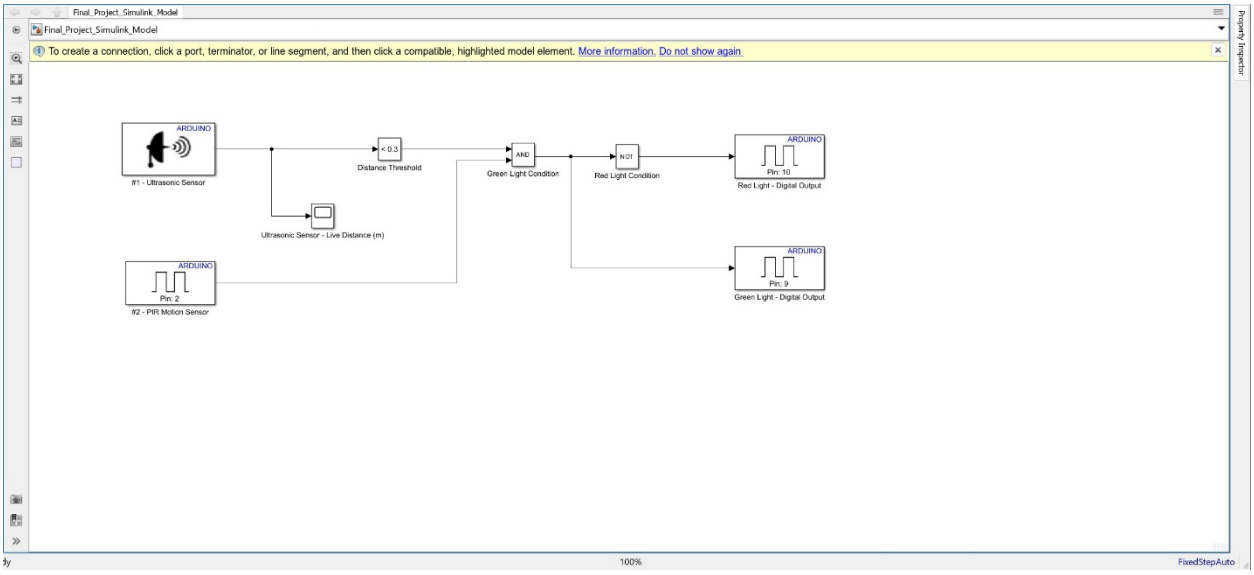
Final Project – Motion / Distant Detection with Arduino Uno R3

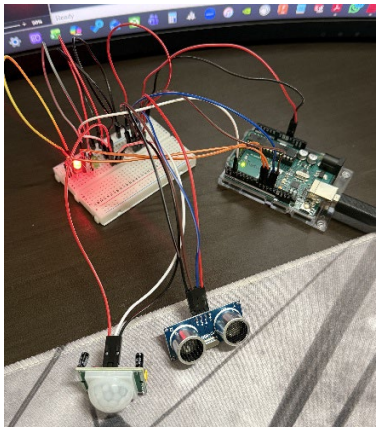
Project Overview:

This project implements a real-time motion-and-distance-based LED indicator system using an Arduino Uno R3, an HC-SR04 Ultrasonic Sensor, a PIR Motion Sensor, and two LEDs (Green and Red). The system is designed in MATLAB Simulink and deployed to the Arduino using the Simulink Support Package for Arduino Hardware. The objective is to detect whether an object is both within a specified distance threshold and exhibiting motion, and to communicate this state using colored LED outputs.

Simulink Model:



Hardware Setup:



Model Architecture:

The model is built using hardware-specific Arduino blocks provided in the Simulink library. The core components include:

1. Ultrasonic Distance Measurement Subsystem

The Ultrasonic Sensor block reads real-time distance (in meters) using:

- Trigger Pin: D3
- Echo Pin: D4

The sampled distance is compared against a constant threshold (set to 0.3 m) using a compared to Constant block. The output is a boolean signal isNear that indicates whether an object is closer than 30 cm. This connection and configuration follow the hardware mapping defined in the Step-by-Step Guide.

2. PIR Motion Detection Subsystem

A Digital Input block reads the output signal from the PIR Motion Sensor (Pin D2). This motion status (motionDetected) is boolean, where HIGH indicates detected movement.

3. