Qiu-yang TAO, Yue-hai ZHOU, Feng TONG, Ai-jun SONG, Fumin ZHANG, 2018. Evaluating acoustic communication performance of micro autonomous underwater vehicles in confined spaces. *Frontiers of Information Technology & Electronic Engineering,* 19(8):1013-1023.
https://doi.org/10.1631/FITEE.1700841

Evaluating acoustic communication performance of micro autonomous underwater vehicles in confined spaces

Key words: Autonomous underwater vehicles; Underwater acoustic communications; Confined water space

Corresponding author: Fumin Zhang
E-mail: fumin@gatech.edu
ORCID: https://orcid.org/0000-0003-4428-0537

Motivation

1. Micro autonomous underwater vehicles (μAUVs) are well suited to various applications in confined underwater spaces.

2. Acoustic communication is the preferred solution for lager-sized AUVs in many scenarios, and has become achievable for μAUVs recently.

3. Knowledge of the interference of acoustic communication in confined spaces is essential for the safe and efficient operation in many μAUV applications.

4. However, there is a lack of experimental evidence for acoustic communication of μAUVs in confined water spaces, especially when the μAUVs is in motion.

Method

1. An acoustic communication test contains a μAUV prototype, a compact acoustic modem, and an onshore base station.

2. Stationary transmission tests evaluate the impact of different positions of the μAUV on acoustic communication in confined water spaces.

3. Moving transmission tests investigate the impact of the motion of μAUV on acoustic communication in confined water spaces.

Major results

From the stationary transmission tests in confined pool environments, patterns on acoustic communication performance are observed:

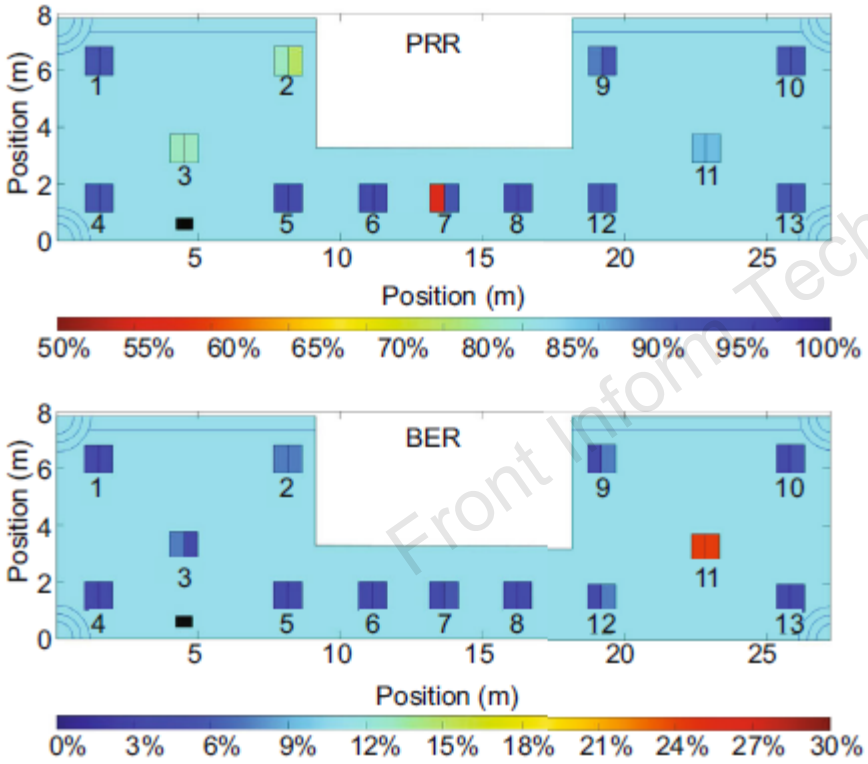
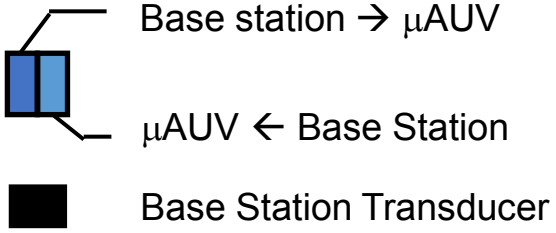


Fig. 10 Packet reception rate (PRR) and bit error rate (BER) of the stationary test

1. Position of the μAUV has dominant the impact on both packet reception rate (PRR) and bit error rate (BER).

2. Distance between μAUV and the base station has an insignificant impact on PRR or BER.



Major results (Cont'd)

Reverberation resulted from the multipath effect in a pool environment disrupts the synchronization signals, and results in package loss and transmission error.

