2-D Mapping with Sonar

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Basic Sonar

Receiver
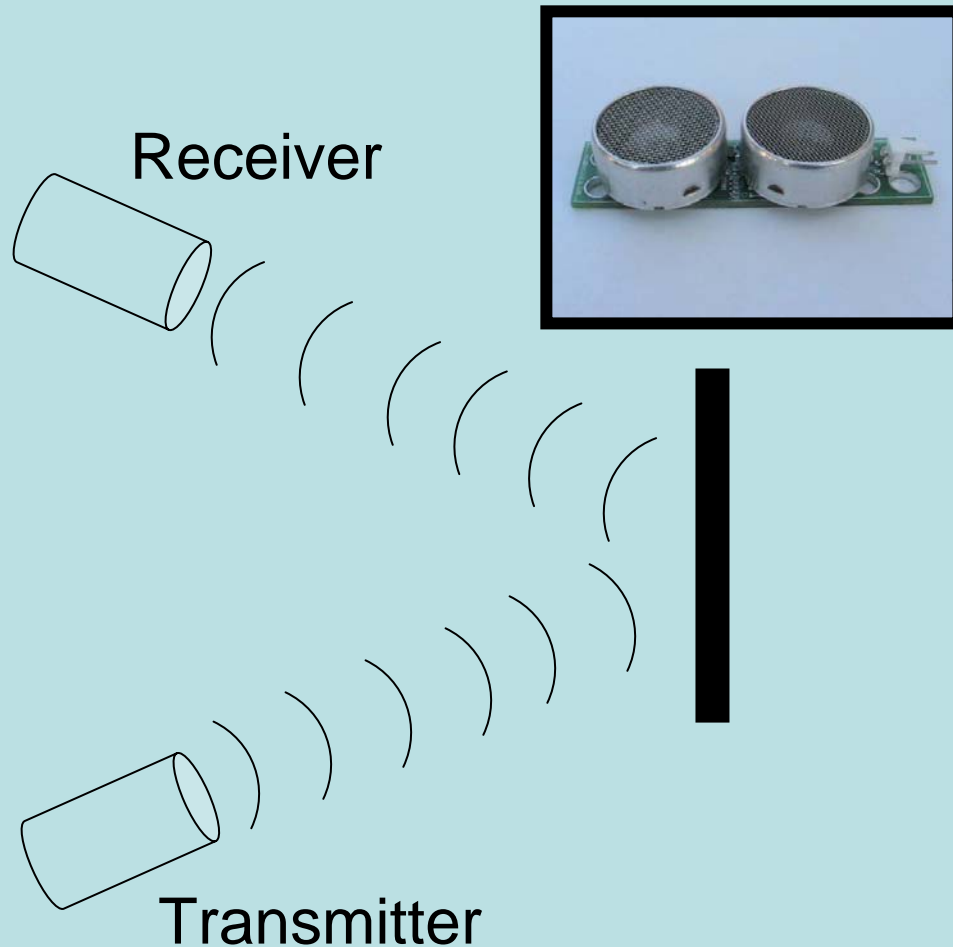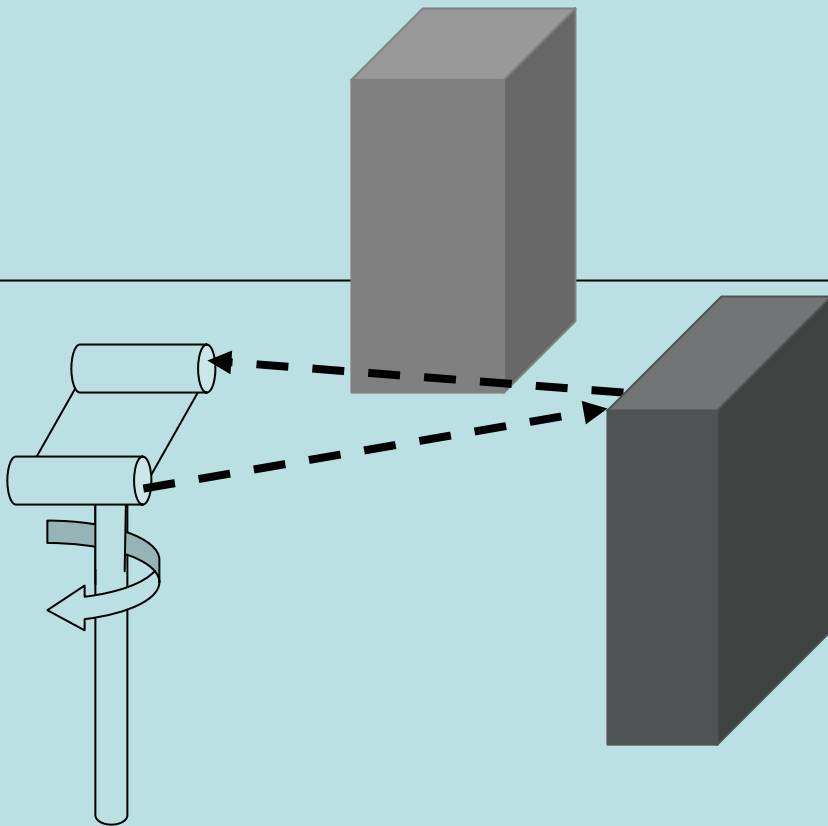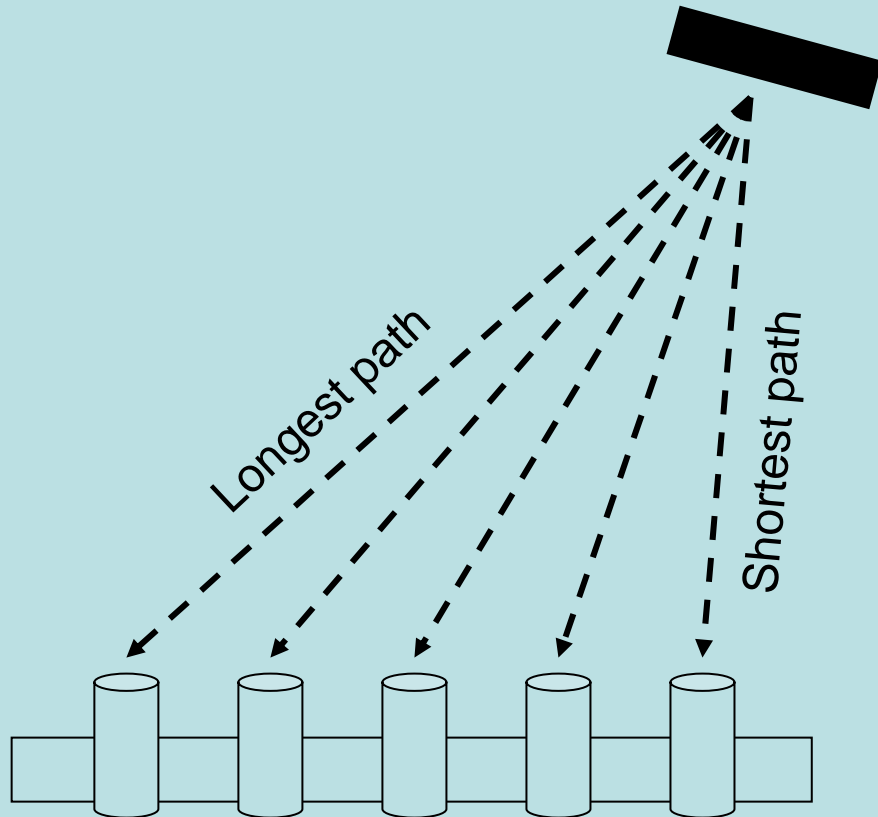
Transmitter

- Ultrasound cannot be heard by people

- Small wavelength => good for short distances

- Time of flight can be used to estimate distance

Basic Mapping

- Rotate receiver/ transmitter to measure distance at every angle

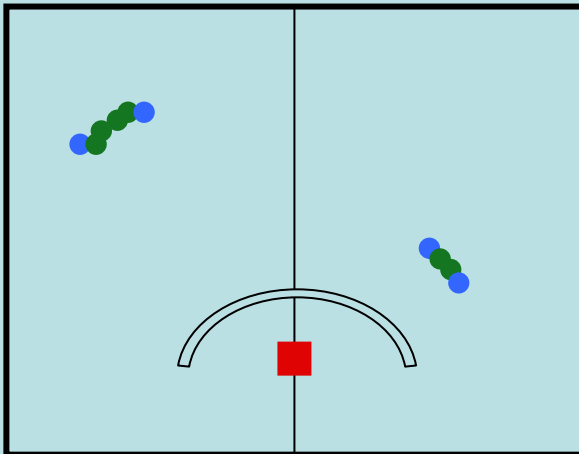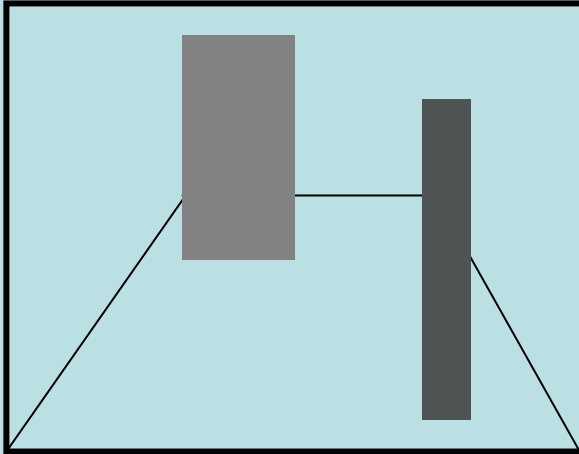- Slow update rates because of many distance measurements

Phase Array

Longest path

Shortest path

- Use multiple receivers, measure different angles using phase relationships

- No moving parts => more reliable

- Faster update rate

Applications

- Draw a top view map of environment

- Security system that detects changes in surroundings

Simplified Block Diagram
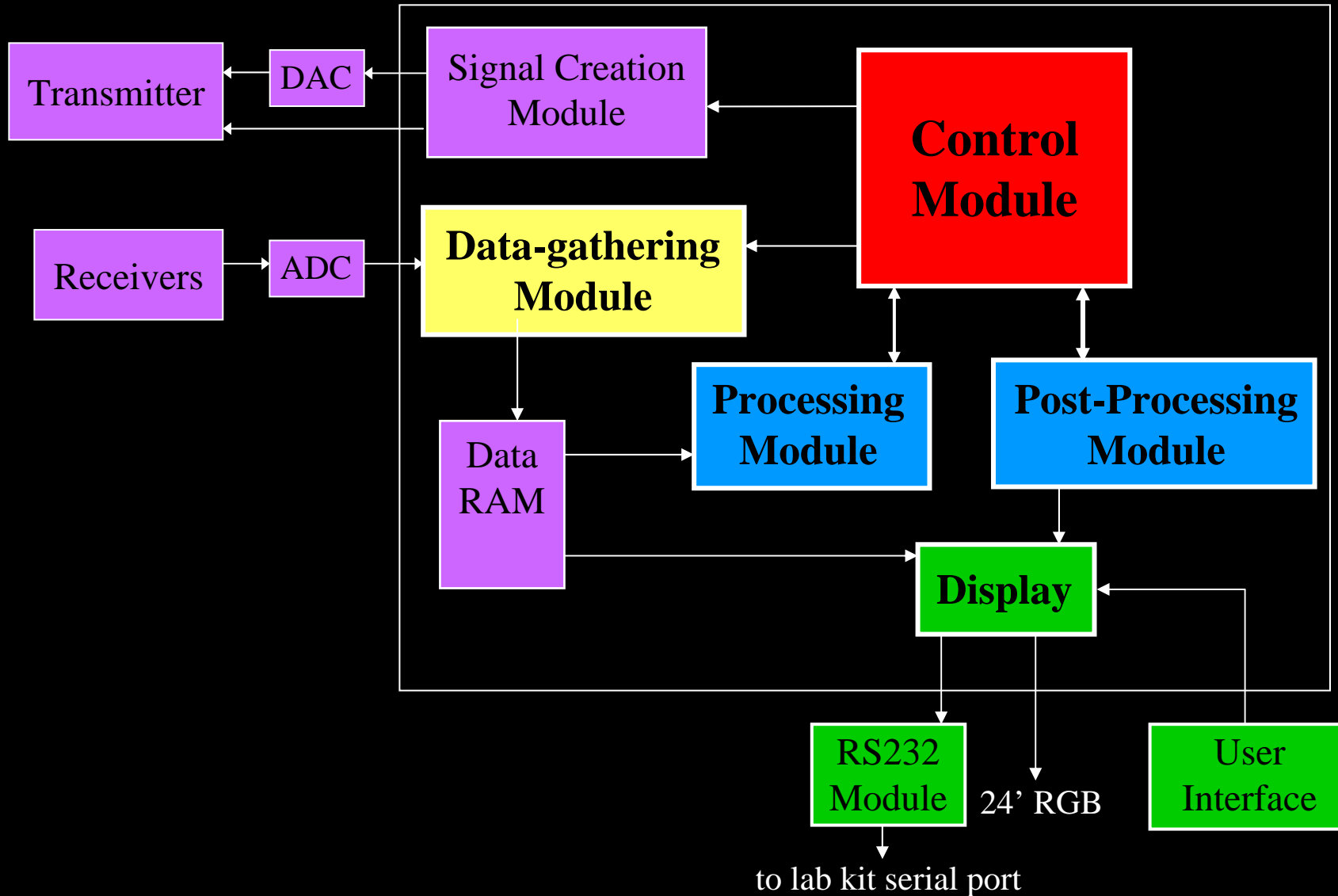
| Transmit/ Receive | Data- gathering | Control/ Process | Display/ Interface |

