Third Generation Positioning System for Underground Mine Environments: An update on progress

Never Stand Still

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OUTLINE

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- Potential Technologies
- Feasibility test
- Approaches Comparison
- Future works

Introduction :
Positioning Technologies in Mining Industry

- The safety of mine workers is one of the highest priorities of the mining industry
- “Golden 72 hours” for workers escape from a mine disaster.
- GNSS system for open-pit mines
- Current positioning system in underground mine
  - ✓ RFID
  - ✓ Zigbee+WiFi
  - ✓ Wireless Ad-hoc System for Positioning

Requirements for a new generation system

- High accuracy
- Less pre-deployed facilities
- Power efficient
- High Reliability/Robustness
- Real time Positioning on server & end device

A Survey of Potential Positioning Approaches for Underground Mines

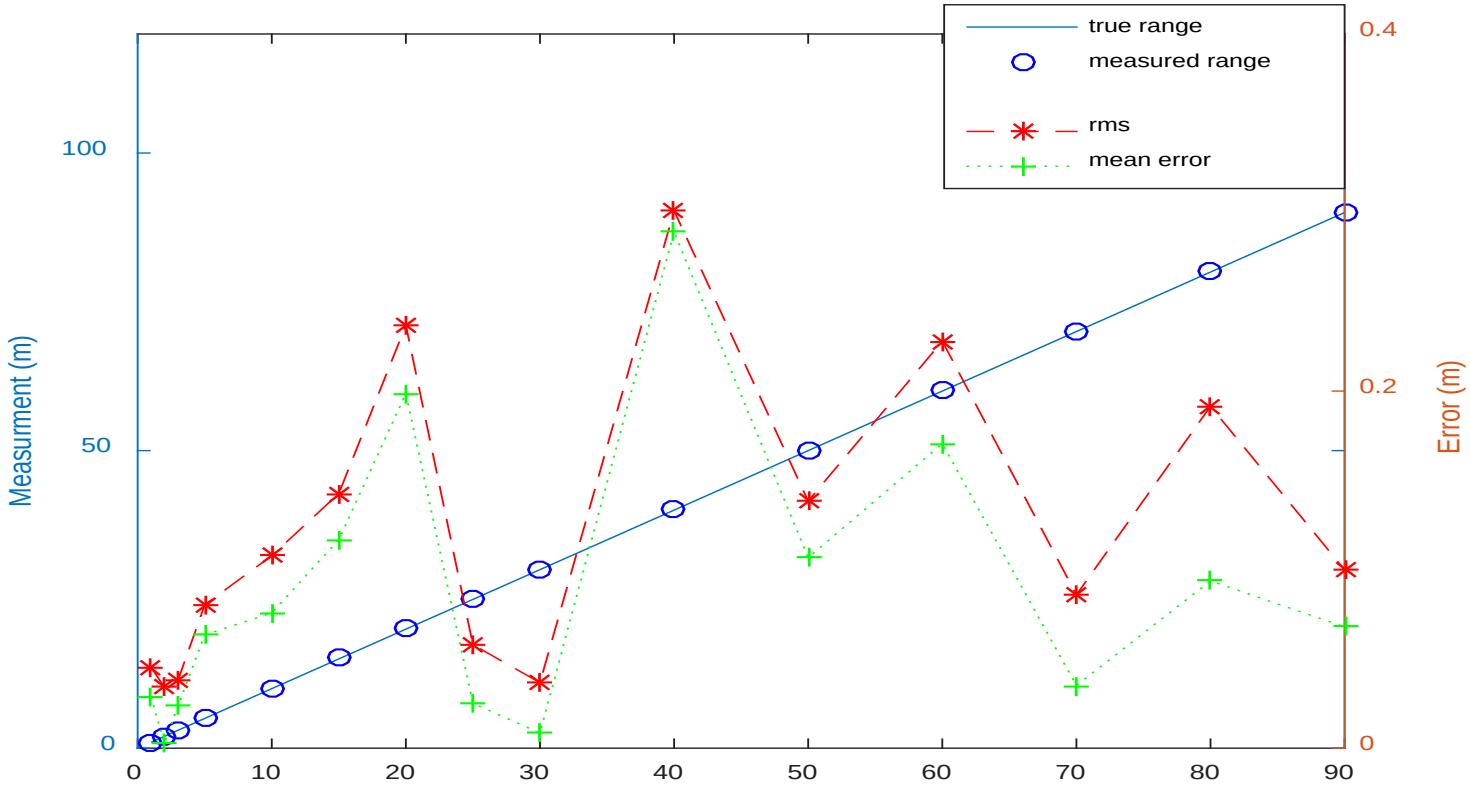
- Passive RFID
- Inertial Measurement Unit (IMU) √
- Received Signal Strength(RSS) based Positioning
  - Bluetooth Low Energy √
  - Zigbee
  - Active RFID
- Ultra-wideband (UWB) √
- Magnetic Field strength pattern matching √
- Very-low frequency (VLF) electromagnetic waves

