

Indoor positioning with the Microsoft HoloLens

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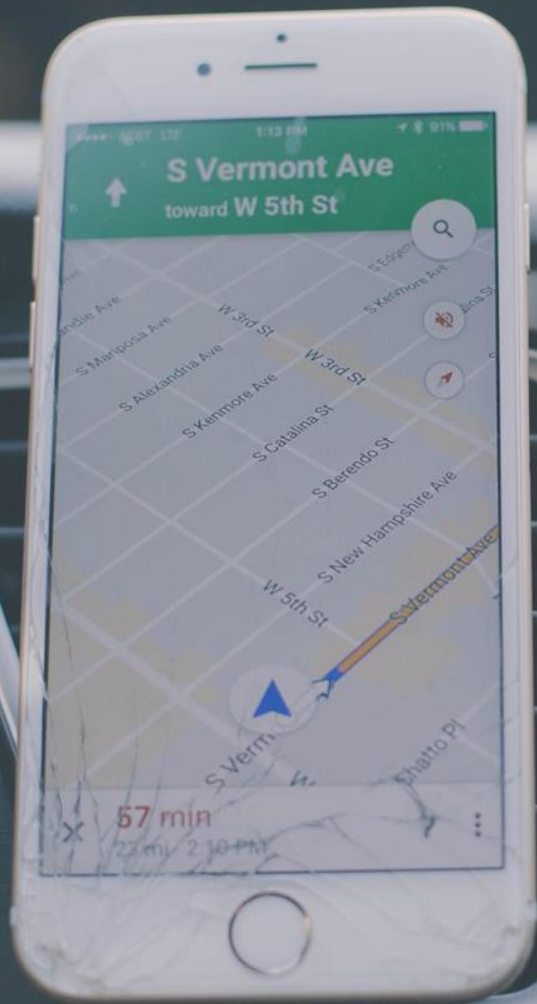
Supervisors

