student Affairs) reports on the student's registration and study progress.
- IDE's Board of Examiners confirms if the student is allowed to start the Graduation Project.

**STUDENT DATA & MASTER PROGRAMME**

Save this form according the format "IDE Master Graduation Project Brief, familyname, firstname, studentnumber, dd-mm-yyyy". Complete all blue parts of the form and include the approved Project Brief in your Graduation Report as Appendix 1!

**SUPERVISORY TEAM **

Fill in the required data for the supervisory team members. Please check the instructions on the right!

- **Chair**: Derek Lomas  
  **dept. / section**: HCD, Design Aesthetics
- **Mentor**: Alessandro Bazzon  
  **dept. / section**: SDE, Internet of Things
- **2nd Mentor**: 
  **organisation**:  
  **city**:  
  **country**: 

Chair should request the IDE Board of Examiners for approval of a non-IDE mentor, including a motivation letter and cv.

Second mentor only applies in case the assignment is hosted by an external organisation.

Ensure a heterogeneous team. In case you wish to include two team members from the same section, please explain why.
Procedural Checks - IDE Master Graduation

APPROVAL PROJECT BRIEF
To be filled in by the chair of the supervisory team.

chair: Derek Lomas  
Date: 28.08.2020  
Signature: [Signature]

CHECK STUDY PROGRESS
To be filled in by the SSC E&SA (Shared Service Center, Education & Student Affairs), after approval of the project brief by the Chair. The study progress will be checked for a 2nd time just before the green light meeting.

Master electives no. of EC accumulated in total: 28 EC
- Of which, taking the conditional requirements into account, can be part of the exam programme: 28 EC
- List of electives obtained before the third semester without approval of the BoE: [Blank]

[ ] YES all 1st year master courses passed
[ ] NO missing 1st year master courses are: [Blank]

name: C. van der Bunt  
Date: 29.09.2020  
Signature: [Signature]

FORMAL APPROVAL GRADUATION PROJECT
To be filled in by the Board of Examiners of IDE TU Delft. Please check the supervisory team and study the parts of the brief marked **. Next, please assess, disapprove and sign this Project Brief, by using the criteria below.

- Does the project fit within the (MSc) programme of the student (taking into account, if described, the activities done next to the obligatory MSc specific courses)? [ ] APPROVED  [ ] NOT APPROVED
- Is the level of the project challenging enough for a MSc IDE graduating student? [ ] APPROVED  [ ] NOT APPROVED
- Is the project expected to be doable within 100 working days/20 weeks? [ ] APPROVED  [ ] NOT APPROVED
- Does the composition of the supervisory team comply with the regulations and fit the assignment? [ ] APPROVED  [ ] NOT APPROVED

remark: the title does not reflect the development of an 'AI powered experience'.

comments: [Blank]

name: Monique von Morgen  
Date: 12.10.2020  
Signature: MvM
INTRODUCTION
Please describe the context of your project and address the main stakeholders (interests) within this context in a concise yet complete manner. Who are involved, what do they value and how do they currently operate within the given context? What are the main opportunities and limitations you are currently aware of (cultural and social norms, resources (time, money, ...), technology, ...).

Our world climate is incredibly complex and ever changing. The reality of climate change and the consequential pressure to act fast to reduce our greenhouse gas emissions and general impact on the world has reached an unprecedented amount of attention from public, political, corporate and academic communities [1]. Recent years have also shown an increased public interest in climate developments, manifesting in climate protests like Friday for Future [2], but also vocal voices of climate change skeptics [3]. Vast resources are pooled into researching its past, present and future developments of our climate with modern data collection methods and intelligent algorithms helping scientists in their understanding and predictive efforts of our climate development [4]. Especially innovations in digital technology, like the continuous progress of artificial intelligence (AI) & machine learning (ML) enables more complex data analysis and even the generation of visuals to bring scientific data and connected predictions to life [5].

Private companies like Google, Microsoft, Amazon and Apple are on the forefront of AI development [6]. Their access to vast amounts of data about our world and consumer behaviour and ability to invest heavily in the development of AI systems allows them to improve their products and in some instances use the emerging knowledge to contribute to climate science. While Google DeepMind, based on climate science, looked into ways of utilizing deep learning to improve energy efficiency of server farms [7], Google Research worked on and published about improving weather forecasting using machine learning models [8]. Continuing their work on the topic gives them an opportunity to improve their public image as green companies and add another example to their list of experimental projects without direct commercial viability.

Academic climate scientists on the other hand are often publicly funded and constrained in their budget and therefore (technical) ability. They, too, need vast amounts of data and accurate models to make sense of the past and predict the future of our climate to suggest appropriate actions to reduce the cause and minimise effects of global warming. One crucial task of climate researchers is to inform others about their findings. They need and have the skill to communicate to their academic colleagues, but also legislators and other stakeholders in order to enable them to make an informed decision. This communication is characterized by numbers, graphs and elaborated reports in scientific language.

While this form of communication is perhaps fitting for their main target group, its complexity and scientific nature makes our climate and ongoing development a topic that is hard to grasp and imagine for a novice. The general public as an active shareholder in our climate discussion requires a different form of communication and preparation of climate findings in order to be able to participate in the discussion. It is challenging to get into the space and understand the complexity of climate modeling and appropriate climate actions - where to start looking? How to understand the data? What to make of different opinions and how to judge it appropriately?

As a designer, how can you support the communication of climate data and make it accessible to stakeholders beyond the scientific community?
image / figure 1: Using ML to predict weather patterns and precipitation cheaper, faster and more accurate [7]

image / figure 2: Exhibitions as a way to engage people and let them explore complex topics in a playful manner
PROBLEM DEFINITION **

Limit and define the scope and solution space of your project to one that is manageable within one Master Graduation Project of 30 EC (≈ 20 full time weeks or 100 working days) and clearly indicate what issue(s) should be addressed in this project.

The issue described in the introduction is mainly the inaccessibility of climate science for the general public. This graduation project will take a deep dive into exploring the opportunity of transforming abstract data and climate models through AI into a playable experience, fostering understanding and making it engaging and immersive for stakeholders beyond the scientific community, while still potentially providing benefits for climate researchers themselves.

Since both domains of AI and climate research are too vast, the project needs to be limited to one concrete kind of AI and one specific topic of climate research. The use of AI in this project will be to generate visual representations of future climate scenarios. The specific definition of the climate niche will be determined through initial research findings in the first stage of the project.

The goal is not to build a finished and financially viable product, but to explore the domain of climate research and prototype a different form of communication by translating it into a playable, visual experience. The prototypes will research the element of play to support the understanding of complex topics and how contemporary technologies like a generative AI could be utilized to support scientists in their communication of future climate scenarios.

ASSIGNMENT **

State in 2 or 3 sentences what you are going to research, design, create and/or generate, that will solve (part of) the issue(s) pointed out in “problem definition”. Then illustrate this assignment by indicating what kind of solution you expect and/or aim to deliver, for instance: a product, a product-service combination, a strategy illustrated through product or product-service combination ideas, ... . In case of a Specialisation and/or Annotation, make sure the assignment reflects this/these.

For the graduation project, I will design and build an AI-powered experience that allows people to engage and play with climate models. The end result will be an interactive piece that allows people to get an understanding and insights into the complexity of our world climate through play, manipulate parameters to trigger different future scenarios and be immersed in the experience.

The main focus of the project will be the prototyping of an AI to generate visuals of future climate scenarios and the exploration of playful mechanisms and elements to make the topic of climate data and modeling accessible to non-scientists, in other words: the general public. This includes the research of technical limitations, supporting interaction methods, exploration of visual, tactile, and auditory communication methods and crucially the actual interest in such an experience.

The prototyping process and concept direction will be guided through a literature review and interviews with climate scientists. The literature review will provide insights on the topics of play as a learning facilitator, psychological factors that support people in developing an understanding of complex relationships and imagine future scenarios while the interviews will be used as a qualitative research method to find out about the scientist's way of working, current use of AI or MI in their processes and present communication struggles with non-scientific stakeholders.
PLANNING AND APPROACH **
Include a Gantt Chart (replace the example below - more examples can be found in Manual 2) that shows the different phases of your project, deliverables you have in mind, meetings, and how you plan to spend your time. Please note that all activities should fit within the given net time of 30 EC = 20 full time weeks or 100 working days, and your planning should include a kick-off meeting, mid-term meeting, green light meeting and graduation ceremony. Illustrate your Gantt Chart by, for instance, explaining your approach, and please indicate periods of part-time activities and/or periods of not spending time on your graduation project if any, for instance because of holidays or parallel activities.

The project planning is divided in four main components: Context exploration, ideation, prototyping and finalization. The start of the project is shaped by a literature review and interviews with stakeholders (climate scientists & AI engineers in the field) to provide a basis for the project.

Extensive prototyping, starting simultaneously with the exploration phase, will allow me to get experience with working with an AI and generating visuals using machine learning from the first week onwards. After the ideation phase, the usage and prototyping of AI and building playful exhibition elements will be focussed to achieve my actual project goal and proceed in quick, iterative cycles.

Each phase is wrapped up with a documentation of my progress and writing down key insights collected in the prior weeks. Reflective moments, although naturally present throughout the project, are planned every second Friday to allow for an agile scope and direction readjustment based on progress and insight gathered up to this point.
**Motivation and Personal Ambitions**

Explain why you set up this project, what competences you want to prove and learn. For example: acquired competences from your MSc programme, the elective semester, extra-curricular activities (etc.) and point out the competences you have yet developed. Optionally, describe which personal learning ambitions you explicitly want to address in this project, on top of the learning objectives of the Graduation Project, such as: in-depth knowledge/ insight on a specific subject, broadening your competences or experimenting with a specific tool and/or methodology. ... Stick to no more than five ambitions.

With this project, I want to strongly improve my prototyping and building skills. I want to work with machine learning and artificial intelligence and use data as a design resource, like pushed for at IDE by Peter Kun [9]. I want to challenge myself by mapping out & communicating a complex space, understanding the data, climate workings, algorithms and public impressions to end up with a project I am proud of. On the way I hope to build professional relationships in a field I want to work in later, on the intersection of technology and research.

I personally believe in the importance of people’s participation and the power of understanding to be the first step to an active involvement. Breaking out of an expert-driven domain and bringing people along in the discussion is an effort I want to be part of. As a designer I can support this through appropriate means of communication.

Lastly, I want to combine two passions of mine: Technology & climate, enabling me as a designer to have a meaningful impact on one of the most important and urgent topics of our time. I want to help enable us to have a future to actually design for.