Experiments for performance evaluation of positioning approaches

- Features of the environment of a underground mine
  - Tunnels
  - Large scale
- Current Testbed
  - Low ground in old main building, UNSW

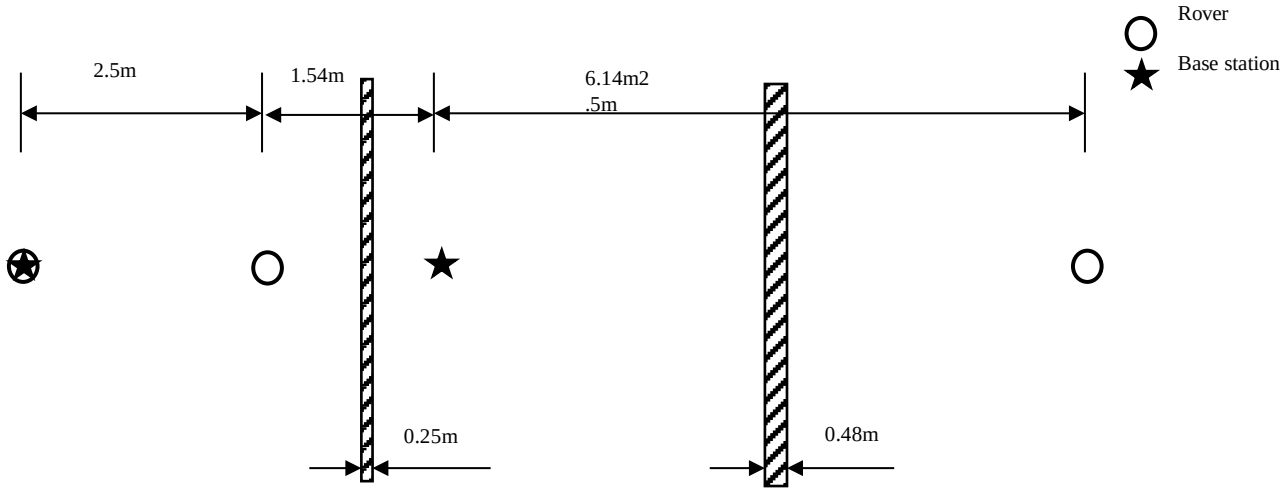
UWB Test

- Ranging Test



UWB Test