Transmitter

DAC

Signal Creation Module

Control Module

Receivers

ADC

Data-gathering Module

Data RAM

Processing Module

Post-Processing Module

Display

RS232 Module

24' RGB

User Interface

to lab kit serial port

Transmit/Receive

Transmitter

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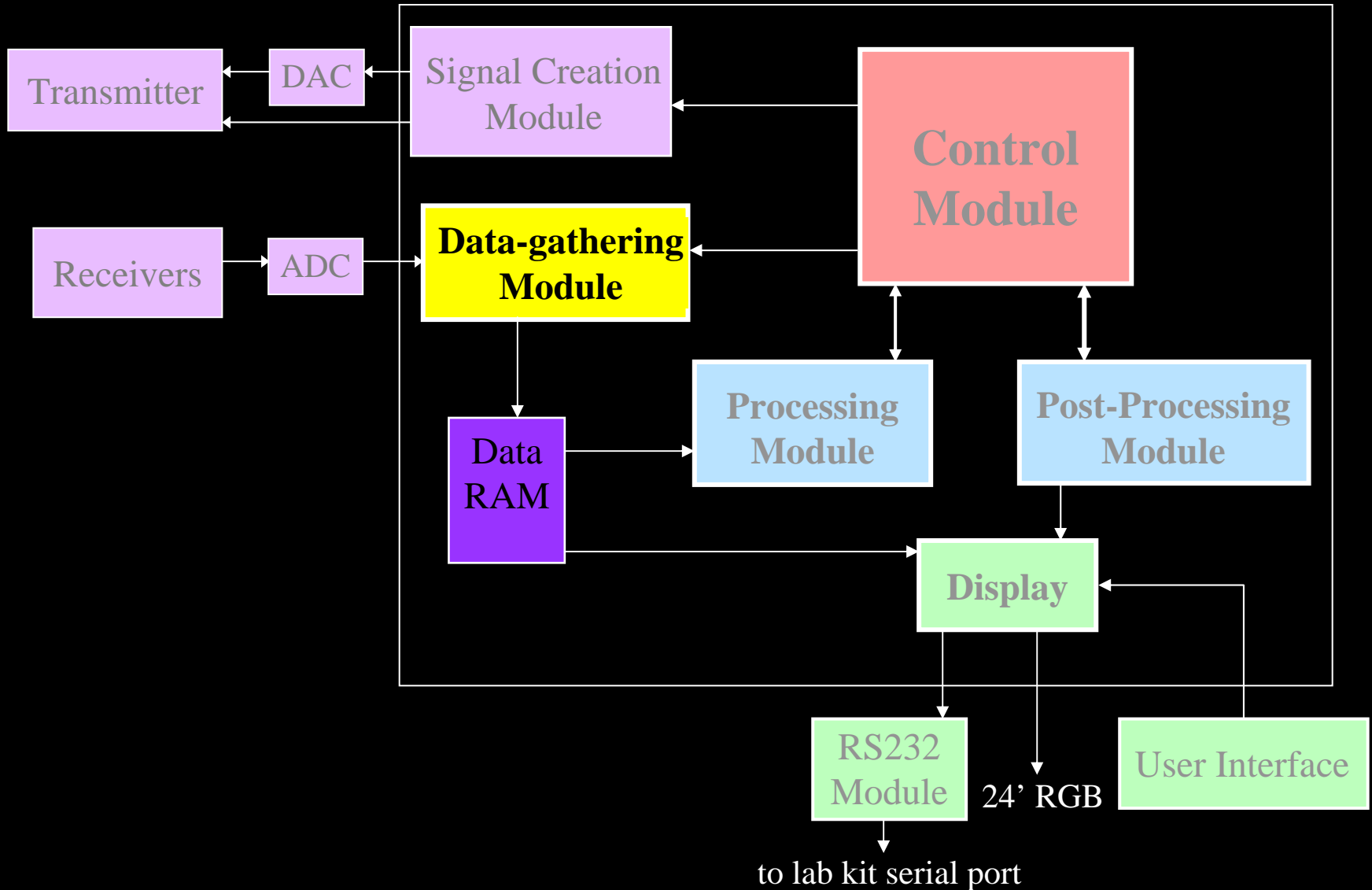
Transmit/Receive

- Transmit a single 40-kHz sine wave pulse (generated from stored values played through DAC)