**References**


[2] Fridays For Future is a global movement active in most countries and our website offers information on who we are and what you can do. (2020, September 1). Fridays For Future. https://fridaysforfuture.org/


APPENDIX 2
Research & Design Activities //

Analysis of prior art

Education Experiences

Games with a building / climate aspect

Simulators
Positive characteristics & mechanics:

1. Actions have a clear impact: immediate, with delay or as a surprise
2. There is always something happening, be it sound, little movements, development of the landscape etc.
3. Time is present, but not linear nor realistic
4. Simplification is needed to make it manageable for the game to simulate, but also for the player to comprehend
5. World can be shaped through: Painting on the landscape, causing world events to happen, building infrastructure
6. Graphs and charts can be used to show hidden aspects
7. The player can move around, zoom in, zoom out and judge the situation from different angles
Main takeaways:

1. The most engaging games were those where the climate was a mechanic, not the focus of the game.
2. It is extremely hard to make a good, balanced game and it has to be complete in order to work.
3. I can take a lot of inspiration and mechanics from these games nonetheless.
4. Educational experiences, probably due to budget constraints, are often dull. I can’t really imagine people playing those, if not forced to do so in a classroom.
APPENDIX 3
Design Cycle 1: Concepts

Our New Planet

Premise
My climate research showed how complex a climate system is and how long changes need to usually take place. Geoengineering requires a good understanding of these interplays and might be a needed intervention to buy more time.

Game Description
Our New Planet is a simulation builder game where players are explorers of a new species that have to geoengineer a new planet to give the last survivors a new home after the old planet was used up.

Players start with a newly generated planet, that for some reason or the other is currently not inhabitable for organic life. They can scan the planet and get a first estimation of what it needs in order to become habitable. Through careful geoengineering the goal is to create a balanced system again. For instance might a planet covered in ice need some artificially introduced greenhouse gases in order to heat it up enough for plants to grow. Once they reach the goal, they get a score of how many years of geoengineering were required for the planet to become inhabitable, which will be many, many years. Their actions and progress can be shared with others on social media.

Desired effects on the player
I would like the players to enjoy the experience of tinkering with a planet, and help them in understanding how the different elements of a climate system work together. The story of playing another species and starting with an inhabitable planet that gets shaped into a habitable, arguably desirable, environment again was supposed to detach the player from our current reality and allow them to be immersed in the game without immediately being scared off by the dystopian narrative. The high number of years needed to finish the process was supposed to showcase the inertia of a global climate system, to not present geoengineering as an easy solution for our current climate crisis. This was a potential pitfall mentioned by two climate scientists from Hamburg and Delft when speaking about the idea of a climate game.

Feedback
The feedback was gathered from multiple participants and condensed:

+ Looks appealing, and has a nice element of world building
+ The balancing act of different climate components, if simplified, is an interesting game mechanic
+ The importance of measuring and adjusting your actions is great
- Geoengineering shouldn’t be seen as a solution
Carbon Capture

Premise
Vegetation, on land or in the water, has a huge impact on our climate by storing carbon, but also naturally cooling the earth through the evaporation of water. However, not every tree is equal and not every tree planting is good.

Game Description
Carbon Capture is an AR, real-world multiplayer game where players are explorers that have to search and collect the biggest, most powerful trees in their area to create a personal collection of trees with the highest carbon captured.

Events pop up on a digital map that show a location close to a player where a special tree might be found and captured. The players have to find their way to the area, analyse the tree and find the biggest carbon capturer in this area. Once scanned and collected, it contributed to the score of the player and can be taken home to be placed with augmented reality (AR) in the neighborhood of the player. The AR placement is uploaded to a shared map, so other players can see your neighborhood be filled with trees again, too.

Desired effects on the player
I would like the players to explore their surroundings again, have fun doing so and learn something about tree properties and history and abilities of different species on the way. Having an ever growing score is supposed to contribute to long term motivation, and placing it in your immediate surrounding in an augmented reality environment should showcase that the shaping of our surroundings is a collaborative effort, and that you as an individual could do your part.
Cloud Musician

Premise
Based on one of my conversations with a cloud modeling professor from TU Delft, I learned that clouds have an immense impact on our climate, and are influenced by it in return. The formation of a cloud is a fascinating process that starts on the micro level by tiny water droplets forming around a dust particle, which then contributes to the structure of a cloud. But not every cloud is equal. Different types of clouds have different effects on our climate, for instance high lying clouds causing a warming effect, while low hanging ones cause a cooling effect.

Game Description
Cloud musician is a music exploration game where players are a controller of forces that have to influence the formation of clouds and play with the different working of parameters in a simplified global world to create a harmonic music experience.

The players witness the life of a cloud, from its initial formation around a wave of dust to its journey around the world and finally its end by raining on a terrain. Each chapter explores a different theme, like the influence of dust, wind, height, temperature and terrain. The game is an aesthetically pleasing experience, with simple swipe interactions to influence different theme parameters. Changing visuals and a generative soundtrack give players feedback over their actions.

Desired effects on the player
I want the players of this game to feel a sense of peace, wonder and fascination, while learning something about the fundamentals of clouds. The experience should be enjoyable in itself, with the idea to shape their understanding of the relation between clouds, our actions and our climate without it feeling like an educational game.

Feedback
+ Through the interaction, it feels like a sandbox game that you only play for a short time
+ Educational aspect / potential is clearly there
+ Visually interesting and abstract
− Perhaps not enough for a proper game
− Still quite vague in how it might feel and look like
Coastal

Premise
Sea level rise is one of the dangers of a changing and warming climate, with coastal towns and tropical islands being the most affected. Water distribution around the world isn’t as easy as you might initially think. It is influenced by different currents, which are equally influenced by temperature changes, and even the gravitation of massive ice sheets in the arctic and antarctic have an influence on the distribution of water around our globe.

Game Description
Coastal is a godlike tower defence where players are builders of a coastal town that have to create a flourishing town and build it in adjustment to the rising sea to a local coastline to keep their citizens safe.

