Drone Scout
Function

- The LGS Drone Scout is a millimeter wave radar system capable of detecting a small UAV or drone in a targeted area.
- By analyzing the micro-doppler signatures of a drone propellers in the radar return signal, we can determine the presence of a drone along with some of its features.
- An external HDMI display will show a waterfall chart plotting the frequencies found in the signal and their magnitudes with respect to time (i.e. a spectrogram).
Applications

● Defend against military and terrorist attacks
  ○ Possible threats include drones carrying dangerous payloads like bombs.

● Protect personal privacy
  ○ Small drones with cameras, microphones
    ■ Can be hard to detect if the drone stays still
Development Team

Austin Hwang
Team Lead
System Design
PCB

Maga Kim
Software Development

Anthony Chen
Software Development

Sungin Kim
Software
FPGA Development
**LGS mmWave Radar**

- **X-Band Radar** (7 to 10 GHz)

  - **ZN2PD2-14W-S+** (0.5 to 10.5 GHz)
  - **PE2055** (6 to 12.4 GHz)
  - **ZX05-14+** (6 to 12.4 GHz)
  - **Narda 4925** (7 to 12.6 GHz) +15dB 7 to 10 GHz
  - WR112 7 to 11 GHz
The MicroBlaze will sample the analog radio signals using the Pmod ADC, and then place the samples into a circular buffer.

Linux program running on the ARMs continuously take blocks of data from the buffer to process.

The sampling and processing tasks are run concurrently.
Frequencies of the ADC is calculated with the Numpy FFT library function and plotted with the MatPlotLib library function.

Feature Detection Algorithm is our next step. We are lacking UAV radar data to design a algorithm with.
Current Progress: Demo

- Live spectrogram of function generator data displayed via HDMI.
Components

- LGS mmWave Radar
- Signal Amplifier: Module; PCB
- ADC: Pmod AD1
- PYNQ Z-1 (Zynq-7000 Development Board)
- HDMI Display
PYNQ Z-1 & Pmod AD1

PYNQ Z-1:
- Arm Cortex-A9 (dual core)
- FPGA
- Pmod interface ports
- HDMI output/input ports

Pmod AD1:
- 2-channel, 12-bit
- Samples up to 1 million times per second
- SPI interface protocol
Signal Amplifier Module

- Needed to amplify the radar signals to an appropriate range for the ADC
- Outputs from this module will connect directly to the PMOD ADC
PCB: Signal Amplifier; UI Peripherals

- Two separate boards for each function

- Signal amplifier circuit:
  - Based on the AD620 module
  - BNC connection; PMOD output

- UI peripherals:
  - Buttons to control system functions
  - Rotary encoders to adjust scaling of the axes on the plot
Signal Amplifier Schematic
# Bill of Materials

<table>
<thead>
<tr>
<th>Product</th>
<th>Description</th>
<th>Distributor</th>
<th>Price</th>
<th>Quantity</th>
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<tbody>
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<td>mmWave Radar</td>
<td>Signal transceiver operating at ~40GHz</td>
<td>LGS</td>
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<td>PYNQ Z-1</td>
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<td>Amplifier for radar signal</td>
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# BOM (PCB Parts)

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## Winter Quarter

- PCB Design: Radar signal interface; UI peripherals
- Python GUI: Live plot; features
- Integrate the current system with the LGS radar.
- Set up testing environment with our drone.

<table>
<thead>
<tr>
<th>python GUI</th>
<th>Platform Migration</th>
<th>PCB Design</th>
<th>Radar Integration</th>
<th>Drone Tests (1 rotor)</th>
<th>Basic Detection (1 rotor)</th>
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Spring Quarter Plan

**Requirements**

- Feature detection algorithm
  - Single and multiple rotor detection
- Assemble final system

**Stretch Goals**

- Improve algorithm efficiency
- Improve sampling method:
  - Write a custom IP core for the ADC and DMA samples into on-board RAM.
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- Duane Gardner
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- Rory McCarthy

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- Carrie Segal
- Brandon Pon
Thank you!

Questions?