- Multiple receivers

- Enable signals from Control Module for transmitting and receiving

Data-gathering

Transmitter

DAC

Signal Creation
Module

Receivers

ADC

**Data-gathering
Module**

Data
RAM

**Control
Module**

**Processing
Module**

**Post-Processing
Module**

Display

RS232
Module

24' RGB

User Interface

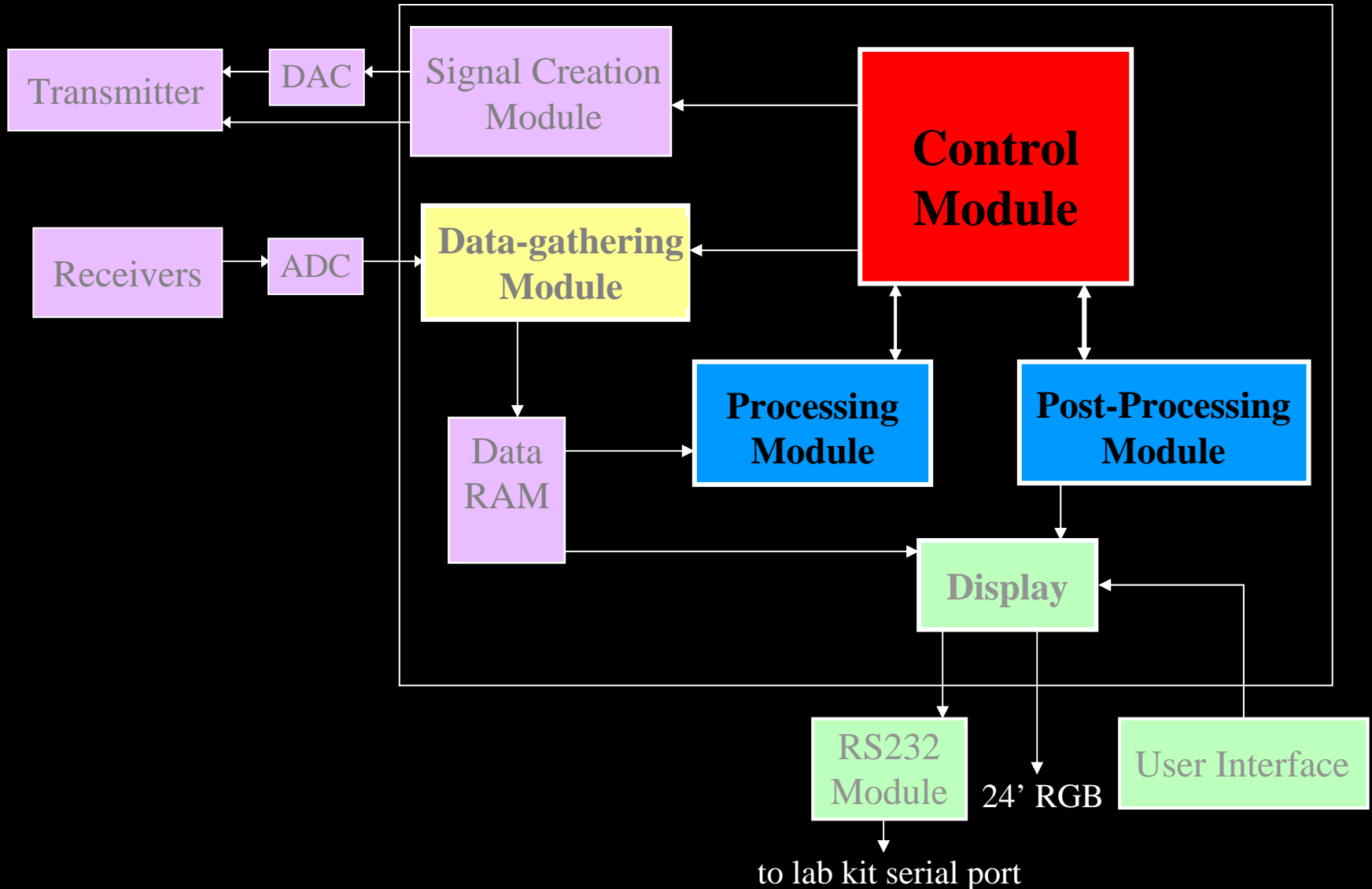to lab kit serial port

Data-gathering

from Control
Module

- Samples data from receivers at intervals dictated by Control Module

- Data stored in one of two RAMs

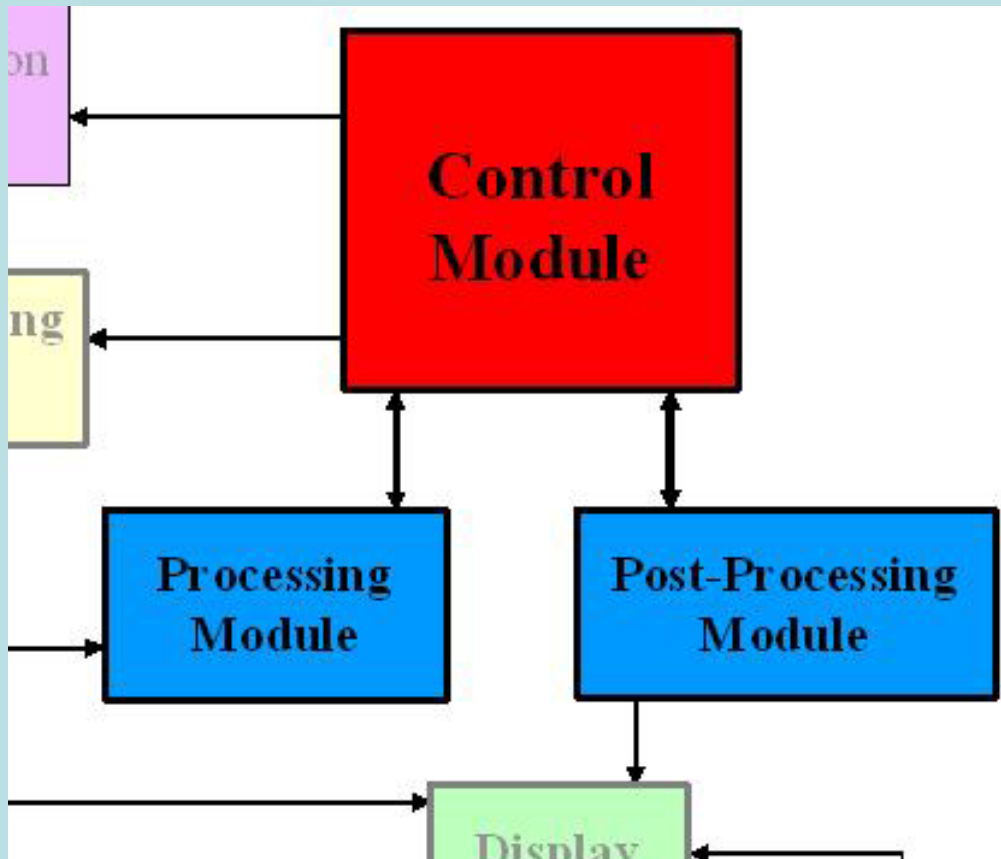- Simultaneous storage and processing of data— "double buffering"

