LIVE RF IMAGE TRANSMISSION USING OFDM WITH RPi AND PLUTO SDR

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Objectives

Design an OFDM-based communications protocol that can span above, surface and underwater with following capabilities:

- Robustness to frequency selective fading & effectively use available bandwidth with additional security measure
- Compensates for multi-path effects at the receiver
- Allows receivers to distinguish among signals simultaneously transmitted by multiple devices

Introduction

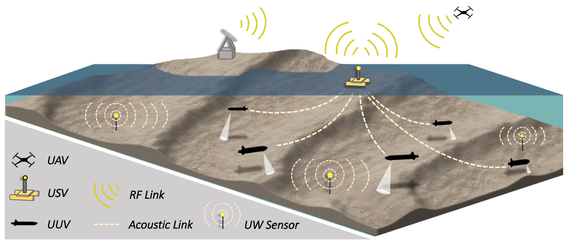

Figure 1:Robotic multi-vehicle collaboration - above and below water[1]

UW-ASNs [1] can consist of sensors on UUV and USV which collaborate with above-water robots like UAV to perform, for example, **collaborative monitoring tasks** (Figure 1). Proof of concept of OFDM, special case of CDMA, has been validated for in-air communication for relaying information from USV to UAV.

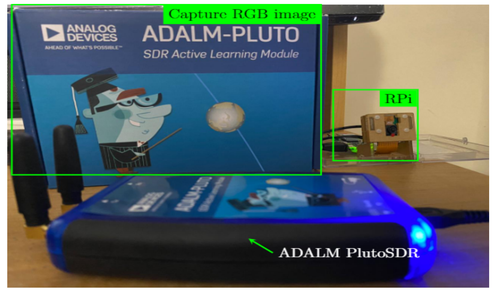

Figure 2:Experiment Setup

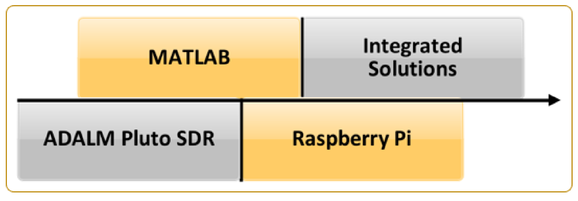

Figure 3:Various components of framework

Background

The motivation of this research follows the concept of [1] where 7-UUVs, 2-USVs, and 1-UAV collaboratively communicate underwater information using **TDMA** for under, on and above water. Proposed, is to use **CDMA/OFDM** instead so the full channel bandwidth is simultaneously used for multiple signals. This can be achieved with a pre-assigned unique code to each node to extract its signal component from the larger signal.
The following tools are being collaboratively used for research:

- **MATLAB, ADALM PlutoSDR, Rpi zero**

Important Result

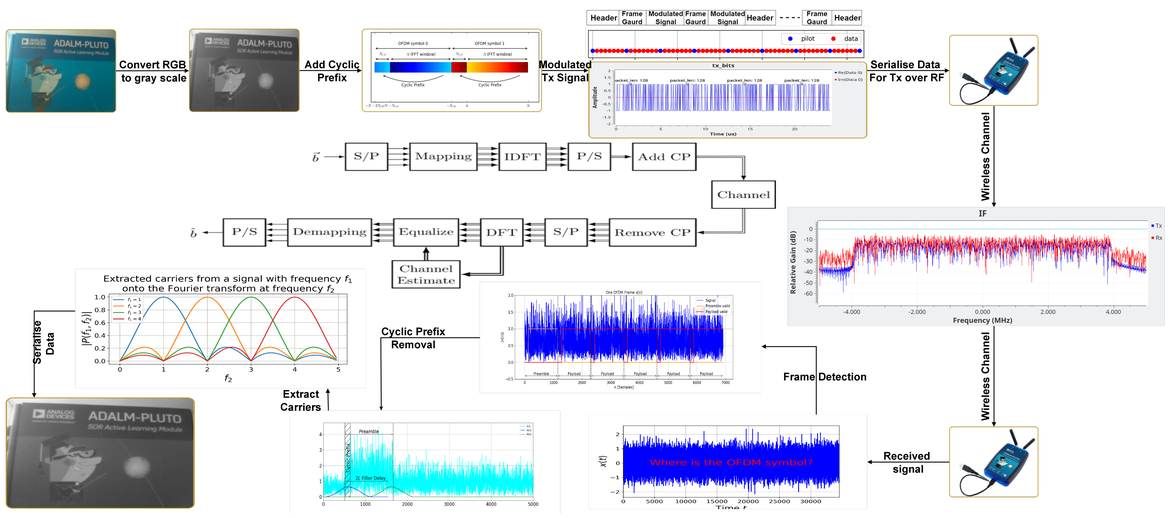

Figure 4:Proposed OFDM flow diagram

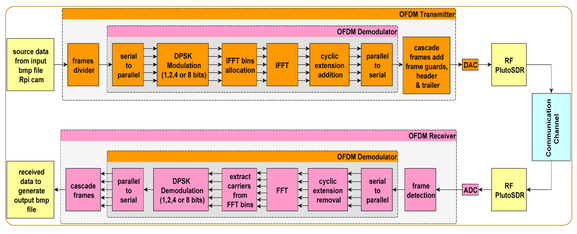

Figure 5:General arrangement for OFDM system

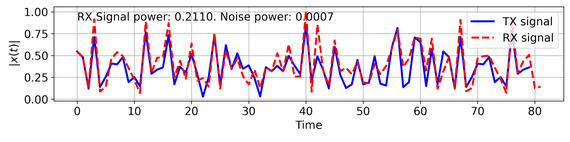

Figure 6:Comparison of Tx and Rx Signal of PlutoSDR

Methods

The following approach is used to carry out the research.

- Live image taken from Rpi webcam at lower frame rate, converted to gray scale to use available bandwidth efficiently
- Matlab prepare image data and push that through via PlutoSDR Transmitter
- Collect data through same PlutoSDR Receiver and decode the received image data
- Note that received image is in gray scale to meet Bandwidth criteria for future underwater OFDM implementation

Results

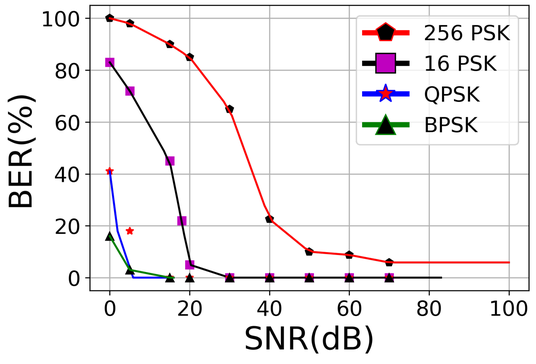

Figure 7:BER(%) vs SNR

Changing SNR value will change the quality of output image.

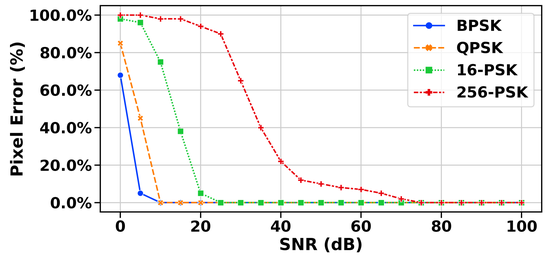

Figure 8:Pixel Error (%) vs SNR

Exceptionally in 256PSK case, low SNR received images have higher BER, but most of the received images are still readable as grayscale images. Most of the received images have different gray level pixel value than original transmitted image but contents are being remain intact. The main challenge during execution of the project are precisely matched de-modulator and modulator.

Conclusion & Future Work

The experimental results are encouraging. Its implementation and integration to multi domain are underway however, merging under, on, and above water models is expected to increase the complexity.

References

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