Passive Inverted Ultra-Short Baseline (piUSBL) Localization: An Experimental Evaluation of Accuracy

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GPS

GPS signals will not work underwater
Doppler Velocity Log (DVL) & Inertial Navigation System (INS)

DVL & INS are too expensive and drift over time
Long Baseline (LBL)
Long Baseline (LBL)

LBL is difficult to deploy and not scalable
Passive Long Baseline (pLBL)

Passive LBL is difficult to deploy
Ultra-Short Baseline (USBL)
Ultra-Short Baseline (USBL)
Ultra-Short Baseline (USBL)

USBL is not scalable
Can we create a scalable, low-cost underwater localization system?
Passive Inverted Ultra-Short Baseline (piUSBL)

Scalable
Passive

Low Cost
One beacon
Pre-Filter
Measuring Range

Received Signal

\[ \tau \]
Measuring Range

Matched Filter Power

Received Signal

\( \tau \)
Range - Speed of Sound
Measuring Angle

\[ d = \Delta \cos(\theta) \]
Measuring Angle
Angle - Azimuth Bias
Combining Angle and Range
Combining Angle and Range
Outlier Rejection
Acoustic Beacon (x2)

Garmin 18xLvC
GPS

Arduino Uno
w/ Wave Shield

Lubell Speaker
Can we do better?

Yes! With a cheap IMU
Particle filter

Last GPS Reading

IMU Readings

Range & Angle

Source: https://www.slideshare.net/kohta/particle-filter-tracking-in-python
Acoustic Beacon (x2)

Garmin 18xLvc
GPS

Arduino Uno
w/ Wave Shield

Lubell Speaker
Passive Inverted Ultra-Short Baseline (piUSBL)

Scalable to multiple robots

Low cost

Easier to deploy
Outstanding Questions

1. How well will the system perform with various
   a. Depth
   b. Pitch
   c. Roll

2. How well will the system perform when not using GPS for synchronization?

3. Will the performance match when using a real IMU?
Thanks for listening!