Control/Process

Transmitter

DAC

Signal Creation Module

Receivers

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Data-gathering Module

Control Module

Data RAM

Processing Module

Post-Processing Module

Display

RS232 Module

24' RGB

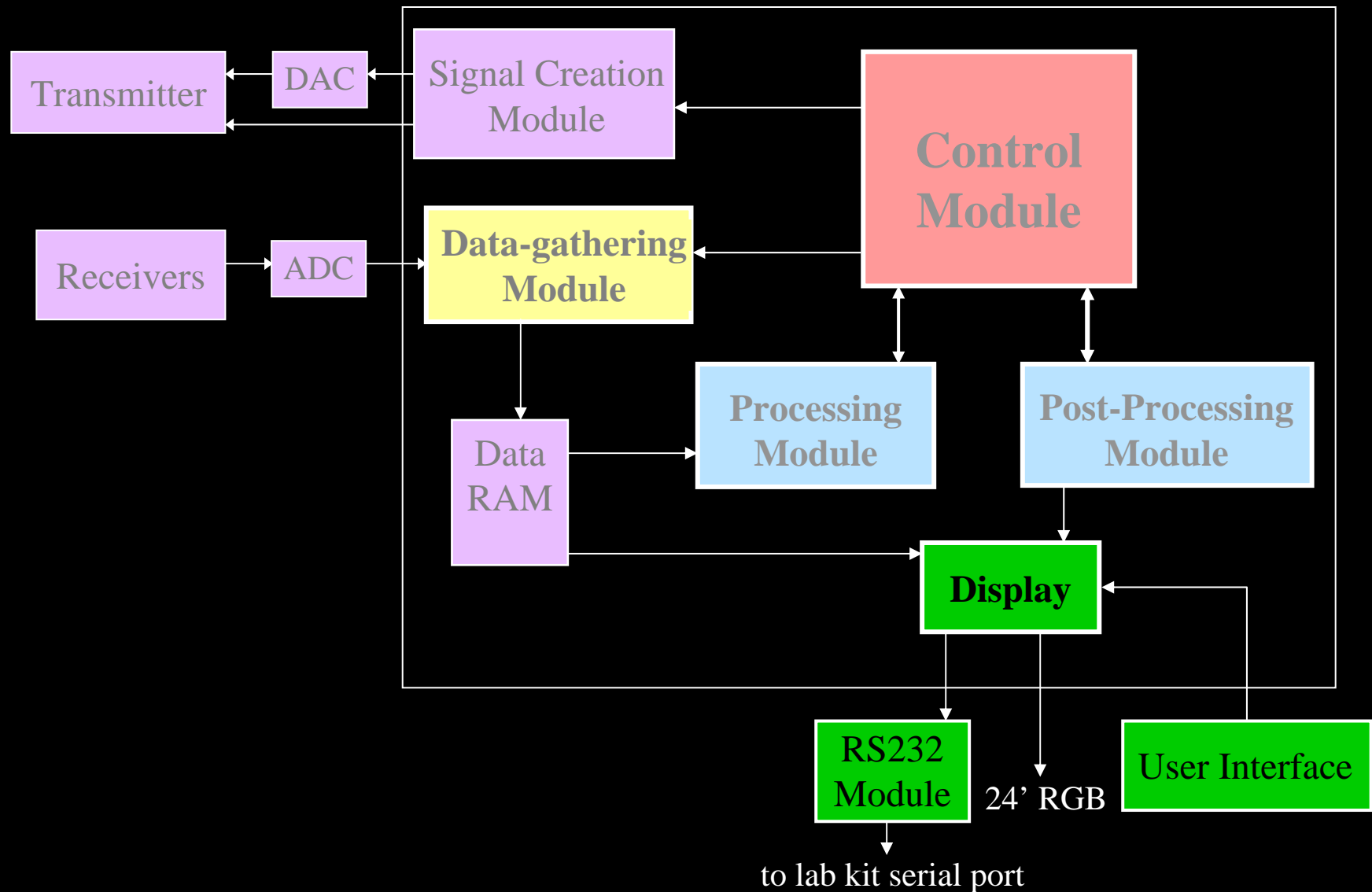User Interface

to lab kit serial port

Control/Process

- Control Module gives Processing Module an angle; Processing Module gives back distance at that angle

- Post-Processor gets angle/distance pairs ready for display and tells Control Module if more data is needed

Display/Interface

Transmitter

DAC

Signal Creation Module

Receivers

ADC

Data-gathering Module

Control Module

Data RAM

Processing Module

Post-Processing Module

Display

RS232 Module

24' RGB

User Interface

to lab kit serial port

Display/Interface
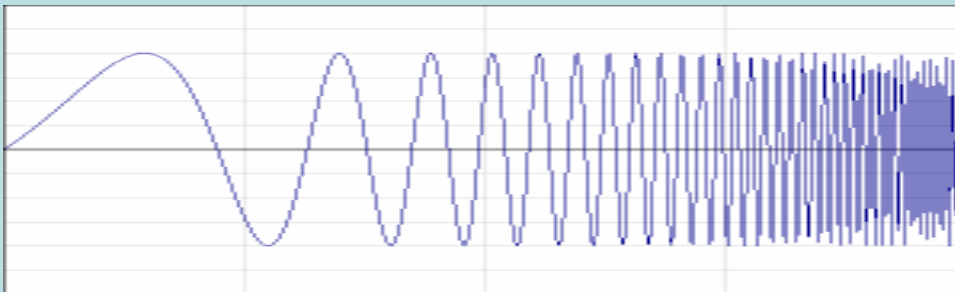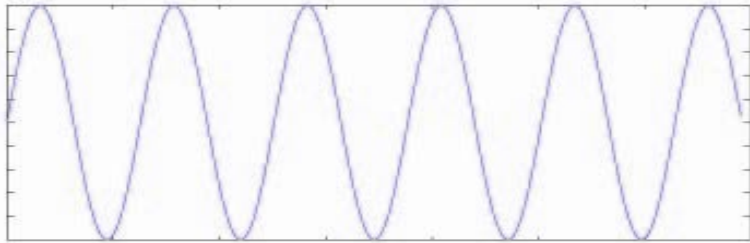