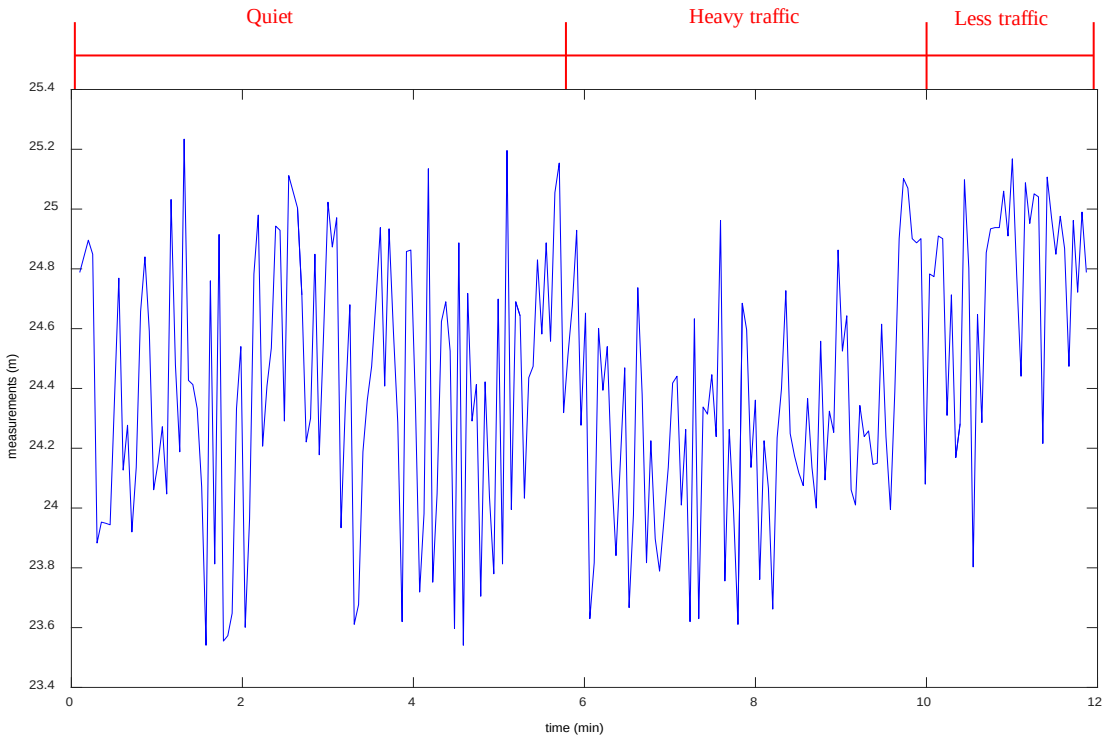
Test in in NLOS propagation scenarios



True range (m)	1.54(thin wall)	4.04(thin wall)	6.14(thick wall)	10.18(two walls)
Mean error(m)	0.46	0.64	0.42	0.70
RMS(m)	0.49	0.65	0.42	0.71

UWB Test

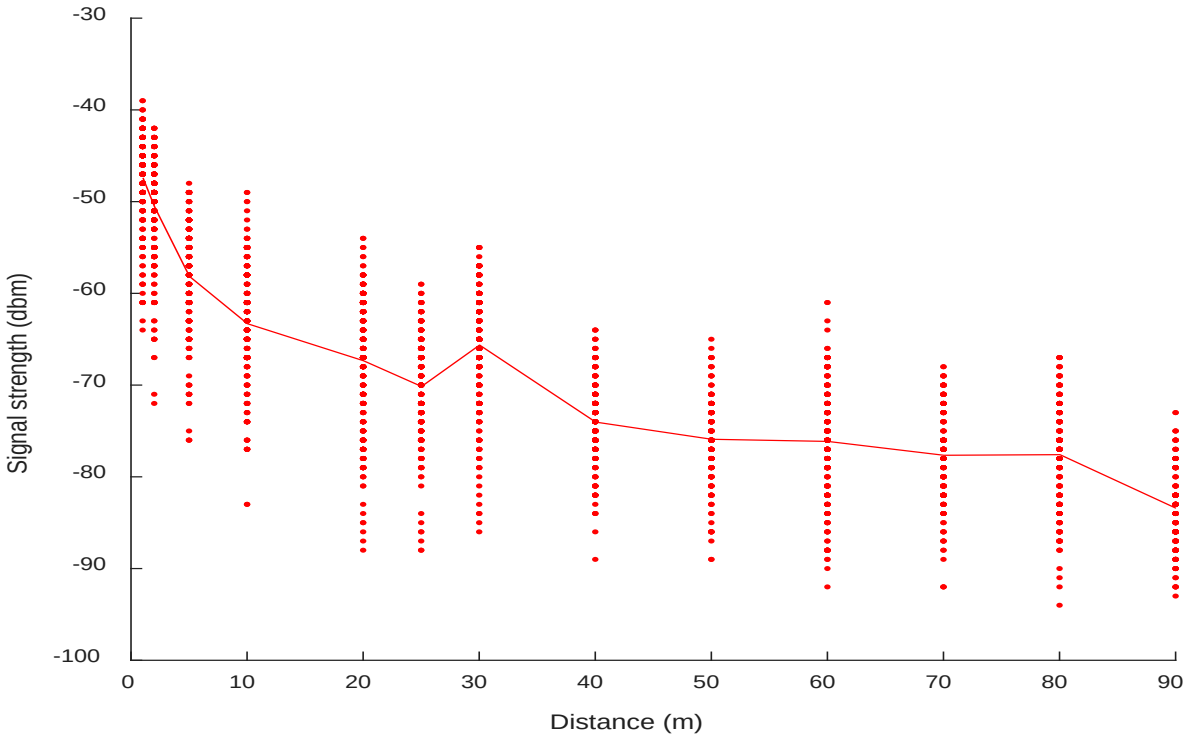
UWB Test with different traffic situation:



RSS-based positioning Test (BLE)

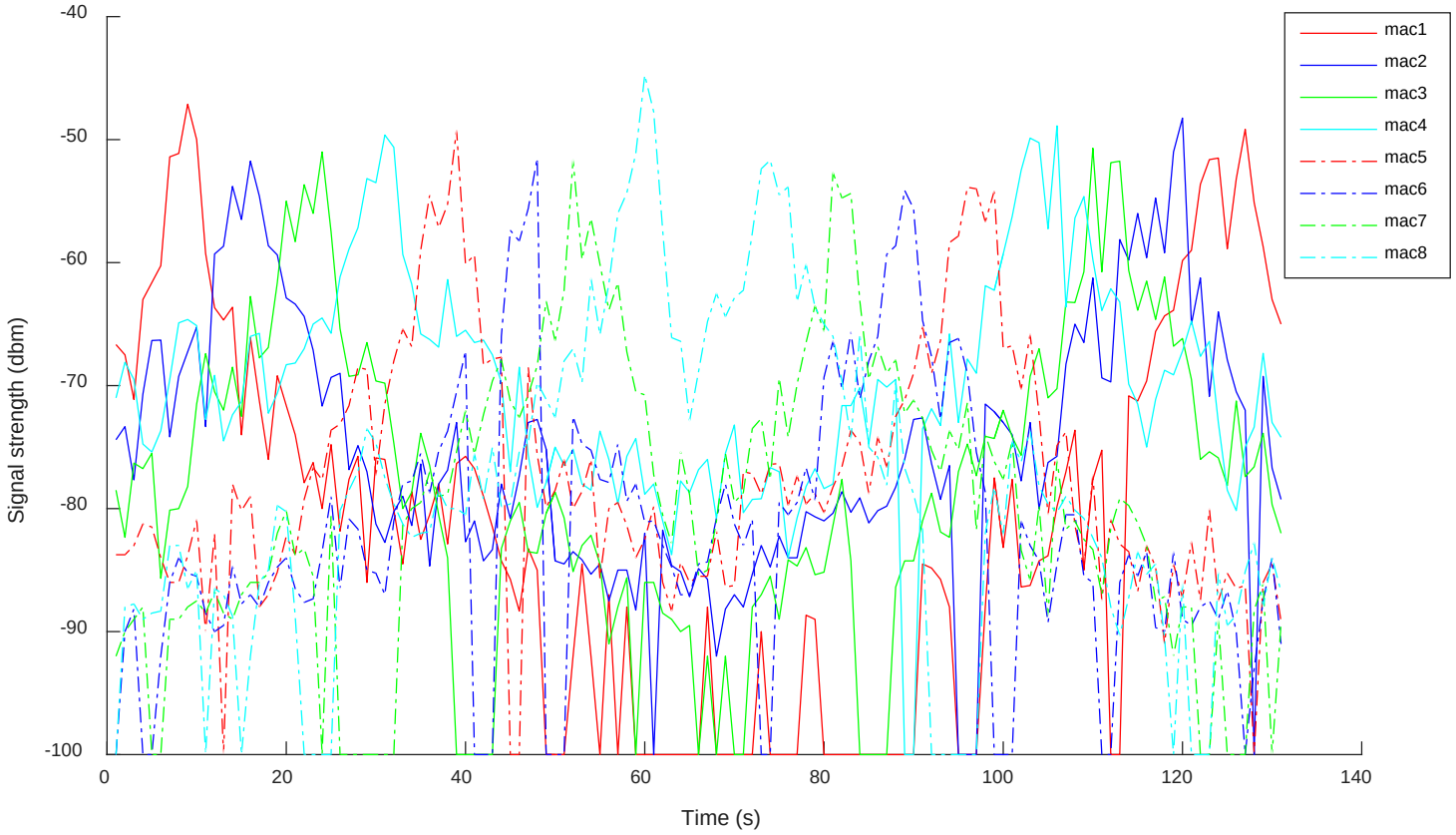
Single transmitter ranging test:

- Signal strength fluctuation
- Multi path of signal propagation



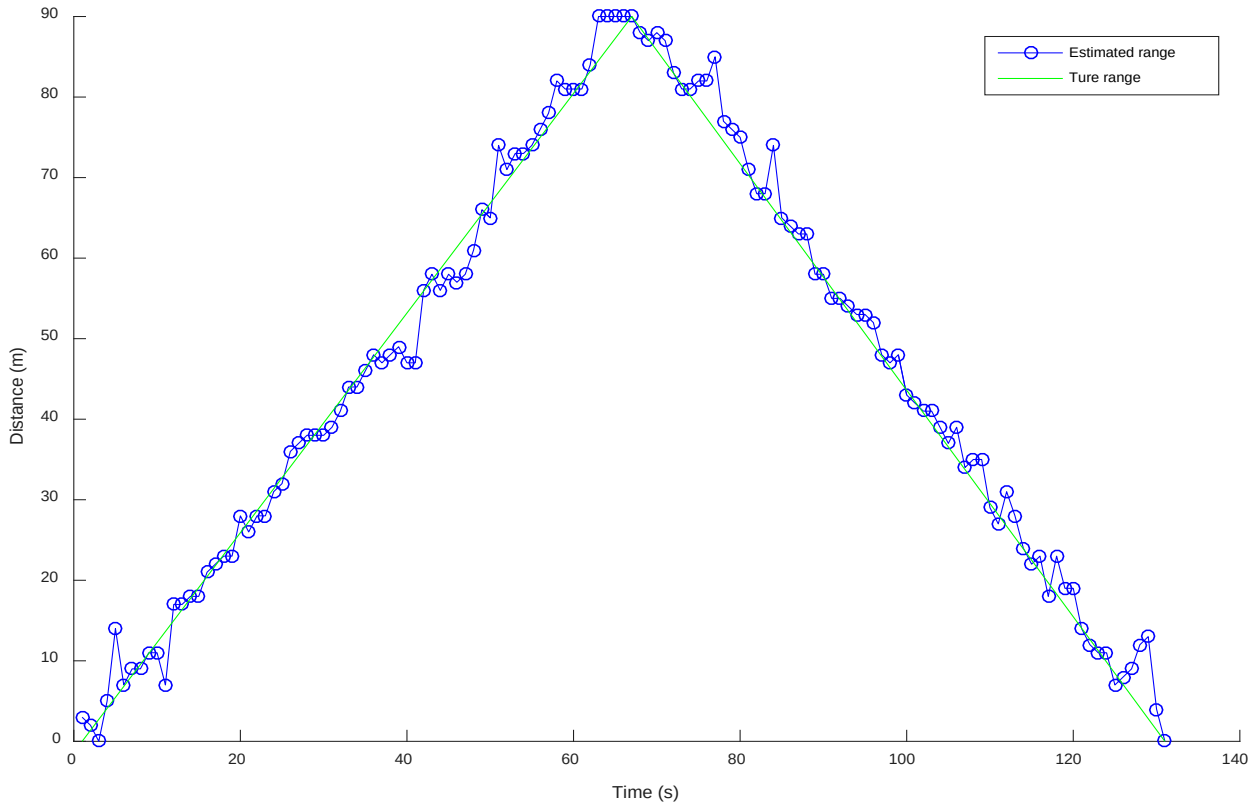
RSS-based positioning Test (BLE)

Multi transmitters :

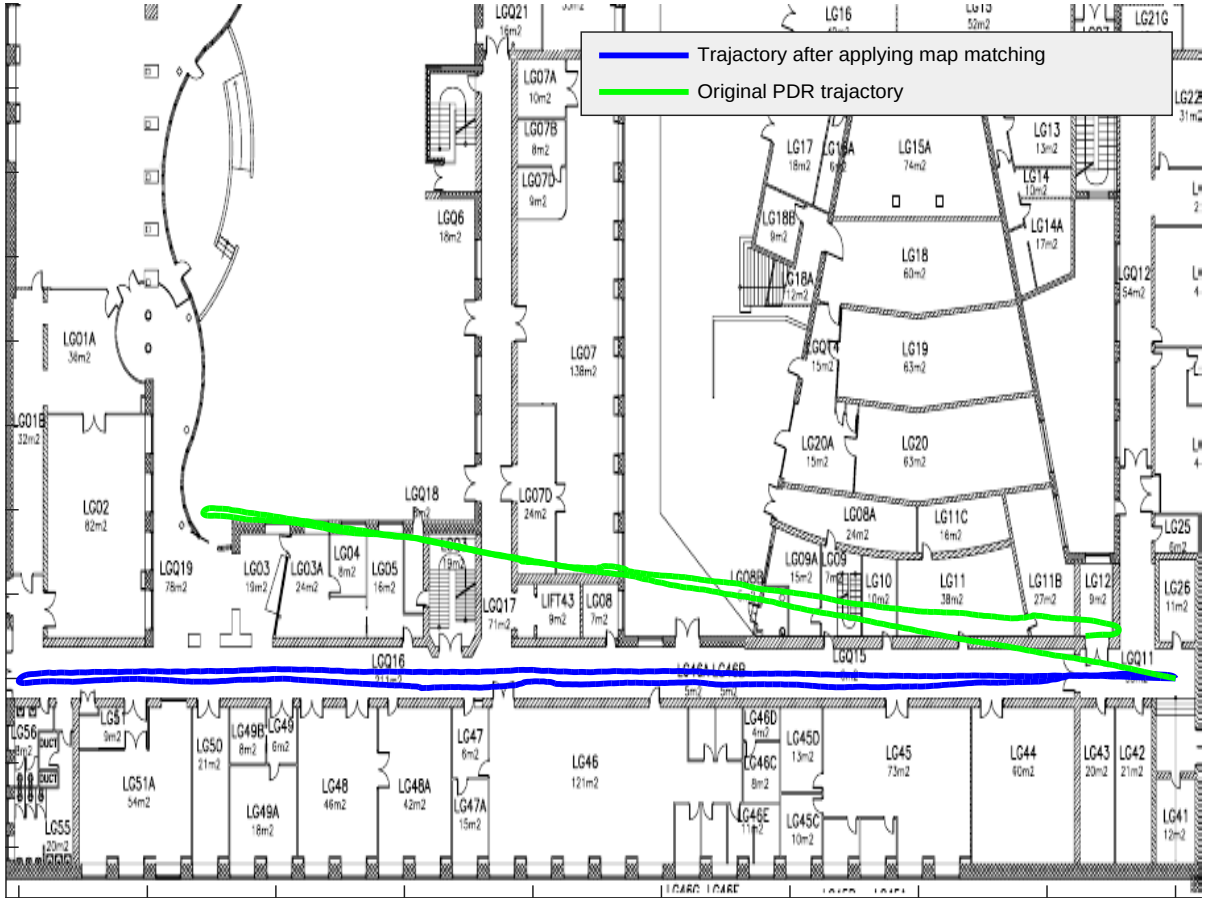


RSS-based positioning Test (BLE)

Multi transmitters positioning test:



IMU Positioning Test:



Magnetic field strength pattern matching

Limitations if it were applied in a mine

1. Pre-established database
2. Two vectors of Magnetic data
3. Irregular movement

Could work as a supplementary approach in a positioning system.

Conclusion:

Comparison of Approaches

	Current Consumption	Robustness	Accuracy	Computation complexity
UWB	Tens of mA	High	< 1m	Low
RSS-based RF system(BLE)	A few mA	High	2-3m	Low
IMU	< 1 mA	Requires periodic initialization	-	Medium
Magnetic Pattern Matching	A few mA	Low	-	Medium/High

Future work

- Hybrid Positioning Algorithm development
- Field test in real mines
- Prototype development

THANKS

Questions