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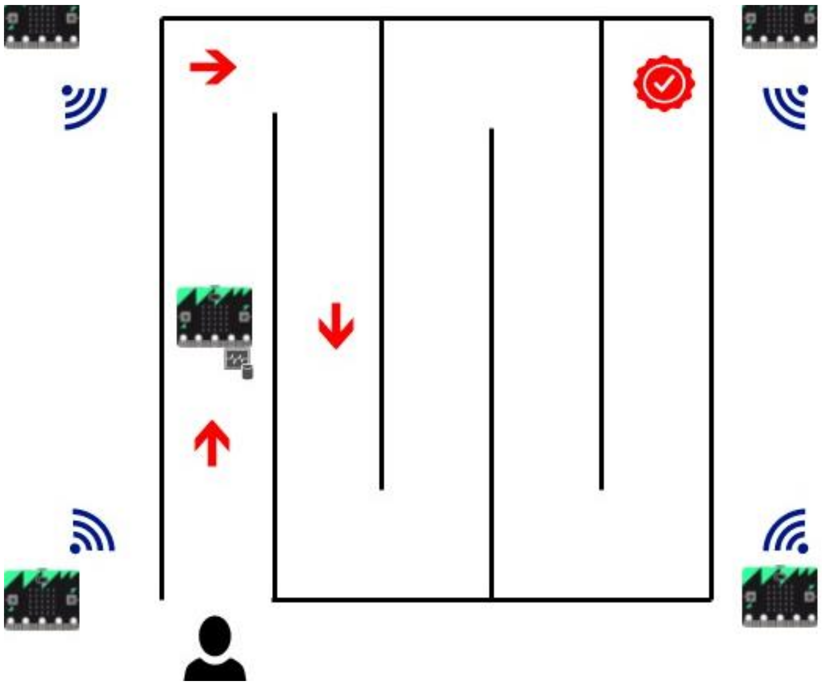
Blind Aid

Blind aid Simulation via Multiple micro:bit and Sensor Integration



Dan Iorga, Georgios Rizos, Georgios Theodorakis, Johannes Wiebe, Thomas Uriot

Project scope

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- Idea: can we utilize multiple micro:bit (4-5) to make a prototype system for aiding blindfolded people in navigating a maze?

- Tasks:
  - Design a **local positioning system** using micro:bit sensors
  - Give audio cues to a blind(folded) person

- Intended as an educational exercise for children**: Teach children about the challenges in a blind person's daily activities and how tech can help**

Proposed setup

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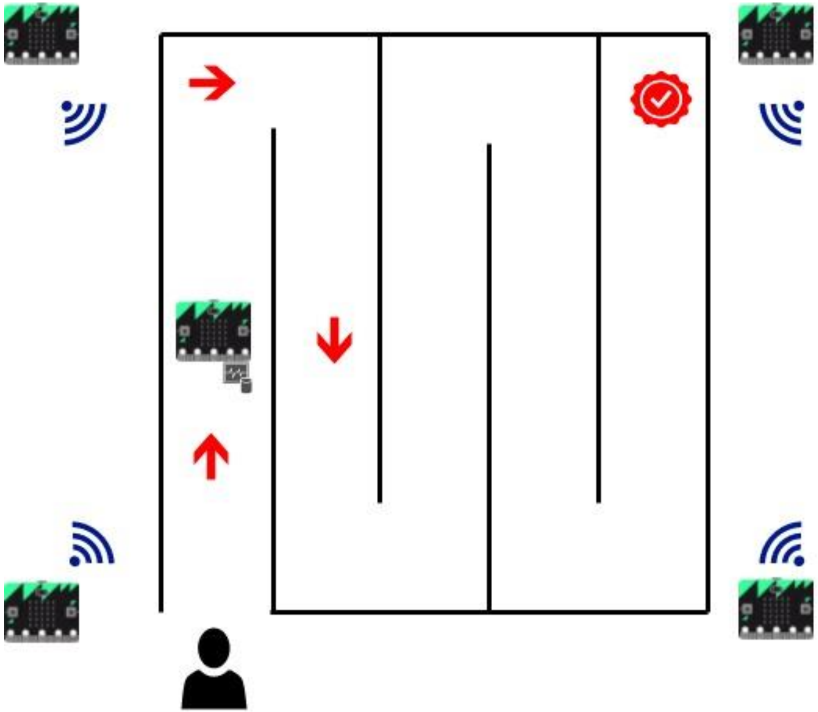

- Set up a maze
- Place micro:bit around maze and have them transmit radio signals
- Determine **position** of micro:bit in the maze
- Communicate **direction** to blind(folded) person

Physical challenges to address

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We need to address:

- Noisy data
- Radio signal interference
- Environment dependent measurement bias
- Compass accuracy
- Memory limitations
- Real time data transfer and communication

Can we utilize radio signal strength?