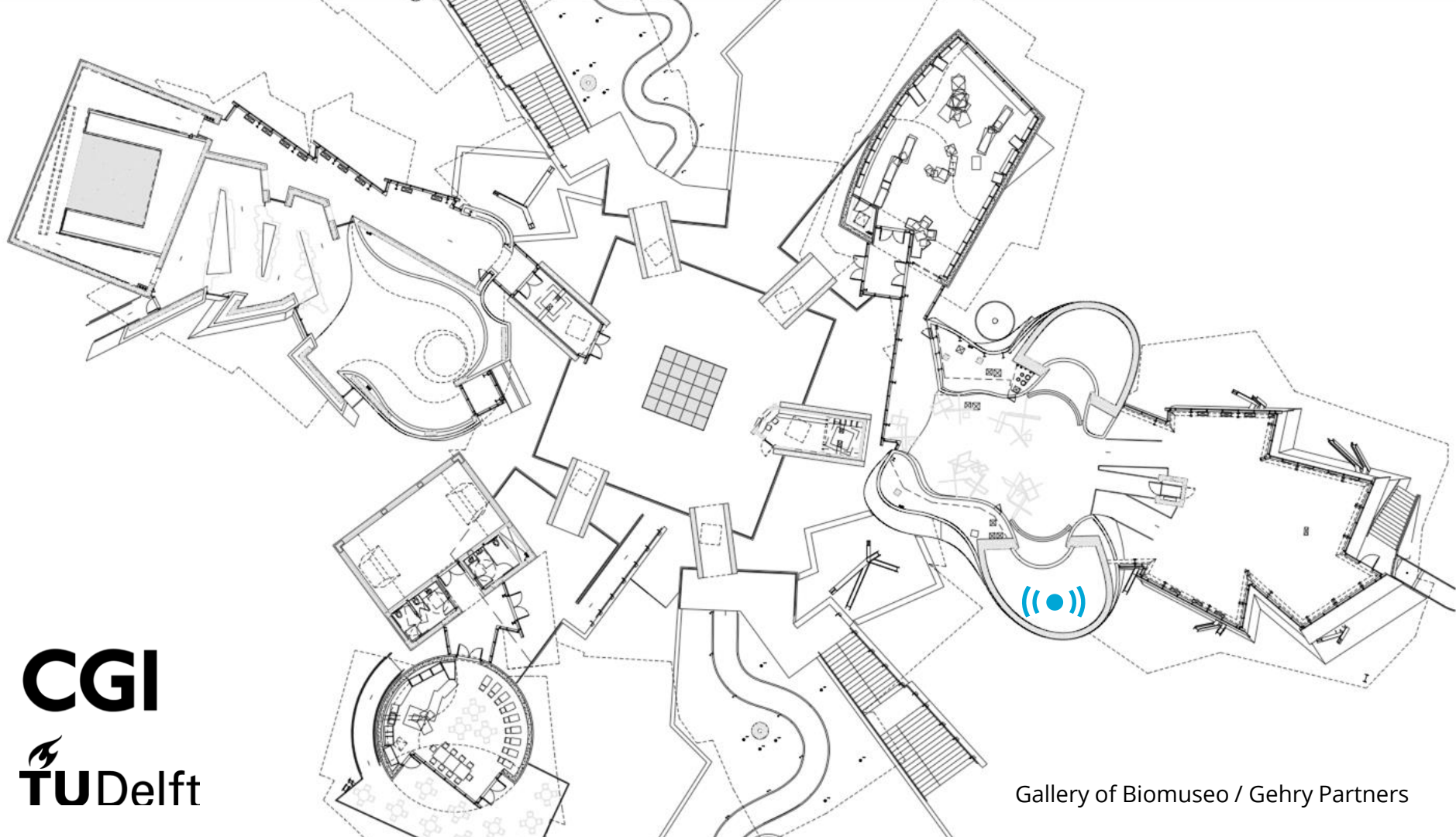
TU Delft Stelios Vitalis

TU Delft Ken Arroyo Ohori

CGI Robert Voûte







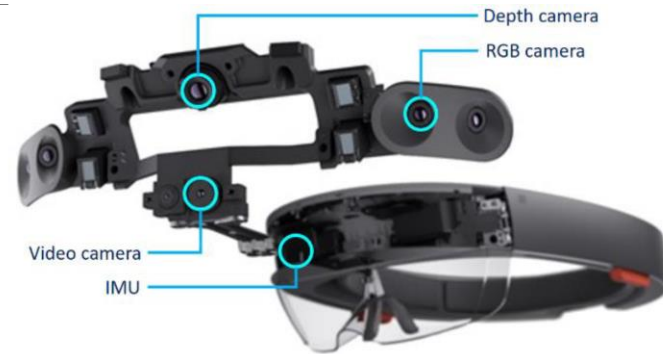
Emergency Response



- . Location not known beforehand
- . Little time available
- . No extensive 3D data at hand

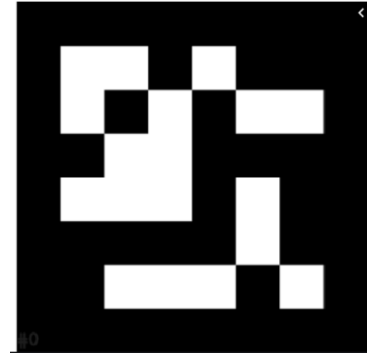
SLAM

- . Simultaneously Localization and Mapping
- . No connection with existing data
- . Drift Error



Previous attempts

- . Marker-Based
- . ICP algorithm



Develop a method to estimate **the position** of the **Microsoft Hololens** on a **2D floor plan**, without any pre-existing infrastructure.

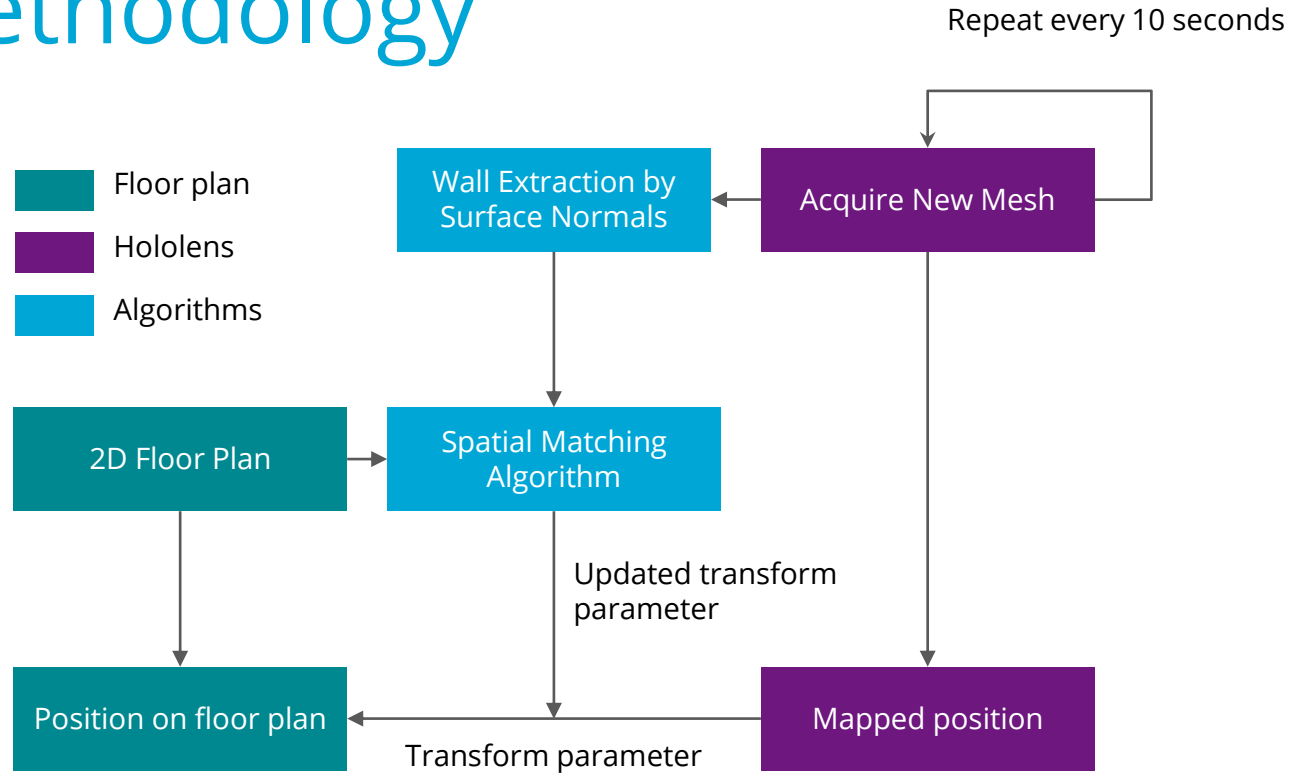
- . Position precision & reliability
- . When does the method fail

