Precise 3D Positioning Using Magnetic Field

Binghao Li$^1$, Kai Zhao$^2$, Serkan Saydam$^2$, Shuai Xu$^3$, Andrew Dempster$^1$

$^1$ACSER, School of EE&T, UNSW, Australia
$^2$School of Mining Engineering, UNSW, Australia
$^3$Key Laboratory of Ministry of Education for Safe Mining, Northeastern University, China
OUTLINE

• Introduction
• Using Geomagnetic Field for 3D Positioning
• Adding Artificial Magnetic Field
• Concluding Remarks
Using a Magnetic Field for Positioning

- Based on pre-deployed infrastructure

(J. Blankenbach and A. Norrdine, 2010)

- Based on signals-of-opportunity

(J. Chung et al. 2011)
Previous Study (1)

24 hours stability
Previous Study (2)

Comparison of the measured magnetic intensities at overlapping corridors.
Testing Setup

- A 45*39*76cm wooden cabinet
- A 30*40*60cm cuboid
- 12 layers (Z direction) and each layer has 48 grids, in total 576 grids
The Uniqueness of the Magnetic Field

- The average intensities of X, Y and Z directions of one layer (Z=2)
- The change of the intensity is noticeable in all directions
The Variation of Magnetic Intensities (1)
Static Test

- 20 test points were randomly selected from 4 layers
- NN applied
- About 70%, the positioning errors are lease than 2 units (10cm)
Dynamic Test

- The sensor was moved alone X=3 and Y=3 in layer Z=6.
- Data were grouped every 10 samples as a test point.
- Error is quite large.
- Systematic offset.
Adding Artificial Magnetic Field

- 10 magnetic blocks
- The magnetic force line against each other to achieve a significant change of the magnetic field
The Variation of Magnetic Intensities (2)
Static Test (2)

- Test points (in total 240) extracted from data base
- Applied NN and 4NN
- A higher possibility position to the true location
- Error <5cm
  - NN: 50% vs 86%
  - 4NN: 72% and 88% (85% <2.5cm).
Dynamic Test

- Results are better
- Systematic error in X=3 testing test disappear
- Systematic error in Y=3 testing is smaller
FUTURE WORK

• The magnetic field positioning may find some specific applications
• The long term stability of the magnetic field
• Integration of IMU with magnetic field positioning
• Increasing the fingerprint elements
• Best way to deploy the magnetic blocks
THANKS

Questions?