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Constructing a positioning model in underground installations with use of mobile technologies.

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Primary goal of the work

Given:

- Position finding for smartphone
- The underground environment

Goal

- Provide positioning information
- “Where am I?”

Topic justification

- “Mining goes digital”,
- Smartphone as a tool,
- Lack of positioning information in underground installations.

Scientific problem statement

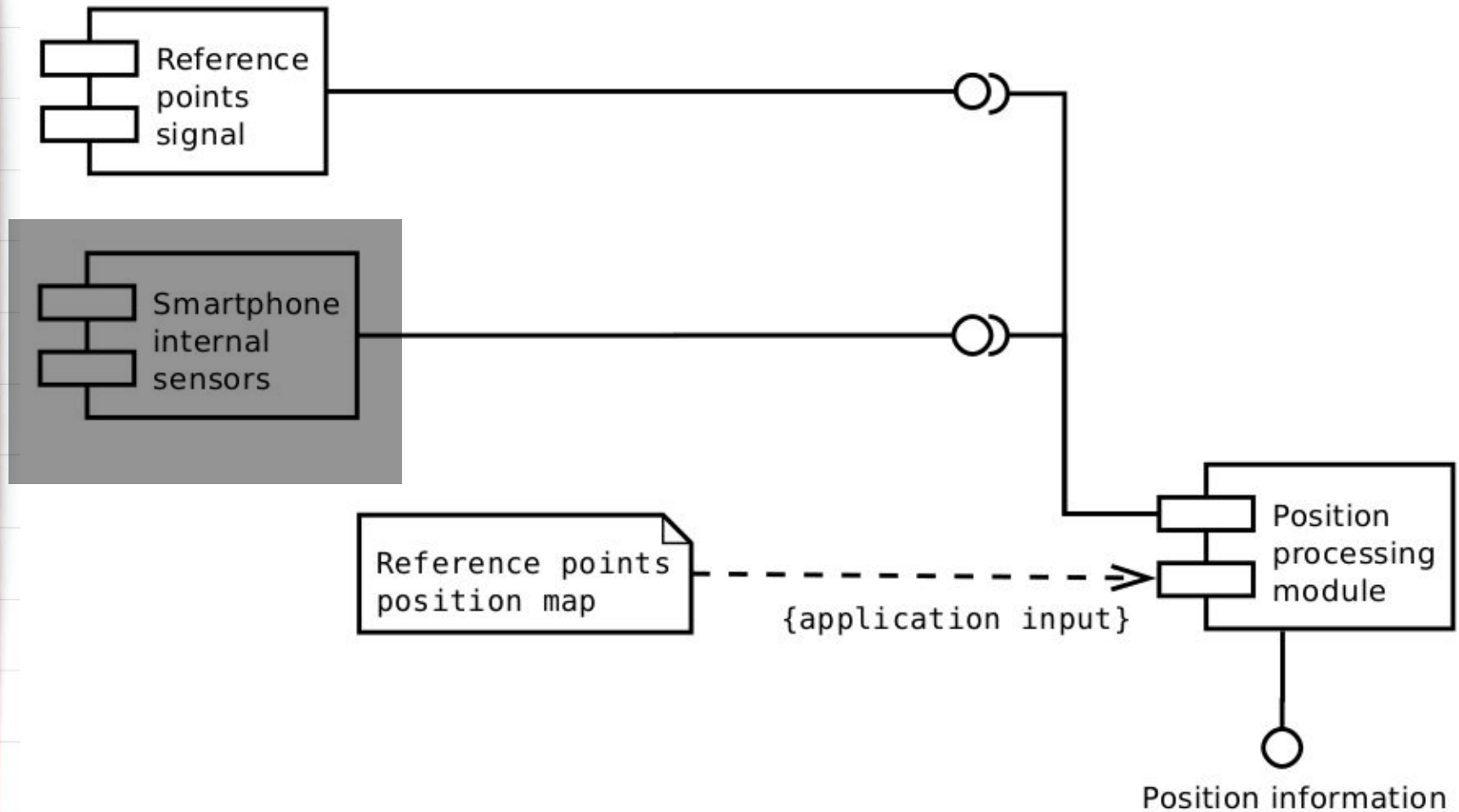
How to combine smartphone features with the underground environment characteristics in order to obtain the current position?

- What is the environment?
- What are smartphone features?