Research Questions

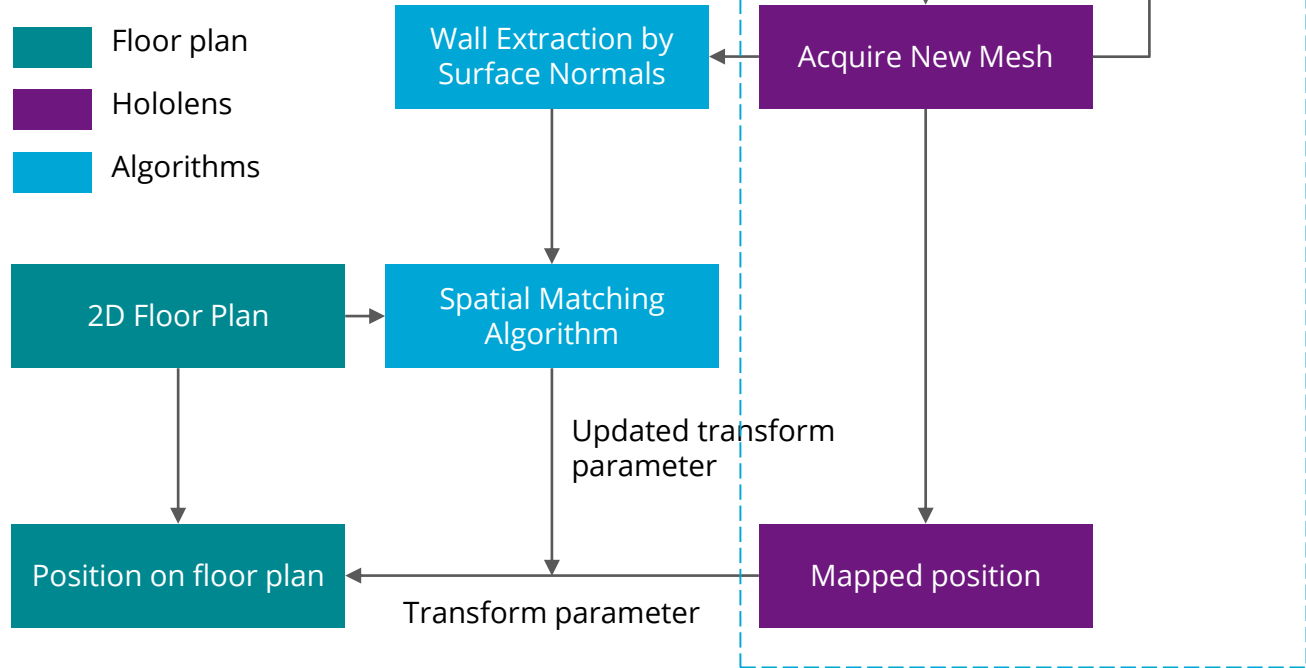
How can the Microsoft Hololens improve indoor positioning, using the on-the-fly produced mesh with an existing 2D floor plan?

1. What **spatial matching techniques** are feasible to match a **3D mesh** acquired real-time with the Microsoft Hololens with an **existing 2D floor plan**?
2. What is the most promising spatial matching technique in terms of **accuracy** and **speed**?
3. How can the **indoor positioning** of the Hololens be improved by making use of the researched positioning method?
4. In which cases does the researched positioning method **fail** to estimate the position on a 2D floor plan?