from Data RAM

Display

RS232 Module

24' RGB

User Interface

to lab kit serial port

- Display Module gives VGA controller appropriate RGB signals

- Main purpose is to draw a 2-D, color-coded map of the environment

- RS232 Module is for debugging

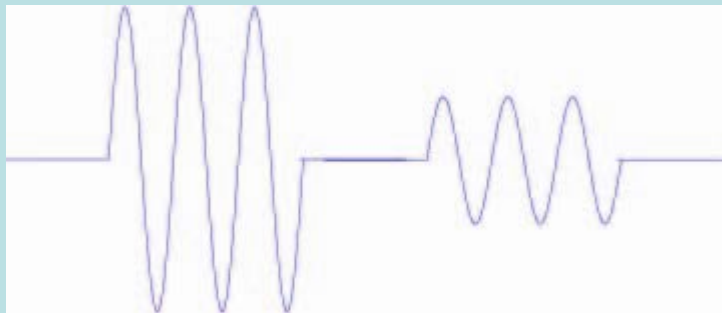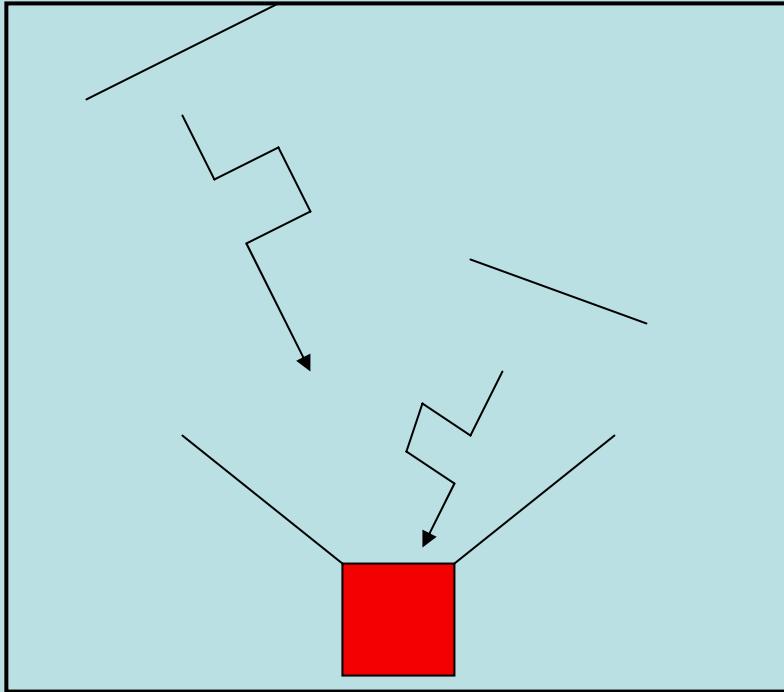- User can choose what is displayed

Sines, Chirps, and Pulses
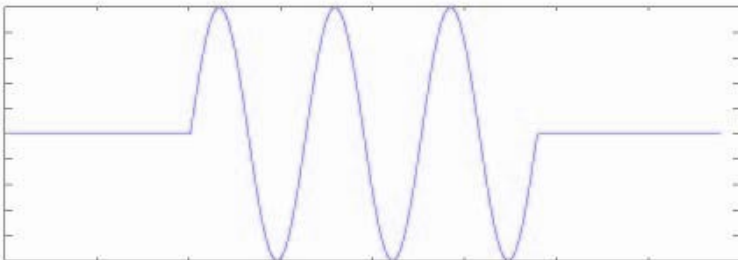
- What kind of signal to transmit?

- Steady Sine Wave

- Chirp (linearly changing frequency)