The game explores the interplay between a small coastal city and the vast water system of our earth. By zooming in and out, the player can explore the sea on the local as well as on the global level and explore coastal cities other players build around the earth.

Desired effects on the player
I would like the player to enjoy the experience of building their own little coastal town, and aid this through quick and fun interactions with the game. Starting in different regions of the world, for instance a coast in north europe or an island in the tropics, is supposed to showcase that our global water system is complex and solutions to sea level rise are not a one-fits-them-all approach. I would like the player to understand more about how elements of our climate play together and that with the right treatment the sea could be seen as a partner instead of an opponent that needs repression.

Feedback
- Looks like a fun game
- Hard to see the big picture perhaps, and the other towns
- “You can’t just fix the climate yourself; so how do you see the impact you are having?”
- It might be a good idea of zooming out and not having the pettz human perspective, but focus on something bigger perhaps
Hindsight

Premise
Today’s world is shaped by past decisions and inventions, some of them being discovered by pure luck. Often, things are taken as given and it can be hard to think of alternative histories and futures our societies and planets might have taken. But what if you could go back in time and alter some of our decisions made in the past?

Game Description
Hindsight is an adventure game where players are time travelers that have to manipulate key events in history and alter the course of time to prevent the occurrence and effacing impact of climate change.

Starting in a dystopian future, with the knowledge of the impact of different discoveries or events on our climate, the player has to go back in time and manipulate these events in just the right way to open up the path to an alternative future.

Desired effects on the player
I would like the player to be immersed in the story and develop an understanding of how we got to the point we are today. Technological discoveries, like the discovery of the steam engine, had a massive impact on our history and the world we live in today. Through going back in time and understanding our technological impact on the climate, and opening up a window to alternative realities, I would like the player to again start questioning the status of our current society and feel like we have an agency over what happens in our future.

Feedback
- Would be interesting to experience and change concrete events and then speculate what might have happened
- Difficult to avoid a set agenda from the game designers
- Easy to lose a target group by pushing an agenda
Landshapes

**Premise**
Our actions have an impact on the surface of our earth, and the properties of the surface have an impact on our climate. It makes a difference if sunlight hits a reflective ice sheet, a vegetated area or an asphalted city. We often can’t see the impact of our actions, either because they are too small to notice or the effect happens elsewhere. To act against climate change, we have to do it globally and do it together.

**Game Description**
Landshapes is a free exploration experience, where players can influence the surface of a generated map tile through swipe interactions and shape it to their desires. The landscape resulting from their individual actions is merged into a collaborative, physical art piece in a remote exhibition.

The interactive experience is surrounded by stories about fascinating interactions with and in our climate system that players can explore.

**Desired effects on the player**
I would like the players to enjoy the interaction with my experience, and have fun and be engaged for as long as they want. The engagement can last from only a few seconds to a few minutes or longer. I want them to feel a fascination for the shaping of landscapes and our climate system again and understand that our actions and how we choose to shape the world with our individual, as well as communal actions, does have an impact on the earth - even if you can't see it right away.

**Feedback**
- Very abstract, so you would need to see your impact and a sense of progress
- On this abstract level it is very interesting
- Aesthetically pleasing and fascinating
- Very nice and engaging visuals
- Catching the attention
- How would people take notice of this experience?
- “What will people take out of this experience?”
- Interesting message, but it has to be clear and sharp
- Might be difficult to balance between desired outcome and freedom
- Going to an exhibition is a lot of commitment for people
- Testing data
Cycle 2: Interaction Testing

The prototypes were tested remotely with three participants over Zoom and the feedback gathered in an informal fashion to encourage conversation and free expression. After each prototype test, the participant was asked to switch to a provided Miro board and give qualitative feedback. This process was supported by the PrEmo tool (Laurans & Desmet, 2017) to help participants express the emotions felt while using a prototype.

Procedure

1. **On Boarding**, explaining what the test will be about
2. **Testing** each prototype, sharing the screen at the same time and collecting comments on the way
3. **Evaluation**, collecting comments and feedback to each prototype on Miro
4. **Creative session**, collecting ideas and input

Questions asked during the interview:

1. How would you assess the aesthetic of the prototype?
2. How did this interaction feel to you?
3. What did you like? What didn’t you like?

Analysis

The feedback of participants was combined and clustered into positive, neutral and negative feedback towards each prototype and color coded to aid quick viewability.
Prototype Testing: Cycle 1 // Participant 1

P1: One Button

Like

Dislike

General

Satisfaction

“I like seascapes, and there was always a sea present”

Desire

Curious what landscape comes next when pressing the button

Curious what comes next
P2: Swiping

Most visually interesting (.transitions)

Like
- All the details you can see are interesting
- Interesting to interact with the prototype

Dislike
- I'd like to keep it as a wallpaper
- First thought the website was broken, as nothing happened
- Not clear how to interact, or that you can interact
- Frustrating that I couldn't figure out how it works, or how to influence the landscape

General
- I would feel proud if I would've figured it out
- Mini introduction needed

Fascination
- Unclear if I missed hidden interactions somewhere

Joy
- Transition was joyful to watch
- Swiping was uncomplicated

Desire
- Mini introduction needed
P4: Choosing

**Easiest interaction**
- Most satisfying interaction (clear interaction)

**Like**
- Uncomplicated interaction, no redundant buttons
- I don't expect other interaction methods
- Good that there is a click mouse handle
- Nice, simple website layout
- "Not clickable anymore, so it is apparently done"
- I always have two options and apparently create an image in the end
- I get a different image in the end than I actually wanted
- I'd expect that during the last step that I can choose one of the above

**Dislike**
- Either the last step has another change

**General**
- No Indication of "make your final choice"
- The last step is confusing
- I do not understand why I am doing all the work if there is something completely different in the end

**Fascination**
- Satisfying that you come to an end
- Clear threat to follow
- Wondering what's coming next?
- Selbstwirkungsführung
- Wondering what's coming next?