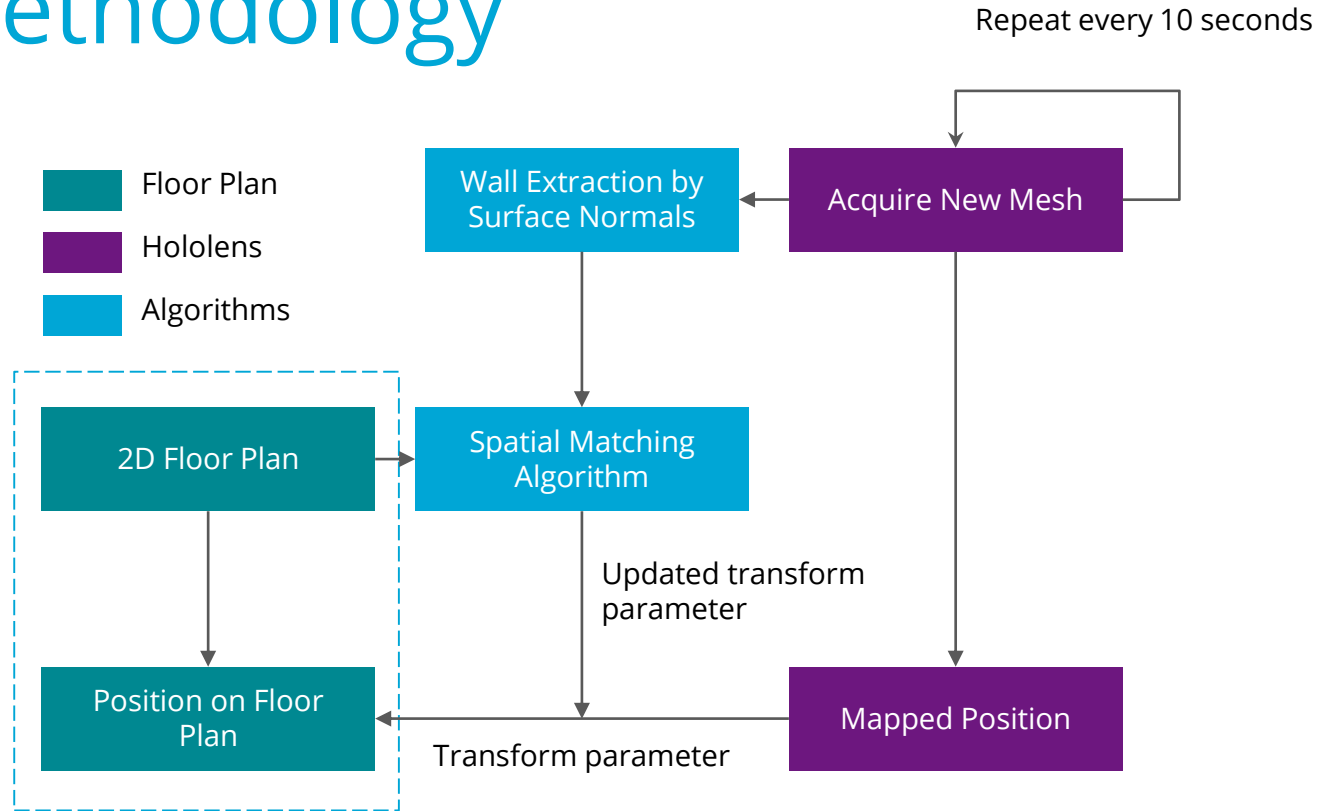
Methodology



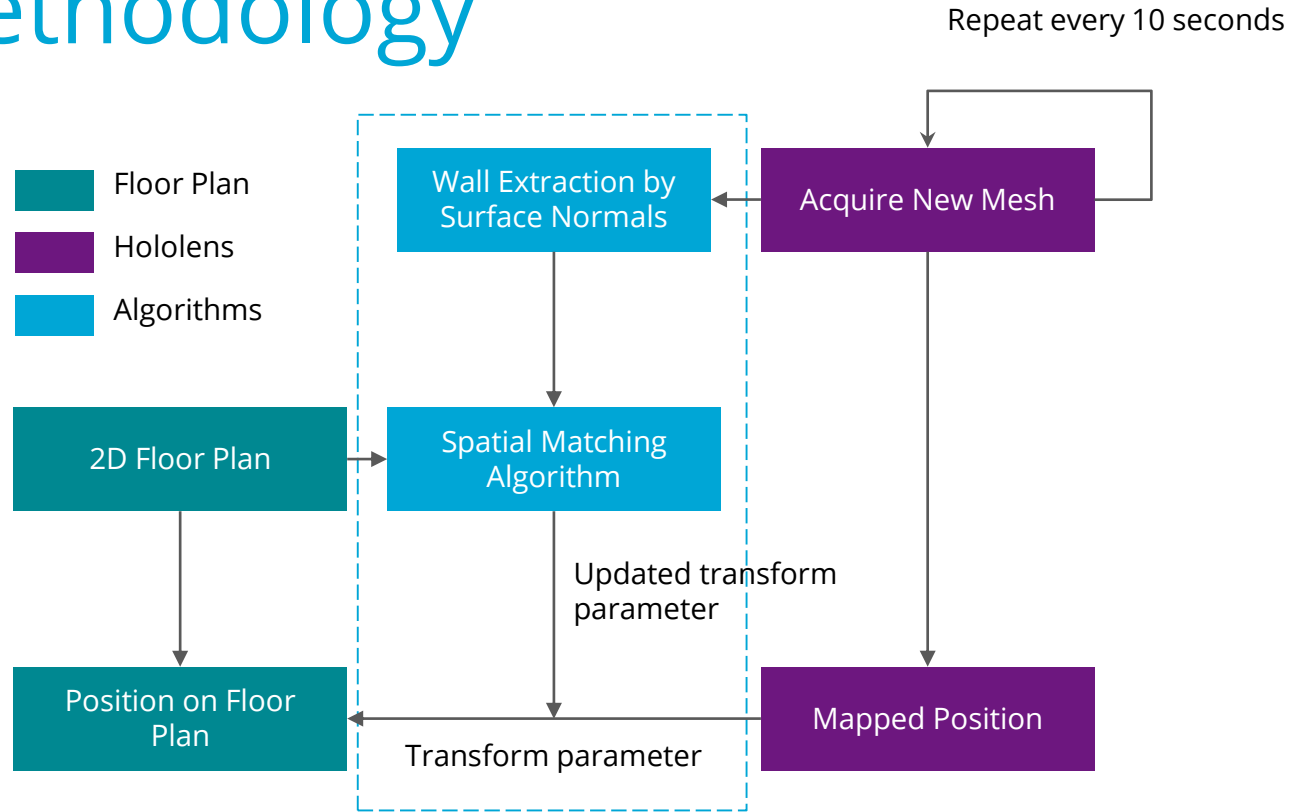
Methodology



Methodology



Methodology





"I'm in the bedroom"

Location