- Short pulsed sine wave
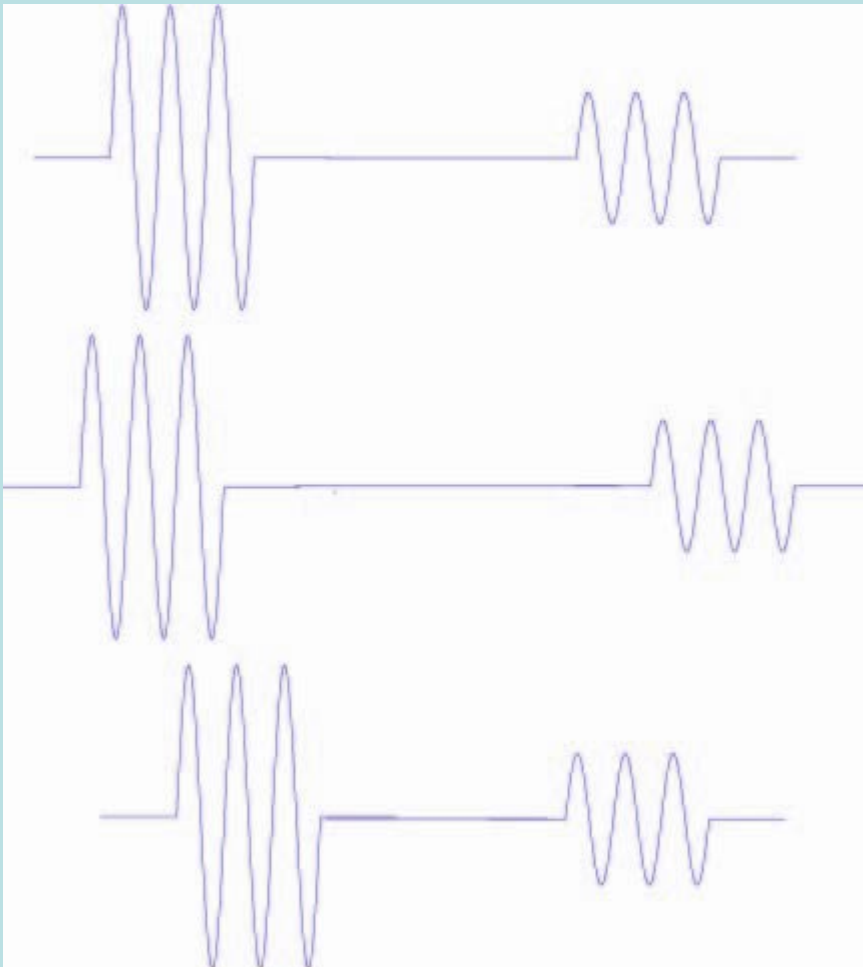
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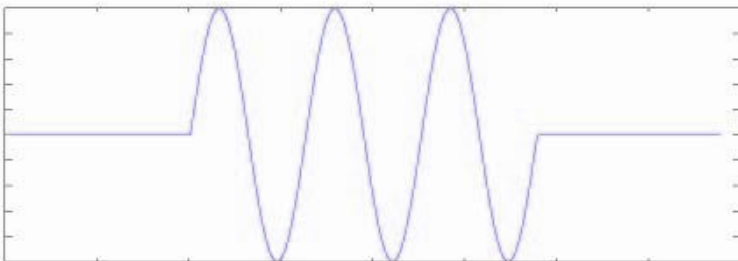
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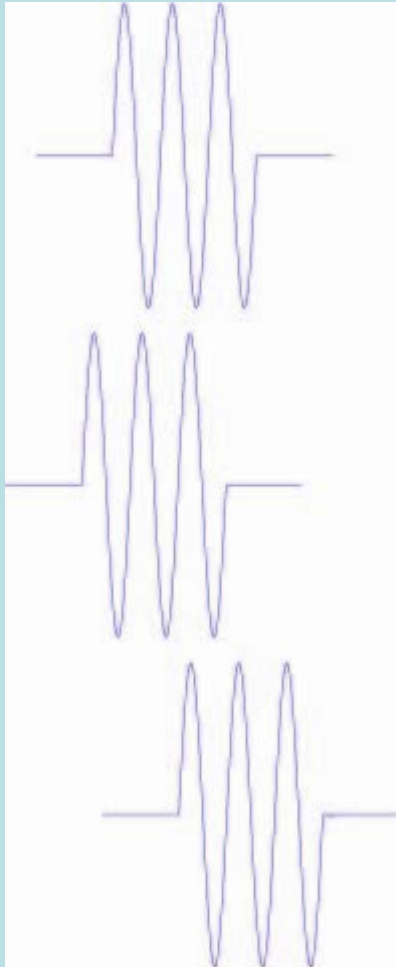
Game Plan

- Send a pulse, receive attenuated & shifted signal

Game Plan

- For each reflection, different receivers have similar attenuation, but slight phase shifts.

- Can expand as 2 delays:

  - Object to receiver 1 - **DISTANCE**

  - Receiver 1 to Receiver N - **DIRECTION**

The Process

1. Find where a certain phase relation is most likely to have occurred (similar to matched filtering)

2. Record the delay to this region of the signal

3. Distance = (half delay to max) * (speed of sound)

The Process
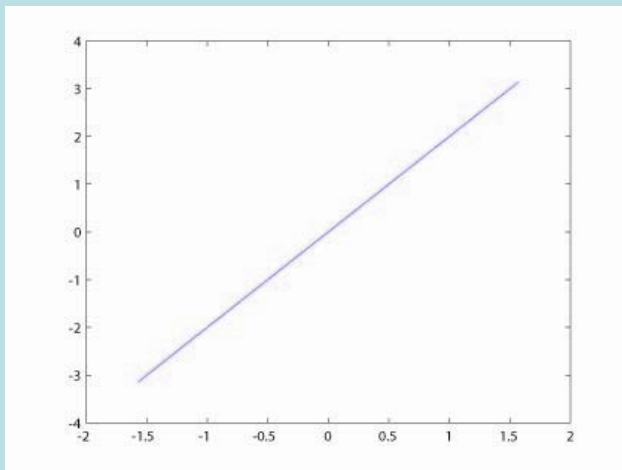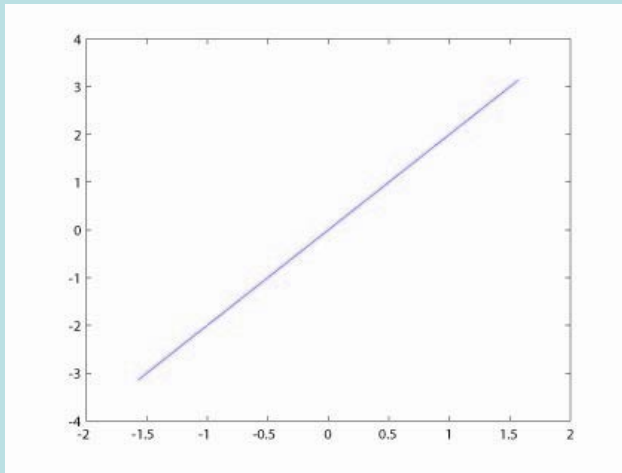
After post-processing, matches almost perfectly in simulation.