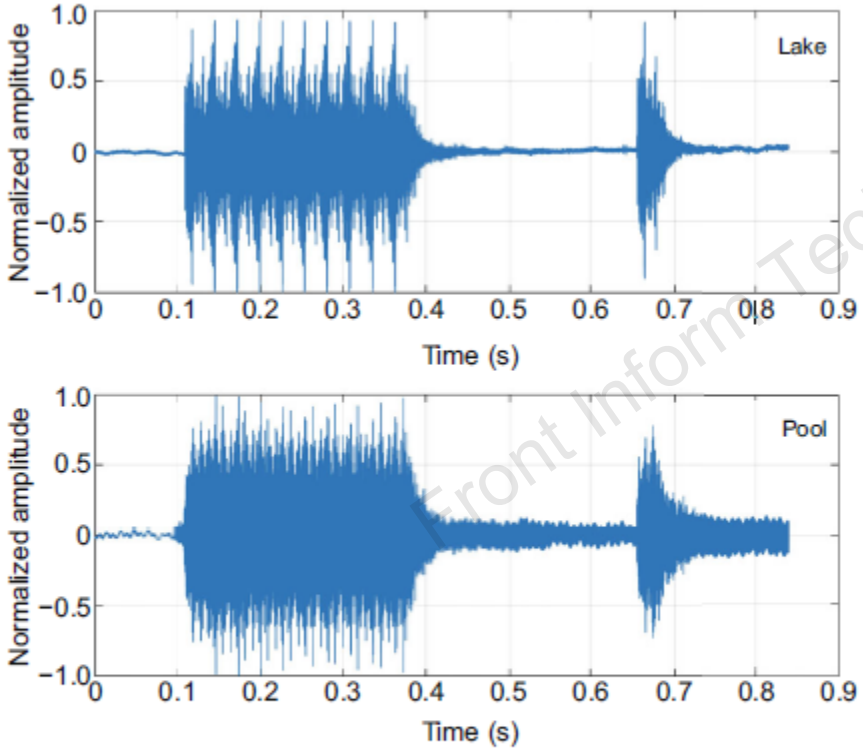


Fig. 14 Synchronization signal of the acoustic modem in lake and pool environments. Waveform during the first 0.1 s is environmental background noise

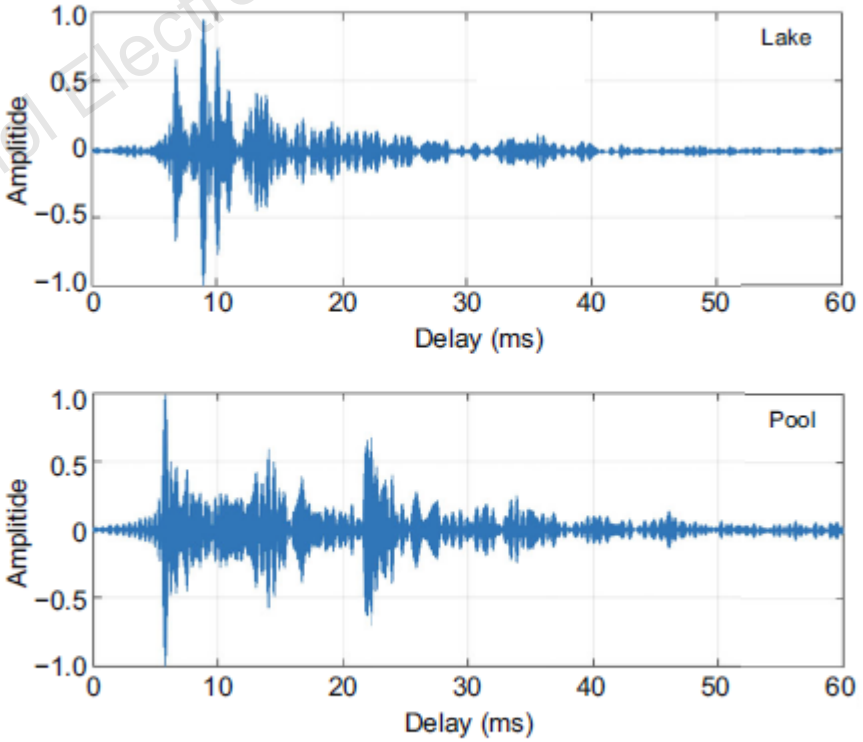


Fig. 15 Channel impulse response of the last (11^{th}) synchronization signal

Major results (Cont'd)

From moving transmission tests in a pool environment, movement between the μAUV and base station has dominant impact on BER.

