Vision-Based Indoor Localisation for People & Robots

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Introduction

Navigating indoors is difficult due to the lack of technology available for people to use. This issue arises from Global Positioning System (GPS) signals being inaccurate for small distances and obstructions by buildings.

The system, shown in Figure 1, utilises a smartphone as it is a widespread possession. It has an internet connection and the processing power required to run the system. It also has a camera able to capture visual information to localise the user. A monocular camera was trialled as it is the most common camera type.

Aims

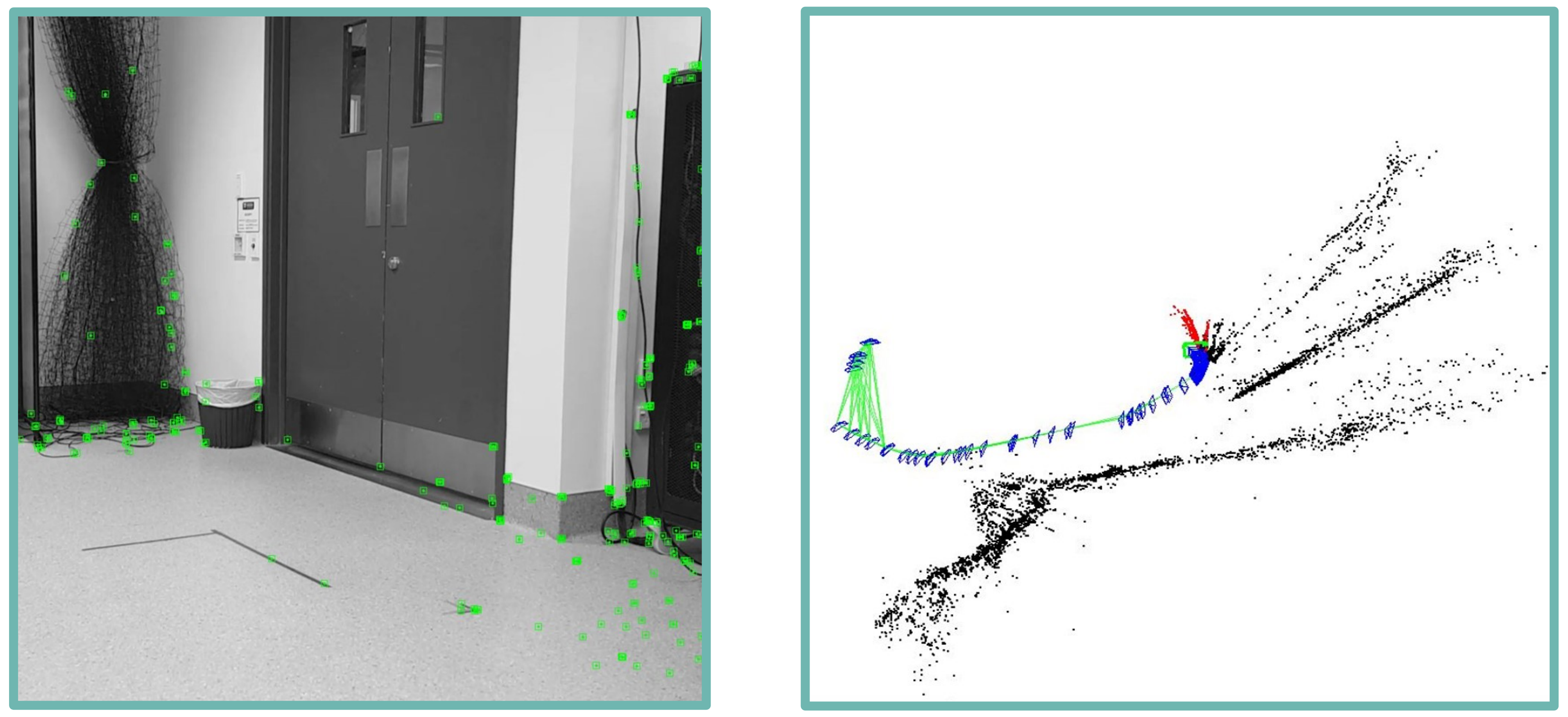
- ❑ Evaluate ORB-SLAM[1]
- ❑ Introduce map reusability
- ❑ Improve orientation performance

Evaluation of Software

The system was evaluated based on the needs of the system and user requirements.

