Orthogonally-Coded Array for High-Speed Synthetic Aperture Radar (SAR) Imaging

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**Objective:** To improve the quality of synthetic aperture radar (SAR) images, and reduce measurement time through the implementation of orthogonal coding.

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**Overview**

- SAR imaging involves the coherent summation of backpropagated microwave measurements made from many locations and over a band of frequencies.
- Traditional SAR imaging scans one antenna, or electronically switches between many antennas, one-by-one, to transmit and receive microwave signals from many locations.

**Proposed Approach**

- Create an antenna array, operating at Ka-Band (26.5-40 GHz), that simultaneously transmits and receives with all antennas in order to collect more data.
- Each transmitting antenna must be encoded by a unique, orthogonal binary code, which is also known to the receiver.
- The receiver then decodes the received signal by correlating it with the codes for each transmitting antenna.

**Future Work**

- Make measurements on the implemented system.
- Investigate the optimal coding sequences for speed and noise.

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**Examples of binary orthogonal codes:**

- Equivalent to switching antennas

\[
\begin{array}{cccc}
0 & 1 & 0 & 0 \\
0 & 0 & 1 & 0 \\
0 & 0 & 0 & 1 \\
\end{array}
\]

- Enables simultaneous transmission, with bits represented by phase shifts

\[
\begin{bmatrix}
1 & 1 & 1 & 1 \\
1 & 1 & -1 & -1 \\
1 & -1 & 1 & -1 \\
1 & -1 & -1 & 1 \\
\end{bmatrix}
\]

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**Antenna Design**

- An antenna was designed and tested for this system.
- Measurements and simulations show antenna is suitable for imaging purposes.

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**Simulation Results**

- Modeling shows improvement in image signal-to-noise ratio (SNR) as the number of simultaneously transmitting antennas increases.