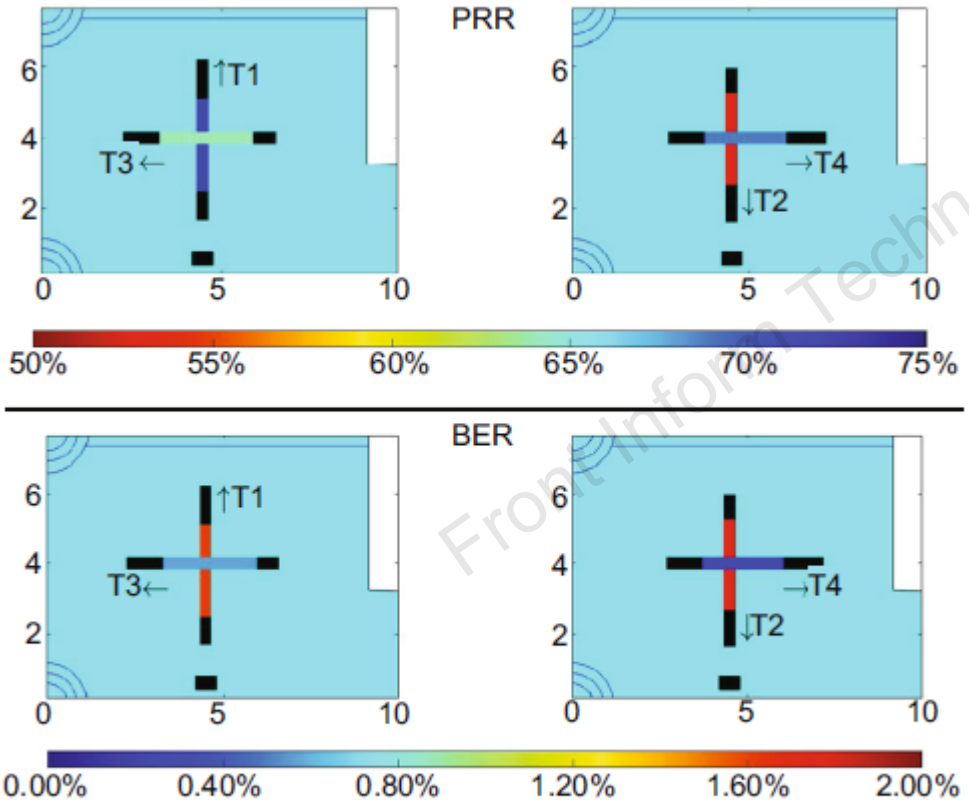
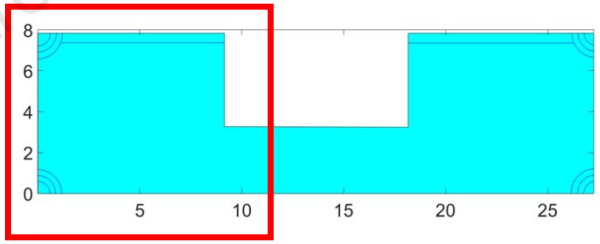


Fig. 17 Packet reception rate (PRR) and bit error rate (BER) in the moving test



Higher relative speed on trajectories T1 and T2 leads to an inferior BER.

Base Station Transducer

Conclusions

From stationary transmission tests, we can have:

1. Multipath effect is the dominant interfering factor in a confined environment.

2. The resulting reverberation interferes the synchronization signals, and causes an inferior PRR and BER.

3. Quality of the acoustic channel is spatially variant, and depends on the geometry of the confined environment.

From moving transmission tests, we can have:

1. Path hopping due to the movement of μAUV causes an inferior PRR and BER.

2. A higher relative speed has a noticeable impact on BER.