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- In theory:

$$\boxed{\text{Signal strength} \sim 1/(\text{distance})^2}$$

Radio signal interference is problematic

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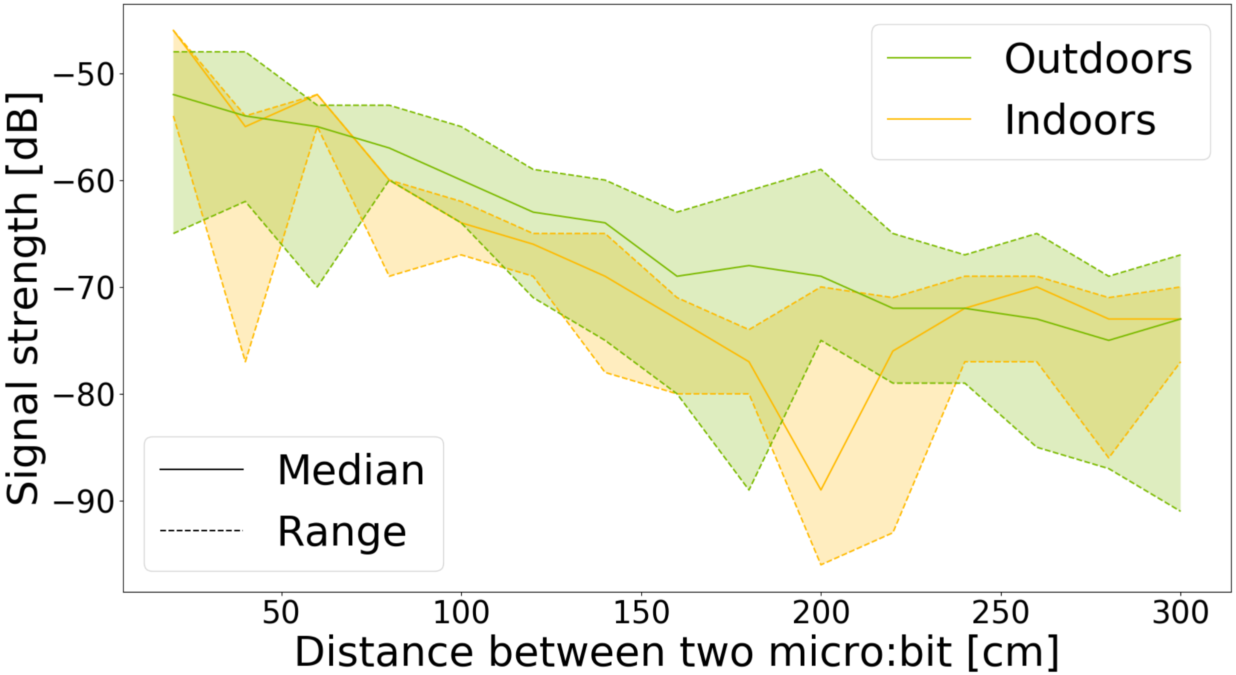
- In theory:

$\boxed{\text{Signal strength} \sim 1/(\text{distance})^2}$

- In practice: diffraction and reflection make physics based approach infeasible



Instead: use machine learning approach

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- Position based data collection:
  - Collect data by standing in different locations throughout the maze
  - Label data with corresponding position
- Trajectory based data collection:
  - Collect data by walking through the maze
  - Label data with recorded compass measurements
- **Disadvantage:** Increased compute requirement!

