Underwater Communication: an open challenge

High speed communication in underwater scenario is a very challenging task. Huge power degradation and large attenuation of electromagnetic waves in water renders them unsuitable for underwater communication. Among others the acoustic signals are mostly used for this purpose, but they also get attenuated and absorbed a lot in medium. Transmission is limited by range dependent bandwidth, severe multipath, large fading and large and differential Doppler-shifts.
Many methods have been suggested to enhance the data rate and to reduce Bit Error Rate (BER) in typical underwater communication environment, but the task of achieving high-rate is still open.

One of the state-of-the-art solutions devised to solve is Time Reversal Mirror (TRM). TRM is a broadband beam forming at transmitter side that exploits the reciprocal property of sound wave equation. Active TRM communication system utilizes spatial diversity at transmitter rather whereas, passive TRM uses receiver diversity. It reduces the complexity of the receiver by focusing the energy in time and space.

Orthogonal frequency domain Multiplexing is another technique to solve this challenging task, but the frequency dependence of this technique in highly Doppler underwater environment possess another challenge.

This tutorial is for the researchers working in the area of underwater communication, students who want to explore the area and for industry that is manufacturing or using underwater modem. We will assume that the audiences are aware of communication fundamentals.

In this tutorial, we would like to cover following,

- Underwater Communication: Brief History
- Challenges of Underwater Acoustic Communication
    - Multipath Channel, Non-Gaussian noise
- Underwater acoustic communication techniques
    - TRM, OFDM, Chirp based communication etc.
    - Methods to handle multipath channel
    - Methods to handle Doppler shifts
    - Methods for time and frequency synchronization
- Some notes from the actual experiments
- Li-Fi Based underwater communication : Overview
- Future of Underwater Communication

The audio video equipment's will be required for power point presentation. A copy of the presentation may be provided to the participants if so desired. We are working in this area from almost a decade. The details about the author can be found at http://care.iitd.ac.in/People/Faculty/M_Aggarwal.html