*"I'm at point
(0.5, 10) with a
precision of 3m
"*

Position



"I'm in the bedroom"

Location



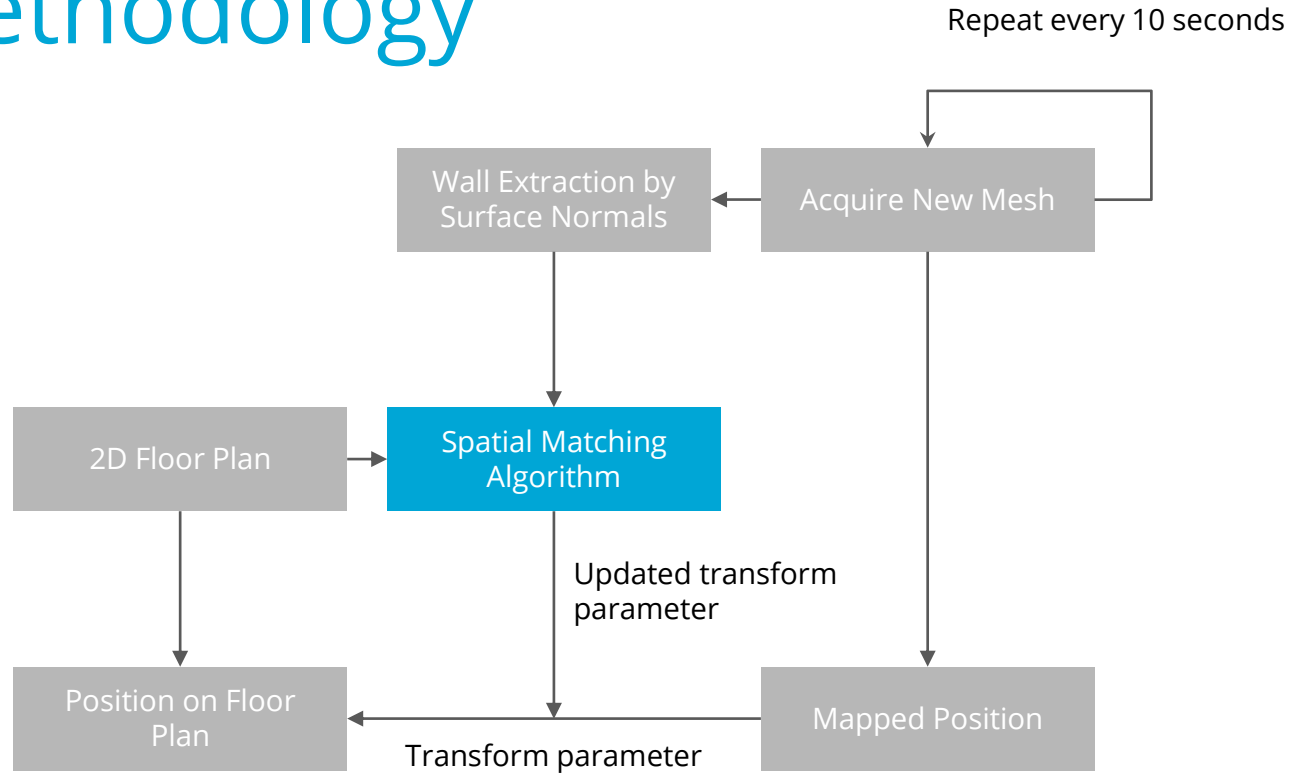
*"I'm at point
(0.5, 10) with a
precision of 3m
"*