**Anger**
- I always have two options and apparently create an image in the end
- I get a different image in the end than I actually wanted
- I'd expect that during the last step that I can choose one of the above
P5: Drawing

Most engaging interaction (from a result)

Like

- Frustration that I wasn't done yet
- A bit too open with no starting point

Dislike

- Confusing in the beginning, thought it would be only a paint
- Open end can be good and bad

General

- The tools where not the nicest, with the paintbrush and so on

Fascination

- Get nice once you saw it translate into the photo landscape
- Want to explore more of what you could do

Joy

- "I could spend way more time with this"

Ugly website

- Drastic
Prototype Testing: Cycle 1 // Participant 2

P1: One Button

Like

Dislike

General

I wouldn't go to this website for fun

Like that it looks realistic or does not exist

The pictures don't look that realistic though

Like that there is a button to get a new picture, compared to [this person does not exist]

Figuring out what the different pictures show

Aesthetics of it

Fascination

Fascination
P2: Swiping

**Like**
- General
- A lot happens
- It is very pleasing
- I haven't figured it out yet
- It is impressive
- I wouldn't do that often, because I do not know what it is for

**Dislike**

**Satisfaction**
- I want to keep playing with it, I want to figure it out
- The fun is a bit gone once you figure it out

**Joy**
- I like the dragging of the mouse visualization
P3: Fly-through

Like
- It's cool, it's fun! It's quite an experience to fly through this
- I like the feeling of flying through something

Dislike
- The controls are easier and free/versatile than the one before (after the explanation)

General
- I'm exploring and trying to see the different landscapes
- Feels more like a game compared to the prototype before
- The purpose is still not clear, but with this experience it does not matter too much. The experience makes it worthwhile

I want to do more with it
- Like you fly into the cube and a whole new world appears
- With more variations I would go here and play more often
- (perhaps because of my sick prototyping skills)

Excitement!

Joy

Fascination
P5: Drawing

Like

Dislike

General

It's fun

I'm not a landscape architect, so I do not want to design landscapes

Joy

It's cool to turn a sketch into a high res pictures

Admiration

For the tool

I'd like to adjust the options more
Prototype Testing: Cycle 1 // Participant 3

P1: One Button

- Like:
  - When looking for an image, the minimalism was fitting

- Dislike:
  - The button is on a corner and the image is too small

- General:
  - Very much on point when your goal is looking on images

- Fascination:
  - You can create a narrative for yourself when looking at the image
  - It could be even a tool for artists to find new patterns and backgrounds
  - A little "ahha" moment
P2: Swiping

**Like**
- the most engaging experience
- swiping the best emotional interaction
- Good that you already have something to start with
- It is more interesting than the prototype before
- Feels like a nice foundation to build on top
- I like that it is reacting to what I am doing (acting, reacting)

**Dislike**
- Image size is too small again
- I am missing a narrative around it
- Opportunity to add a narrative there

**General**
- There needs to be a prior setup to make it personal
- Would be nice to have sliders to see what you are influencing
- How to make it more personal?
- How to allow them to attribute personal invasiveness?
- It feels organic, the transitions between images

**Satisfaction**

**Fascination**
P3: Fly-through

Like

Dislike

3D is sacrificing controllability

3D pulls away the focus from the images

General

There needs to be a tooltip to explain the controls

P3: I like the 3D mobility

It could also be layers after layers, and you go and fly through them

Opportunity to add a narrative

Curiosity of what is happening in the 3D space

Fascination

Like mario

64 paintings, rippling like water

The cursor position could have another functionality
P4: Choosing

Like

- It is interesting to see the transition of the images. You try to find a logic in it.

Dislike

- I don't know what to do at this page
- I am missing a direction of what is going on
- "Make a choice" and "Go back" look like the same element

General

- Choice based on what? Could be a question that you have to answer
- If it is not open play, then there is the need for a narrative
- If there are limited choices, why are those the options?
- You don't know if your own logic is the same as the one that the developer thought of

Confusion: "But why?"
P5: Drawing

Like

Dislike

General

Interesting that they are telling you what you will end up with

It is interesting for exploration

What if some people are creating environments and some people are destroying them?

If the images are self-generated, I do not need to worry about the selection of the images

Interesting that you can break something

You could invest a lot of time, which could be a good or a bad thing
Additional exploration
OUR WORLD IS PRECIOUS. JUST LIKE YOU.

Land/Scopes is an AI-driven experience that allows you to discover marvelous stories about our world’s climate and lets you impact our communal vision of the future.

Start exploring
THE LITHOSPHERE

Our earth crust is a constantly shifting layer of rock, like mountains, gravel and sand. Over billions of years, those movements formed our seven continents.
THE HYDROSPHERE

More than 71% of our planet are covered in oceans. With water being the foundation for all life on earth and crucial habitat for many organisms, it influences every other climate system.
OUR PLANET, OUR CLIMATE

Introduction
THE ATMOSPHERE

Our planet is encapsulated by a layer of gas, which we know as the atmosphere.
import processing.serial.*;
import java.io.File;
import processing.video.Movie;

Movie myMovie;
float fps = 25;

int startTime = 1;
boolean ended;

int dWidth = 1920;
int dHeight = 1080;

boolean debug = false;
boolean goUp = false;

// Mask
PImage mask;
boolean masked = true;

boolean rotate = false;
float rotationAngle = 0;
float rotationIncrease = 0.1;

boolean automatic = true;
int autoTimer = 100;

Serial myPort;
String val;
int pos = 0;
int oldPos = 0;
float increment = 0.5;

void setup(){
    //size(1024,1024);

    myMovie = new Movie(this, "outputR1.mov");
    myMovie.jump(startTime);
    frameRate(24);
    myMovie.jump(startTime);
    myMovie.jump(startTime);
    fullScreen();
    println(width, height);
    mask = loadImage("maskFS.png");
    printArray(Serial.list());
}

void draw(){
    background(0);
    if (myPort.available() > 0) // If data is available,
        val = myPort.readStringUntil(’\n’); // read it and store it in val
    if(val != null){
        try {
            pos = Integer.parseInt(val.trim());
            autoTimer = 100;
            automatic = false;
            myMovie.play();
            if(pos > oldPos){
                myMovie.jump(myMovie.time() + increment);
                goUp = true;
                //rotationAngle += rotationIncrease;
            } else{
                myMovie.jump(myMovie.time() - increment);
                goUp = false;
                //rotationAngle -= rotationIncrease;
            }
            myMovie.read();
            myMovie.pause();
            oldPos = pos;
        } catch (NumberFormatException npe){
        }
}

if(myMovie.time() >= myMovie.duration() && goUp){
    myMovie.jump(0.0);
} else{
    if(myMovie.time() <= 0 || !goUp){
        myMovie.jump(myMovie.duration()-0.2);
    }
    oldPos = pos;
} catch (NumberFormatException npe){
}
if(autoTimer < 0 && automatic == false){
    automatic = true;
    println("Switch on Automatic");
    myMovie.loop();
}

if(automatic == true){
    myMovie.read();
    rotationAngle += rotationIncrease;
}

if(rotate){
    pushMatrix();
    translate(width/2,height/2);
    rotate(radians(rotationAngle));
    image(myMovie, -512, -512, 1024, 1024);
    popMatrix();
} else{
    image(myMovie, width/2 - 512, height/2 - 512, 1024, 1024);
}

if(masked){
    stroke(255);
    strokeWeight(5);
    image(mask,0,0,width,height);
}

if(debug){
    text(pos, 20,80);
    text(autoTimer,20,60);
    text(frameRate, 20,20);
}

myPort.clear();

//println("Current Time = " + myMovie.
time() + " || " + " Current Rotary Pos = " + pos/
fps);

autoTimer--;
}
Arduino Code for Video Control

/** Encoder Library - Basic Example
 * http://www.pjrc.com/teensy/td_libs_Encoder.html
 * 
 * This example code is in the public domain.
 */

#include <Encoder.h>

// Change these two numbers to the pins connected to your encoder.
//   Best Performance: both pins have interrupt capability
//   Good Performance: only the first pin has interrupt capability
//   Low Performance: neither pin has interrupt capability
//   avoid using pins with LEDs attached
Encoder myEnc(2, 3);

void setup() {
  Serial.begin(115200);
  Serial.println("Basic Encoder Test:");
}

long oldPosition = -999;

void loop() {
  long newPosition = myEnc.read();
  if (newPosition != oldPosition) {
    Serial.println(newPosition);
    oldPosition = newPosition;
  }
}

This notebook demonstrates how to save an Earth Engine [image collection animation] (https://developers.google.com/earth-engine/ic_visualization) to Google Drive.

### Setup Earth Engine

```python
import ee
import ee.mapclient
import urllib.request
ee.Authenticate()
ee.Initialize()
```

### Mount Google Drive to Colab VM

```python
from google.colab import drive
drive.mount('/content/drive', force_remount=False)
```

### Sentinel 2 Export

```python
import pandas as pd
locations = pd.read_csv('/content/drive/MyDrive/Studies/Design for Interaction/5. Semester/Graduation/10 Data Collection/5000_random_land(excluding extremes).csv')
print(locations)
startLocation = 2087
for index, row in locations.iloc[startLocation:].iterrows():
    print(index, row['id'], row['X'], row['Y'])
    longitude = row['X']
    latitude = row['Y']
    #longitute = -93.98257930473329
    #latitute = 77.5110301473185
    zoom = 8
    min = 0.0
    # change the image output based on snow probability of latitude
    if latitude < -61 or latitude > 65:
        print("adjusted max")
        max = 8000
    else:
        max = 3000
    # Create custom color palette
    palette = ["000000", # Unknown
               "33FF99", # Shrubs
               "33FF99", # Herbaceous vegetation
               "33FF99", # Cultivated and managed vegetation / agriculture
               "FF0000", # Urban / built up
               "FFFF00", # Cultivated land
               "CC33CC", # Bare / sparse
               "FFFFFF", # Snow and Ice
               "00FFF0", # Permanent water bodies
               "00FF00", # Forest
               "00FF00", # Forest
               "00FF00", # Forest
               "00FF00", # Forest
               "00FF00", # Forest
               "00FF00", # Forest
               "00FF00", # Forest
               "0000FF" # Ocean
               ]
    center = ee.Geometry.Point(longitude,latitude)
    s2 = (ee.ImageCollection("COPERNICUS/S2_SR")
          .filterBounds(center)
          .sort('CLOUDY_PIXEL_PERCENTAGE')
          .filterDate('2019-01-01', '2019-12-30')
          .first())
```

