Temasek Defence Systems Institute

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PHOTONIC DIRECTION FINDING (DF) SYSTEM: FRONT-END SYSEM DESIGN AND PERFORMANCE MEASUREMENT USING LPI SIGNALS

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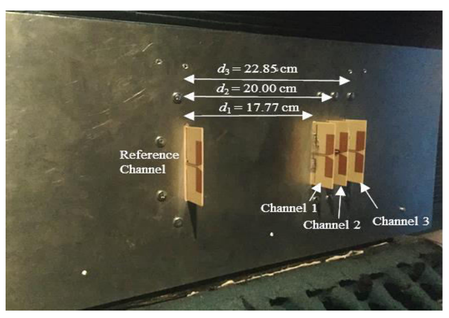
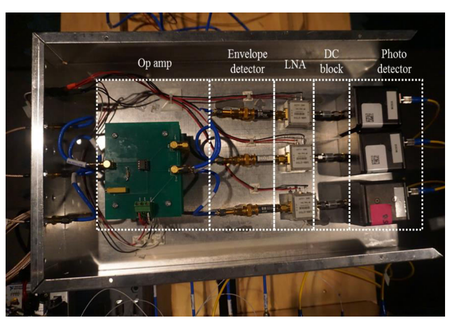
1. Objectives of thesis

- Design and develop a physical microwave-photonic (MWP) phase sampling linear DF system.
- Characterization of components used in the system design.
- System integration with the photonics back-end post processing.
- Testing the front-end microwave photonics circuit design using low probability of intercept (LPI) signals in NPS anechoic chamber.

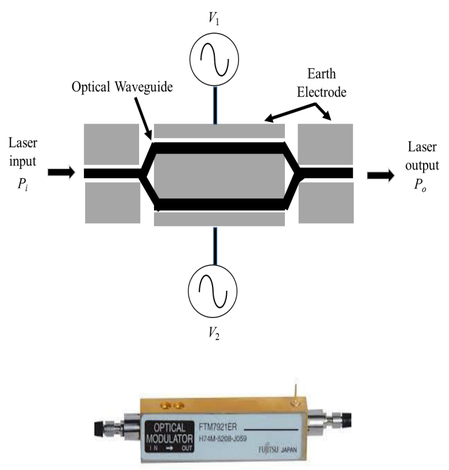
2. Main research ideas



Using only four-antenna elements to detect and convert RF electromagnetic (EM) waves into electrical signals. → Results in small baseline of 23cm for the antenna design



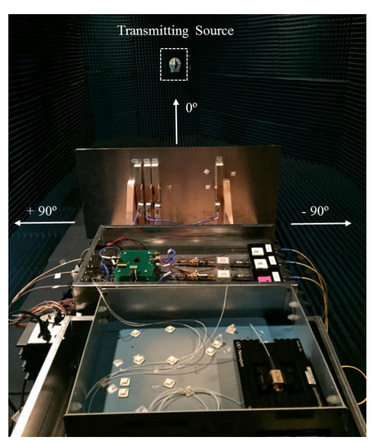
Modular design of DF subsystem into various Aluminum boxes. → Enable the ease of transportation, testing and system integration.

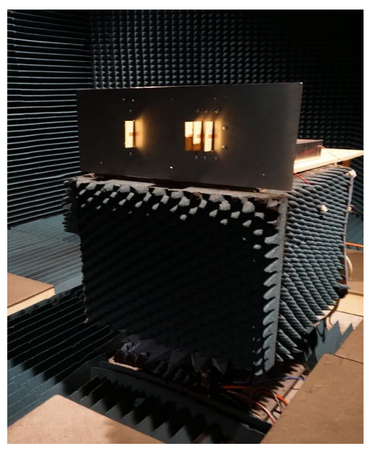


Development of an innovative microwave-photonic phase sampling linear DF architecture. → Achieves the advantage of direct sampling of received signals offered by photonic device, and eliminate the need of RF down-conversion.

For example, with the use LiNbO3 Dual Electrode Mach- Zehner Modulator as part of DF antenna design.

3. Research Results





System testing and validation in NPS anechoic chamber using LPI signals at 2.4 GHz.

System was capable of estimating the angle-of-arrival for:

- P4 modulation signal with RMS error of 0.32° at <1° resolution.
- Frequency Modulated Continuous Wave (FMCW) signal with a RMS error of 0.29° at < 1° resolution.

DF receiver has relative good sensitivity of −62.96 dBm.

4. Potential application of the research

Use of microwave-photonic components in DF architecture design reduces size, weight, power requirement, and cost (SWAP-C) of DF system.

Possible deployment for miniature air vehicle applications in the future.

5. Recognition

This thesis was awarded with 132nd AFCEA John McReynolds Wozencraft Electrical & Computer award.

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