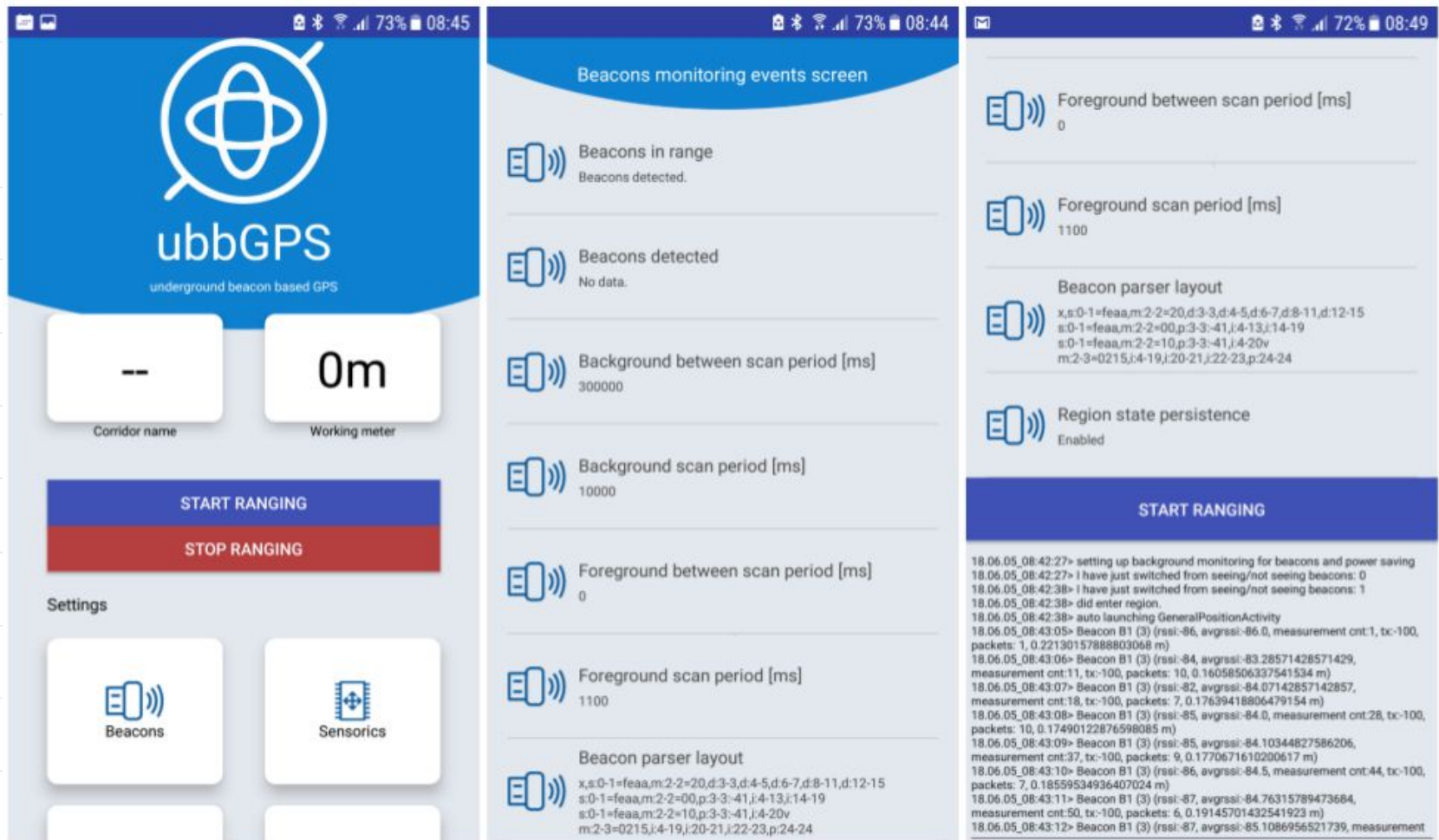
Overview of related work

- Indoor positioning solutions,
- Wireless technologies for positioning,
- Sensor based positioning,
- Visible Light Communication,
- Magnetic Field pattern matching,
- Methods of signal processing and analysis.

Proposed solution architecture



Proof of concept smartphone application



The image displays three screenshots of the 'ubbGPS' (underground beacon based GPS) smartphone application. The app is designed for Android, as indicated by the status bar at the top of each screen showing battery level, signal strength, and time.

Left Screenshot (Main Screen): The app's logo, 'ubbGPS', is at the top. Below it, there's a 'Corridor name' field with a dashed line and a 'Working meter' showing '0m'. Two buttons, 'START RANGING' (blue) and 'STOP RANGING' (red), are prominently displayed. At the bottom, there are 'Settings' and two icons for 'Beacons' and 'Sensorics'.

Middle Screenshot (Beacons monitoring events screen): This screen lists various monitoring events with icons of a smartphone and signal waves. The events include:

- Beacons in range:** Beacons detected.
- Beacons detected:** No data.
- Background between scan period [ms]:** 300000.
- Background scan period [ms]:** 10000.
- Foreground between scan period [ms]:** 0.
- Foreground scan period [ms]:** 1100.
- Beacon parser layout:** A detailed log of beacon data including coordinates (x, y, z), time (t), and other parameters.

Right Screenshot (Settings/Status Screen): This screen shows the 'Beacon parser layout' and the 'Region state persistence' status, which is 'Enabled'. It also features a 'START RANGING' button at the bottom. The bottom section contains a detailed log of system events and beacon data, similar to the middle screenshot.

Test methodology

- Exclusively focused on radio propagation,
- Measure the installation configuration impact on the radio link parameters.



Evaluation

- Radio attenuation curve on short distances is similar to that in free field distribution,
- Beacon placed horizontally on the ceiling ensure the best signal coverage and smaller fluctuations,
- Recommended values were determined statistically,
- Accuracy of the proposed method is 2.5m.

Future work

- Higher level filtering method,
- Combine the solution with inertial sensorics,
- Automated maintenance methods.

Summary

- Underground installations have to be extended by digitally recognisable landmarks,
- Sensing the beacon based infrastructure is a suitable solution for underground installations,
- Smartphones contains components making the position estimation more precise.

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Thank you.