Real-time	★★★★☆
Calibration robustness	★★★★★
Turning & sideways motion	★☆☆☆☆
Loop closure	★★☆☆☆
Dynamic objects	★★★★☆

The evaluation showed an inadequate performance of certain requirements. These were addressed with the last two aims of the project.



(a) Visual data from camera **(b)** Map of environment

Figure 1: ORB-SLAM output

Map Reusability

Map reusability was implemented using an existing, open-source resource. Saving was realised by writing the settings and map components to a file upon cessation of the session. Loading functionality was implemented similarly, whereby the system reads and imports the saved data.

Tests were run on various smartphone models to evaluate the ability of ORB-SLAM to share maps across different devices. Ten trials of each combination were conducted to ensure the validity of results.

Height robustness was evaluated by conducting tests on samples collected between 40cm and 130cm in 10cm intervals. The system parameter that determines the thresholds for localisation was adjusted to achieve the largest functional height range (Figure 2).

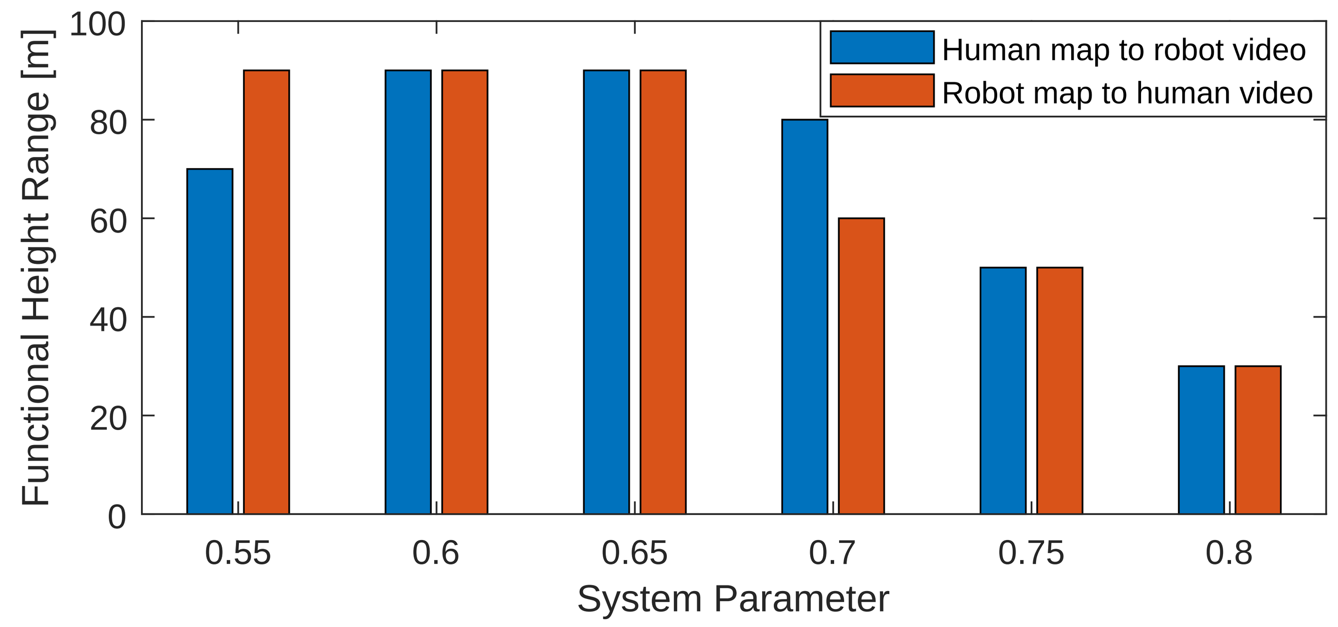


Figure 2: Plot of height range against system parameter

Orientation Performance Improvement

A Kalman filter was realised to merge ORB-SLAM's estimation with sensor data. The sensors used are a combination of a gyroscope and a magnetometer to correct the drift associated with only using the gyroscope.