Position

Floor Plan

- . Correct scale
- . Vector format
- . Semantics
- . No noise

Methodology



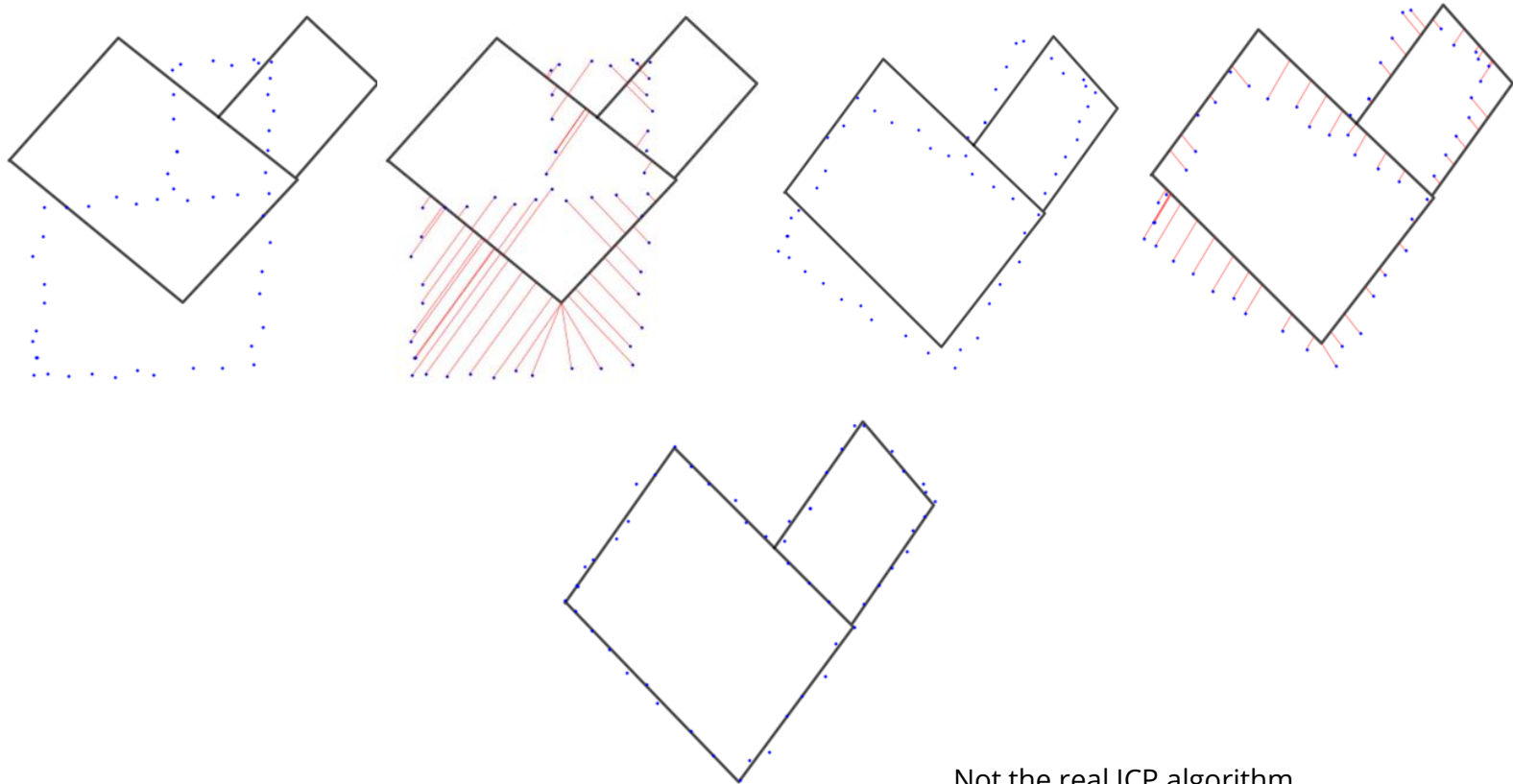
- . Iterative Closest Point (ICP)
- . Local Quadratic Approximation & Instantaneous Kinematics
- . Hough Transform