Instead: use machine learning approach

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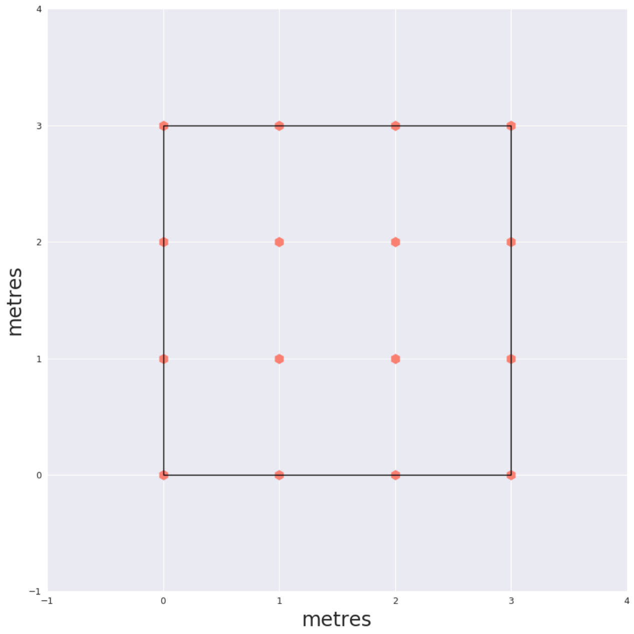
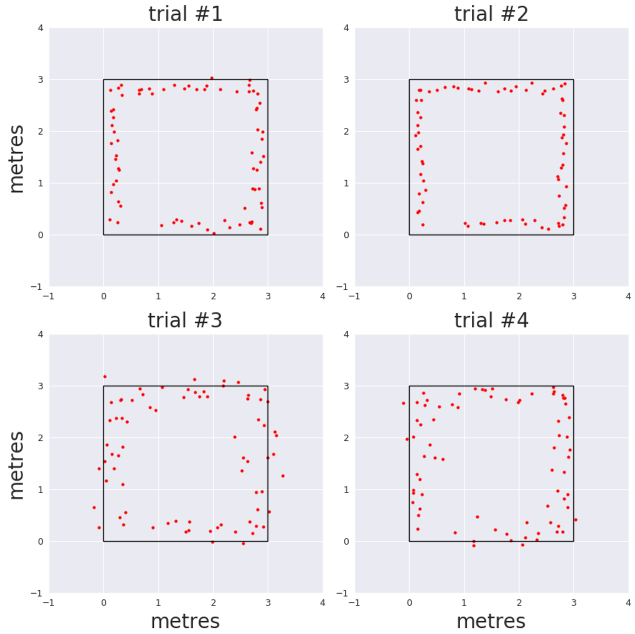
- Position based data collection:



- Trajectory based data collection:



Three steps for utilizing micro:bit data

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Smart sensing

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PC post processing

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Machine learning

Smart sensing: recording data effectively

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Smart sensing

PC post processing

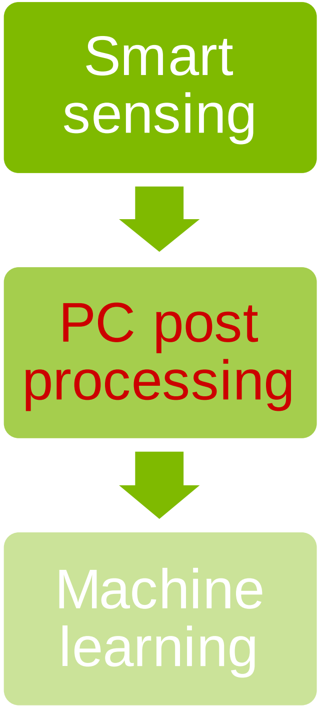
Machine learning

- Collect data from **all transmitters and various micro:bit sensors** (signal strength, ultrasonic, compass)
- **Smooth data** on micro:bit using **expontential moving average**:

$$\boxed{\bar{X}_t = \alpha \cdot X_t + (1 - \alpha) \cdot \bar{X}_{t-1}}$$

- **Forward data to PC** via radio and USB

Post processing: prepare data for ML



- Transmitting data via radio is challenging: Some data is lost → **Replace missing values**
- **Apply gaussian filter** for smoothing

Machine learning: predicting direction

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Smart sensing

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PC post processing

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Machine learning

- Train random forest regression model to **predict position/desired direction** in maze
- **Signal strength, ultrasonic data, compass heading** are used as features
- Trajectory based approach: **Features are augmented** with the output of the position based approach

