Data collection and progress monitoring using autonomous rover and IoT

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Problem statement

- Progress Monitoring is a manual and time-consuming task
  - Not very accurate
  - Needs to be automated

Research objectives

- Automated progress monitoring on construction site
  - Automated data collection
    - Autonomous robot navigation
    - Autonomous data merging
  - Comparison between as-built and as-planned model
    - 3D reconstruction
  - Automated generation of dashboards
**Project Workflow**

1. **BLE Beacons Location**
   - Used to collect the position of small elements of the as-built model.

2. **Dashboards of progress monitoring**
   - The final goal is to generate dashboards to help the construction workers on site.

3. **Comparison between as-built model and as-planned 4D model**
   - Compare the two models to see the differences.

4. **Data Collection by the Rover**
   - Used to collect video, pictures and point cloud.

The final goal is to generate dashboards to help the construction workers on site.
The Rover

**Veloodyne Puck**
- 32 laser lines
- Field of View: 360° horizontal and 40° vertical
- Range: 120 m

**Clearpath JACKAL**
- All-terrain vehicle
- Size: 508 x 430 x 250 mm
- Weight: 17 kg
- Max payload: 20 kg
- Max speed: 2.0 m/s
- Run time: 4 hours
- IMU and Wheel Encoders: can help with SLAM

**Realsense T265**
- Two Fisheye lenses: large field of view
- Inertial Measurement Unit: accurate measurement of rotation and acceleration
- V-SLAM algorithm: tracks camera position and orientation

**Ouster OS1-32**
- 32 laser lines
- Field of View: 360° horizontal and 45° vertical
- Range: 120 m

**Realsense D435i**
- RGB camera: 1920 × 1080 pixels / 30 frames per second
- Depth: Measures distance to objects in the environment
Goals and challenges

• Modification of A* algorithm
• Path planning based on BIM/IFC semantics
Ontology:
Overall dataflow

1: Robot Operating System
Data Point Cloud

The goal of the data point cloud is to compare the as-built with 4D as-planned model, to see what are the differences.

We will use data point cloud to compare LOD200 elements: Walls, Floors, Ceilings.

Treatment of the Point Cloud

1. Unstructured Point Cloud
2. Segmentation
3. Classification
4. Clustering
5. Reconstruction

Data Point Cloud
This data point cloud was collected by the Rover on the CHUM construction site.
BLE Beacons

The goal of the BLE beacons is to localize small elements of the construction to see if they are well positioning.

We will use BLE Beacons to compare small elements: Fire System, Sprinklers…

1. Place the beacons on an element
2. Localize the element on construction site with Smartphone
3. Process the information to see if the element is well positioned
Conclusion

• Project progress
  – Sensor integration
  – Robot Navigation with BIM and without BIM
  – Autonomous navigation on construction site
  – Point Cloud extraction

• Future steps
  – BIM / IFC path planning
  – 3D reconstruction
  – Comparison between the models
  – Semi-automated progress monitoring
Thank you for your attention!

We thank our partners: