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### Weekly Report #4 – Project Proposal Revision and Prepared List of Questions

#### **Project Proposal Responsibilities**

- An overview of the digital signal processing on the Raspberry Pi 3
- Planned approach for programming the SDRs with GNU Radio to cross correlate in-phase and quadrature samples from SDRs (Whiting, Sorensen, and Moon)
- Including an addendum to the literature review or technical section including more sources in digital signal processing methods that can be used to improve direction finding accuracy such as the pros and cons of different interpolation methods for low sampling rates (taking into account that the highest safe sampling rate of the I/Q Extraction is 2.56 MS/s on the RTL-SDR (Superkuh)).

#### **List of Questions for Dr. Kan**

- Studies have been conducted on passive tags in an indoor environment. How flexible will heuristic optimized continuous-wave ranging be with an active tag system. Would the effects of multipath from an outdoor environment require additional functionality for a high error tolerant system, especially when tracking over large distances?
- Forward compatibility to light-weight tags in our system. In one of the studies an advanced tag was used, “The WISP unit...performs the functions of energy harvesting, reader command decoding, computation, and protocol control.”
- When “LoS is strong, AoA calculated from digital beamforming should yield a very similar angle for different frequencies, but when multi-paths are strong, for frequencies separated wider than  $B_c$  (coherence bandwidth), we expected a large AoA gap, which can be used as a measure of multi-path dominance.” Digital beamforming and spatial filtering: are accurate measurements determined concurrently with a MUSIC related algorithm, or is there a two stage process involved (for instance: determining coherence bandwidth at different antenna array sets, determining the best received LoS based on the coherence bandwidths, and then listening only to one of the antenna array sets based on collected information.)

My understanding of the music algorithm is that it consists of signal and noise sub spaces that are computed at different antennas array sets. From this information, the music algorithm determines an optimal angle of arrival.

(Whiting, Sorensen, and Moon) – <https://pubs.gnuradio.org/index.php/grcon/article/download/38/28>

(Superkuh) – <http://superkuh.com/rtlsdr.html>

Music Algorithm -

<https://pdfs.semanticscholar.org/5ff7/806b44e60d41c21429e1ad2755d72bba41d7.pdf>

Indoor Passive Device Ranging by Low-directivity Antennas with Centimeter Precision:

[https://github.com/jakapoor/AMRUPT/blob/master/Literature/General\\_radio\\_direction\\_finding/Types/Phase-based/Ma et al. \\_Unknown.pdf](https://github.com/jakapoor/AMRUPT/blob/master/Literature/General_radio_direction_finding/Types/Phase-based/Ma%20et%20al._Unknown.pdf)