The phone was moved forward, completed a 180-degree turn, then moved back.

Data collected (Figure 3):

- Visual input from smartphone camera
- Sensor readings
- Ground truth using motion capture system

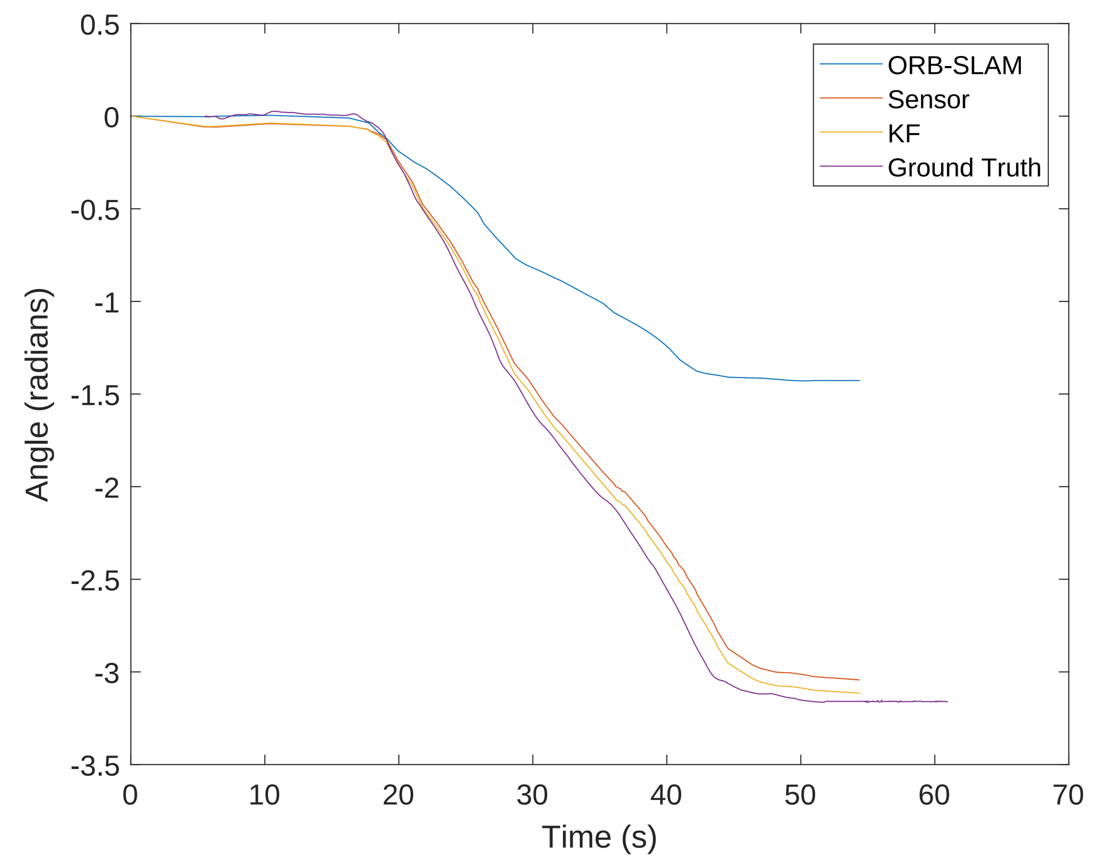


Figure 3: Plot of orientation as given by ORB-SLAM, sensor, Kalman filter and ground truth

Results & Conclusions

- ❑ Saving and loading functionality was successful where maps across different devices were able to be shared with an average success rate of **90%**.
- ❑ Adjusting the system parameter increased the height range detectable from **50cm** to **90cm**.
- ❑ The successful implementation of a Kalman filter, achieved through using smartphone sensor data, showed an **88% decrease in error** for orientation.

References

1. R. Mur-Artal, J. M. Montiel, and J. D. Tardos, "ORB-SLAM: A Versatile and Accurate Monocular SLAM System," IEEE Transactions on Robotics, vol. 31, no. 5, pp. 1147–1163, 2015