---

**Colab Code for Dataset creation**

```python
import pandas as pd
locations = pd.read_csv('/content/drive/MyDrive/Studies/Design for Interaction/5. Semester/Graduation/10 Data Collection/5000_random_land(excluding extremes).csv')
print(locations)
startLocation = 2087
for index, row in locations.iloc[startLocation:].iterrows():
    print(index, row['id'], row['X'], row['Y'])
    longitude = row['X']
    latitude = row['Y']
    #longitute = -93.98257930473329
    #latitute = 77.5110301473185
    zoom = 8
    min = 0.0
    # change the image output based on snow probability of latitude
    if latitude < -61 or latitude > 65:
        print("adjusted max")
        max = 8000
    else:
        max = 3000
    # Create custom color palette
    palette = ["000000", # Unknown
               "33FF99", # Shrubs
               "33FF99", # Herbaceous vegetation
               "33FF99", # Cultivated and managed vegetation / agriculture
               "FF0000", # Urban / built up
               "FFFF00", # Cultivated land
               "CC33CC", # Bare / sparse
               "FFFFFF", # Snow and Ice
               "00FFF0", # Permanent water bodies
               "00FF00", # Forest
               "00FF00", # Forest
               "00FF00", # Forest
               "00FF00", # Forest
               "00FF00", # Forest
               "00FF00", # Forest
               "00FF00", # Forest
               "0000FF" # Ocean
               ]
    center = ee.Geometry.Point(longitude,latitude)
    s2 = (ee.ImageCollection("COPERNICUS/S2_SR")
          .filterBounds(center)
          .sort('CLOUDY_PIXEL_PERCENTAGE')
          .filterDate('2019-01-01', '2019-12-30')
          .first())
```

---

```python
import ee
ee.Authenticate()
ee.Initialize()
```
try:
    footprint = (ee.Geometry.Polygon((s2.getInfo().get('properties').get('system:footprint').get('coordinates'))))
except:
    print("No Footprint found")
    continue

# Create a rectangular export area
exportAreaLarge = (footprint.centroid().buffer(40000).bounds());
exportAreaMedium = (footprint.centroid().buffer(25000).bounds());
exportAreaSmall = (footprint.centroid().buffer(10000).bounds());

# print(footprint.contains(exportArea,1).getInfo())
if footprint.contains(exportAreaLarge,1).getInfo() == True:
    print("Large fits")
    exportArea = exportAreaLarge
elif footprint.contains(exportAreaMedium,1).getInfo() == True:
    print("Medium fits")
    exportArea = exportAreaMedium
elif footprint.contains(exportAreaSmall,1).getInfo() == True:
    print("Small fits")
    exportArea = exportAreaSmall
else:
    print("No fit")
    continue

s2Vis = {
    "region": exportArea,
    "crs": (s2.select('B4').projection()),
    "dimensions": "1024x1024",
    "format": 'jpg',
    "min": 0,
    "max": 200,
    "palette": palette,
    "bands": ['discrete_classification']
}

landcoverVis = {
    "region": exportArea,
    "crs": (s2.select('B4').projection()),
    "dimensions": "1024x1024",
    "format": 'jpg',
    "min": 0,
    "max": 200,
    "palette": palette,
    "bands": ['discrete_classification']
}

s2_url = (s2.getThumbURL(s2Vis))
landcover_url = (landcover.getThumbURL(landcoverVis))

s2_url = "/content/drive/MyDrive/Sentinel Landmass/RGB/S2_{}*{}*{}.jpg".format(row['id'], longitude, latitude)
landcover_url = "/content/drive/MyDrive/Sentinel Landmass/SEG/S2_{}*{}*{}.jpg".format(row['id'], longitude, latitude)

urllib.request.urlretrieve(s2_url, s2_name)
urllib.request.urlretrieve(landcover_url, landcover_name)

print(s2_url)
print(landcover_url)

# Single export
longitude = -93.98257930473329
latitude = 77.5110301473185
zoom = 8
min = 0.0
max = 3000
center = ee.Geometry.Point(longitude, latitude)

# Import Sentinel dataset
s2 = (ee.ImageCollection("COPERNICUS/S2")
   .filterBounds(center)
   .sort("CLOUDY_PIXEL_PERCENTAGE")
   .filterDate('2020-01-15', '2020-12-15')
   .first())

# Import landcover usage set
landcover = (ee.Image("COPERNICUS/Landcover/100m/Proba-V-C3/Global/2019").select('discrete_classification'))

# Working, but with getInfo()
footprint = (ee.Geometry.Polygon((s2.getInfo().get('system:footprint').get('coordinates'))))
except:
    print("No Footprint found")
    continue

# Create a rectangular export area
exportAreaLarge = (footprint.centroid().buffer(40000).bounds());
exportAreaMedium = (footprint.centroid().buffer(25000).bounds());
exportAreaSmall = (footprint.centroid().buffer(10000).bounds());