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Algorithms

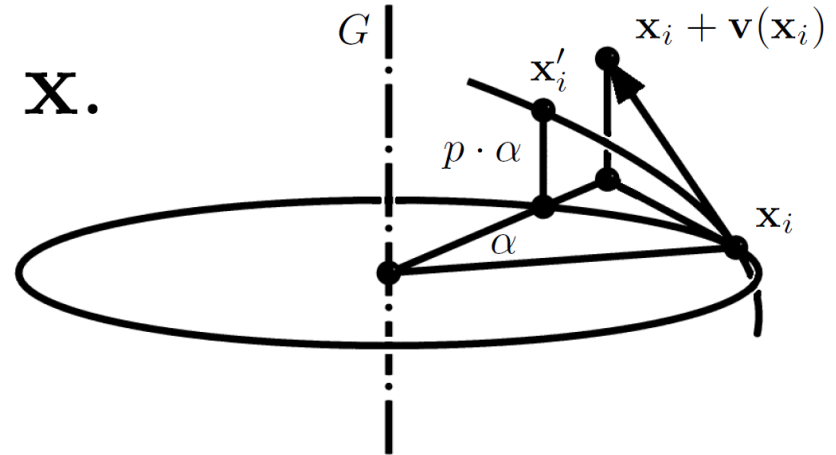
Iterative Closest Points



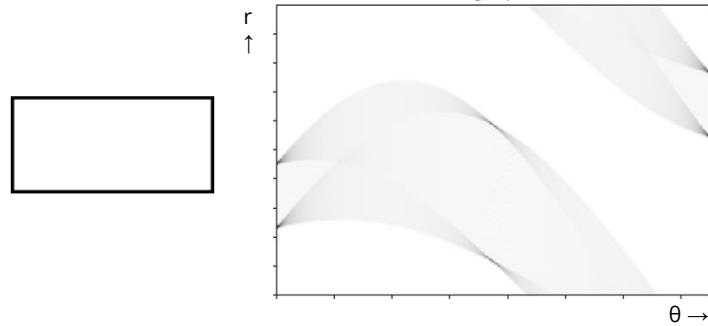
Local Quadratic Approximation & Instantaneous Kinematics

