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Enhanced Pedestrian Dead Reckoning Sensor Fusion for Firefighting

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Introduction

How miscommunication almost burned down a house:

Introduction

- Relaying firefighters position to ~~the~~ leadership ~~can be~~ difficult
- Knowing the position of injured firefighters ~~can shorten~~ rescue times
- Position tracking of firefighters ~~can~~ improve training effectiveness
- ~~Requires a~~ body worn system ~~to track a firefighters position~~

~~Requirements~~ for Firefighting

- ~~Not require~~ prior setup of electronics
- Work in ~~environments with smoke and high temperatures~~
- ~~Lightweight~~
- Wireless data transmission
- ~~Low cost~~

~~Problem:~~

- Existing solutions for indoor tracking can not meet these demands

Existing Solutions

- Magnetic Triangulation
- Lidar Sensors
- RF Localization
- RF or magnetic field mapping
- Inertial measurement unit
- Step detection
- What about an optical sensor?

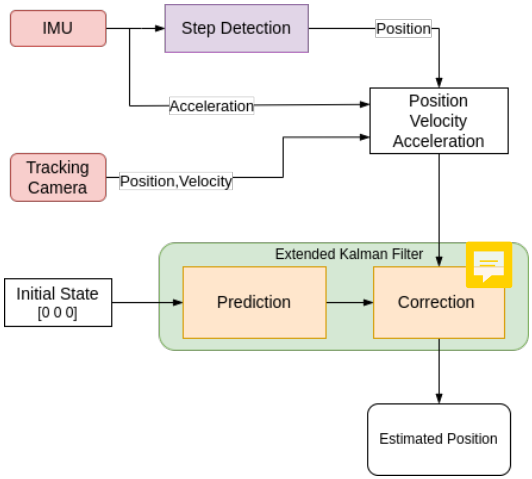
Tracking Camera (Stereo Camera)

Calculates 3D information by measuring the horizontal difference of image points
Works in environments with light smoke or bad lighting

What if the optical sensor is obstructed by debris or heavy smoke?

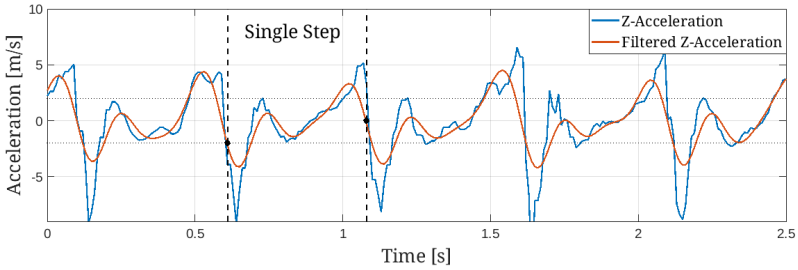
Sensor-Data Fusion

- Sensor-data fusion algorithm combines step-detection and tracking camera data
- Algortihm takes quality of meausrements into account
- ~~Sensor estimates are used in the update step of the Kalman filter~~



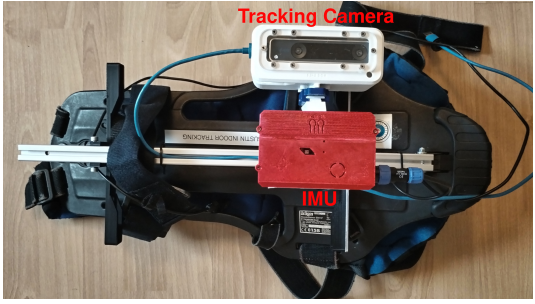
Step-Detection

- Zero-crossing detection
- Step-length estimation ~~with~~ $d = \sqrt[4]{a_{max} - a_{min}}\, c$
- Step-length is added in the direction the ~~individual is looking~~



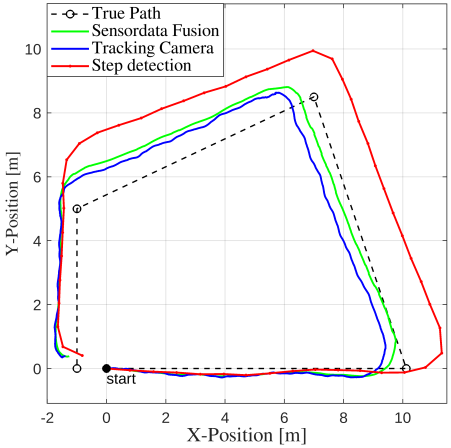
~~Experiment~~

- ~~As a proof of concept and to tune the system~~
- ~~Walked or moved in a crouching movement on a~~ set trajectory
- ~~Analysis of the deviation~~ on defined checkpoints
- Sensor assembly mounted on the backplate of a breathing apparatus



Results

- Significant improvement when the camera is used
- Accuracy when using only the tracking camera is slightly high
- Step-detection accuracy goes down especially when crouching



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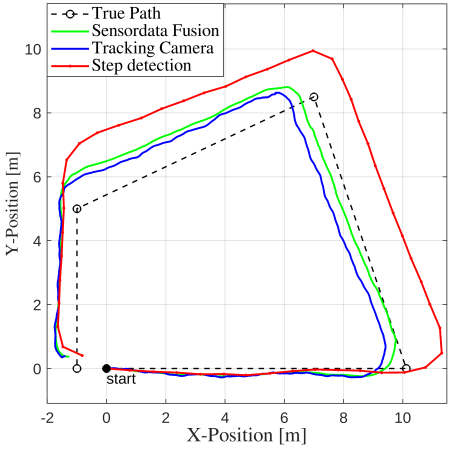
Estimation Method	Mean
Step-Detection only	2.0 m
Sensordata Fusion	0.33 m
Tracking Camera only	0.3 m



~~Conclusion~~

- Promising initial results
- Next ~~step~~: Tests in a firefighting environment ~~(for example in a training container)~~
- ~~Sensor assembly needs to be adapted for~~ this task