# print(footprint.contains(exportArea,1).getInfo())
if footprint.contains(exportAreaLarge,1).getInfo() == True:
    print("Large fits")
    exportArea = exportAreaLarge
elif footprint.contains(exportAreaMedium,1).getInfo() == True:
    print("Medium fits")
    exportArea = exportAreaMedium
elif footprint.contains(exportAreaSmall,1).getInfo() == True:
    print("Small fits")
    exportArea = exportAreaSmall
else:
    print("No fit")
    continue

s2Vis = {
    "region": exportArea,
    "crs": (s2.select('B4').projection()),
    "dimensions": "1024x1024",
    "format": 'jpg',
    "min": 0,
    "max": 200,
    "palette": palette,
    "bands": ['discrete_classification']
}

landcoverVis = {
    "region": exportArea,
    "crs": (s2.select('B4').projection()),
    "dimensions": "1024x1024",
    "format": 'jpg',
    "min": 0,
    "max": 200,
    "palette": palette,
    "bands": ['discrete_classification']
}
# Create a rectangular export area
exportAreaLarge = (footprint.centroid().buffer(30000).bounds);
exportAreaMedium = (footprint.centroid().buffer(20000).bounds);
exportAreaSmall = (footprint.centroid().buffer(10000).bounds);

print(footprint.contains(exportArea,1).getInfo())

if footprint.contains(exportAreaLarge,1).getInfo() == True:
    print("Large fits")
    exportArea = exportAreaLarge
elif footprint.contains(exportAreaMedium,1).getInfo() == True:
    print("Medium fits")
    exportArea = exportAreaMedium
elif footprint.contains(exportAreaSmall,1).getInfo() == True:
    print("Small fits")
    exportArea = exportAreaSmall
else:
    print("No fit")
#continue

s2Vis = {
    'region': exportArea,
    'crs': (s2.select('B4').projection()),
    'dimensions': '1024x1024',
    'format': 'jpg',
    'min': min,
    'max': max,
    'bands': ['B4', 'B3', 'B2']
}

landcoverVis = {
    'region': exportArea,
    'crs': (s2.select('B4').projection()),
    'dimensions': '1024x1024',
    'format': 'jpg',
    'bands': ['discrete_classification']
}

s2_url = (s2.getThumbURL(s2Vis))
landcover_url = (landcover.getThumbURL(landcoverVis))

s2_name = "~/content/drive/MyDrive/Sentinel Coastline/RGB/S2_()`*.jpg".format(row['id'], longitude,latitude)
landcover_name = "~/content/drive/MyDrive/Sentinel Coastline/SEG/S2_()`*.jpg".format(row['id'], longitude,latitude)

urllib.request.urlretrieve(s2_url, s2_name)
urllib.request.urlretrieve(landcover_url, landcover_name)

print(s2_url)
print(landcover_url)

"""## Download the animation to Google Drive"""

s2_name = "~/content/drive/MyDrive/Sentinel Coastline/RGB/S2_()`*.jpg".format(longitude,latitude)
landcover_name = "~/content/drive/MyDrive/Sentinel Coastline/SEG/S2_()`*.jpg".format(longitude,latitude)

urllib.request.urlretrieve(s2_url, s2_name)
urllib.request.urlretrieve(landcover_url, landcover_name)

while True:pass

"""## Landsat Mosaic Export
Retrieved from https://developers.google.
com/earth-engine/datasets/catalog/USGS_ LIMA_MOSAIC#description
"""

saveFolder = '~/content/drive/MyDrive/Antarctica Coastline/coastline_large'

"""## Single Export"""

longitude = 164.619
latitude = -77.99
min = 0.0
max = 10000

center = ee.Geometry.Point(longitude,latitude)

# Import Sentinel dataset
antarctica = (ee.Image("USGS/LIMA/MOSAIC")
.select(['B3', 'B2', 'B1'])
)

# Create a rectangular export area
exportAreaLarge = (center.buffer(50000).bounds);
# Export Area

```python
print(footprint.contains(exportArea,1).getInfo())
if footprint.contains(exportAreaLarge,1).getInfo() == True:
    print("Large fits")
    exportArea = exportAreaLarge
elif footprint.contains(exportAreaMedium,1).getInfo() == True:
    print("Medium fits")
    exportArea = exportAreaMedium
elif footprint.contains(exportAreaSmall,1).getInfo() == True:
    print("Small fits")
    exportArea = exportAreaSmall
else:
    print("No fit")
    # continue

vis = {
    'region': exportAreaLarge,
    'dimensions': '1024x1024',
    'format': 'jpg',
    'min': min,
    'max': max,
}
try:
    image_url = (antarctica.getThumbURL(vis))
except:
    print("Export not possible")
    continue
image_name = "{}/A_Largest_{}*{}.jpg".format(saveFolder, id, latitude, longitude)
urllib.request.urlretrieve(image_url, image_name)
print("Saved", image_url, "to ", image_name)
```

## Multi Export

```python
import pandas as pd
locations = pd.read_csv('/content/drive/MyDrive/Studies/Design for Interaction/5. Semester/Graduation/10 Data Collection/Antarctica_coastline copy.csv')
print(locations)
saveFolder = '/content/drive/Antarctica Coastline/coastline_largest'
startLocation = 0

# Import Sentinel dataset
antarctica = (ee.Image("USGS/LIMA/MOSAIC")
             .select(['B3', 'B2', 'B1']))
for index, row in locations.iloc[startLocation::15].iterrows():
    longitude = row['X']
    latitude = row['Y']
    id = index
    min = 0.0
    max = 10000
    center = ee.Geometry.Point(longitude, latitude)
    # Create a rectangular export area
    exportAreaLarge = (center.buffer(200000).bounds());
    #exportAreaMedium = (center.buffer(20000).bounds());
    #exportAreaSmall = (center.buffer(10000).bounds());
    vis = {
        'region': exportAreaLarge,
        'dimensions': '1024x1024',
        'format': 'jpg',
        'min': min,
        'max': max,
    }
    try:
        image_url = (antarctica.getThumbURL(vis))
    except:
        print("Export not possible")
        continue
    image_name = "{}/A_Largest_{}*{}.jpg".format(saveFolder, id, latitude, longitude)
    urllib.request.urlretrieve(image_url, image_name)
    print("Saved", image_url, "to ", image_name)```