- . ICP & small distances
- . Helical motion

$$\mathbf{v}(\mathbf{x}) = \bar{\mathbf{c}} + \mathbf{c} \times \mathbf{x}.$$



Hough Transform



Reference image



Translation

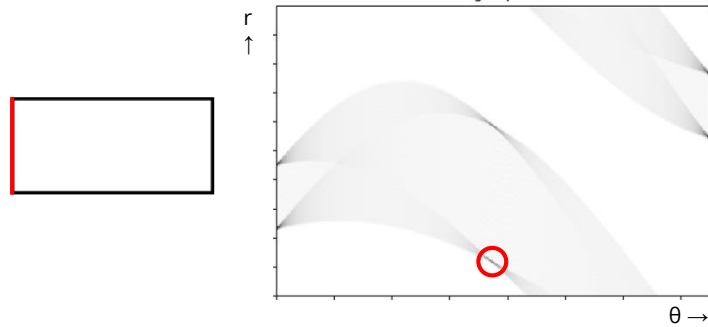


Rotation



Translation + Rotation

Hough Transform



Reference image



Translation

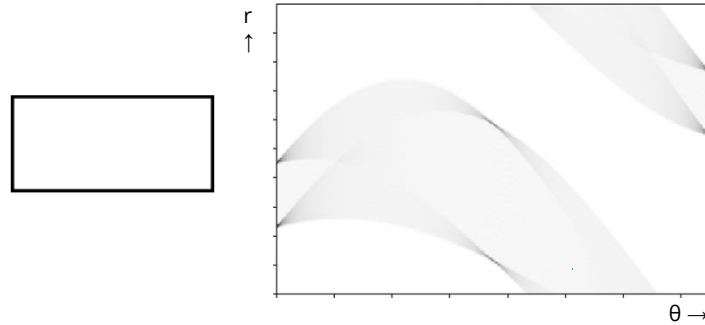


Rotation

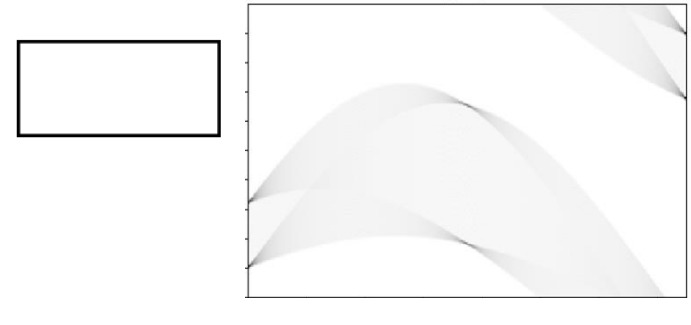


Translation + Rotation

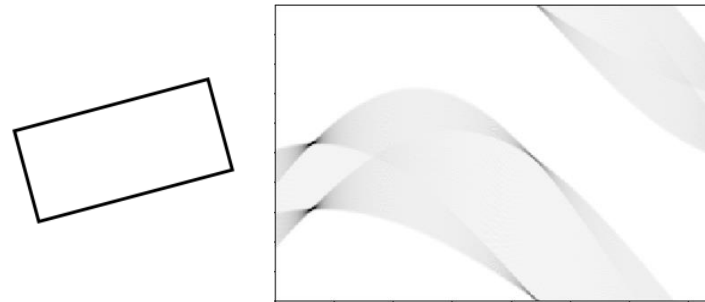
Hough Transform



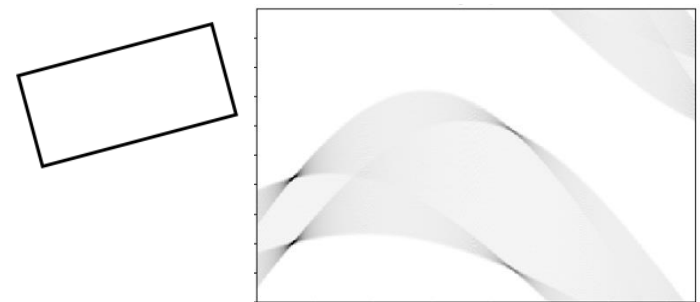
Reference image



Translation



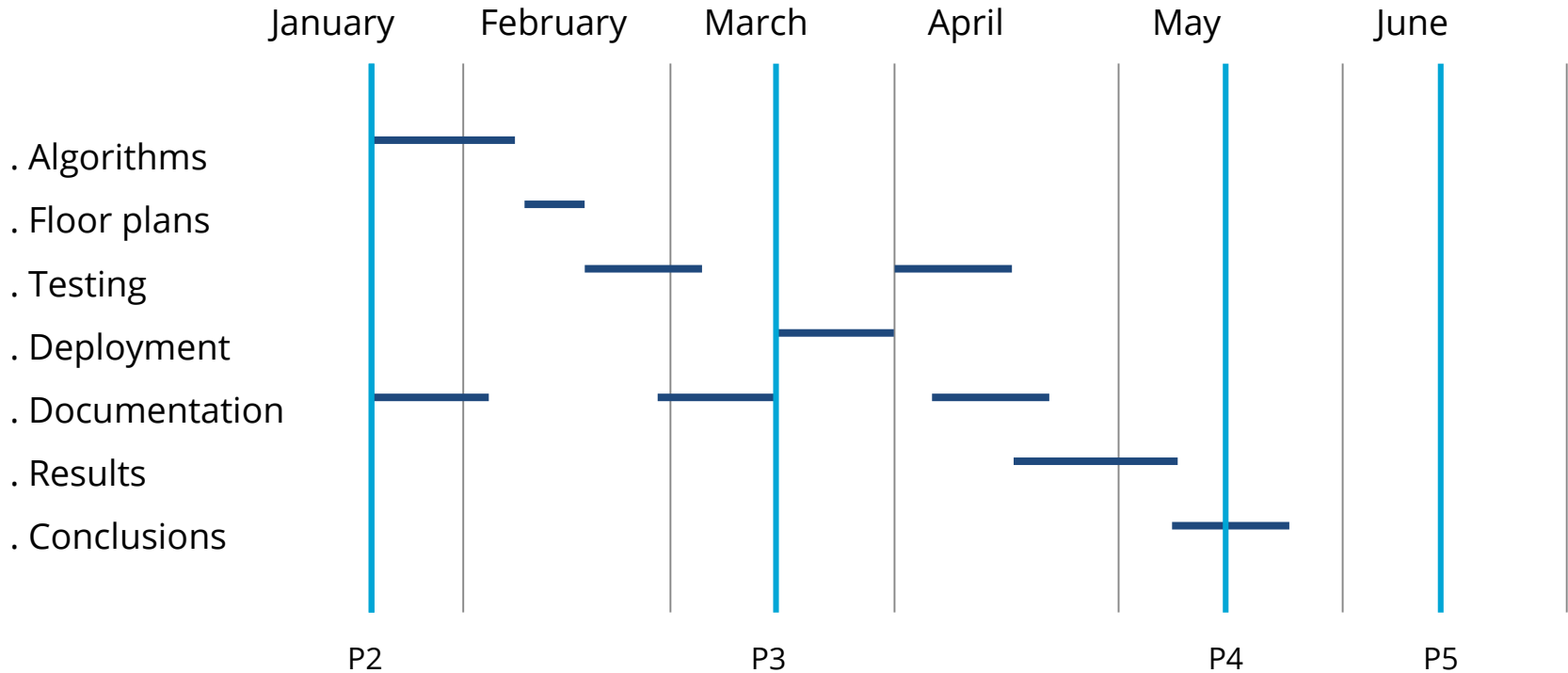
Rotation



Translation + Rotation

Evaluation

- . Accuracy and speed of algorithms
- . On-the-fly error metrics
- . Accuracy of position
- . Robustness (failures)



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Time planning

Questions?

Local Quadratic Approximation & Instantaneous Kinematics

. Distance to tangent plane for $\mathbf{x}(i) + \mathbf{v}(\mathbf{x}(i))$ $d_i + \mathbf{n}_i \cdot (\bar{\mathbf{c}} + \mathbf{c} \times \mathbf{x}_i)$.

. Instead of the regular distance function

$$F(\mathbf{C}) := F(\mathbf{c}, \bar{\mathbf{c}}) = \sum_i (d_i + \mathbf{n}_i \cdot (\bar{\mathbf{c}} + \mathbf{c} \times \mathbf{x}_i))^2$$

. Squared distance approximation:

Hough Transform extra slide