Results: predicting position

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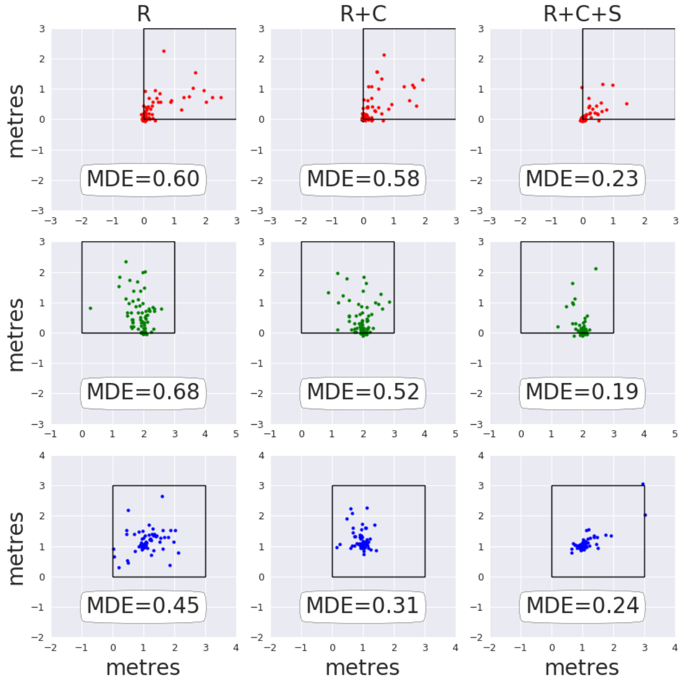

- Position estimates for **corner**, **side**, and **center point**
- Accuracy increases with use of compass (C) and ultrasonic data (S) compared to radio strength (R)

Results: predicting desired direction

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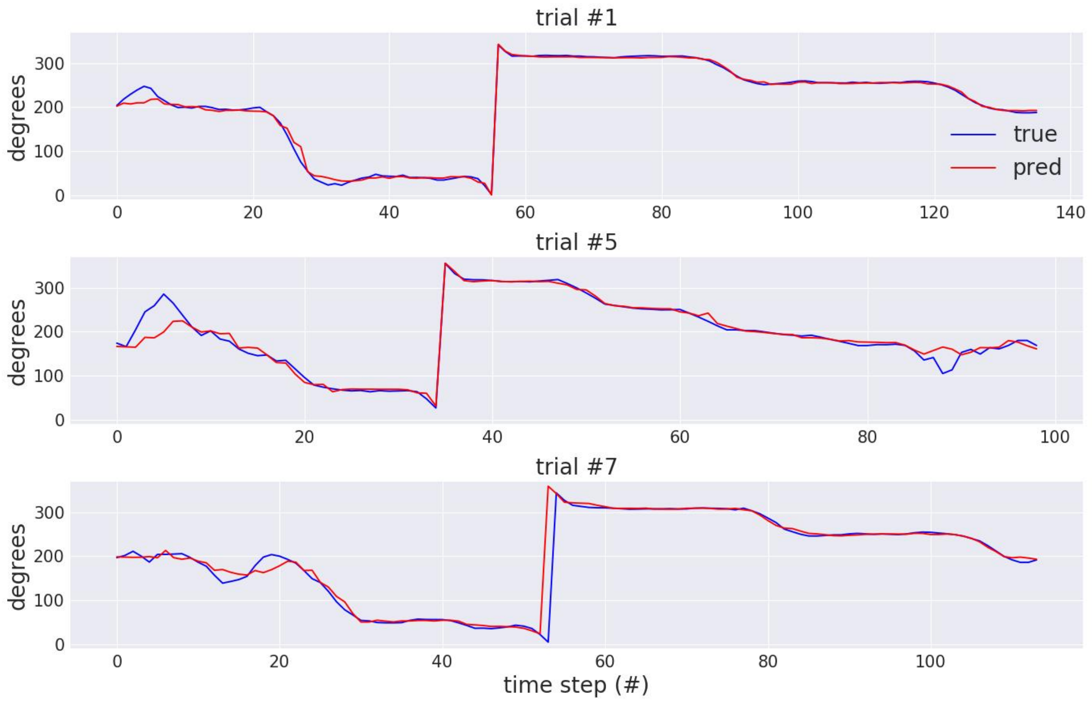

- Leave-one-out trial-based cross-validation
- Approach can predict direction accurately for a maze trajectory that it has been trained on

Remaining challenges for the future

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We needed to address:

- Noisy data → Smart Sensing, Filtering, ML
- Radio signal interference → Ultrasonic Transceiver
- Compass accuracy → Smoothing
- Memory limitations → Connection with PC
- Real time data communication → ☹
- Environment dependent measurement bias → ☹

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Thank you!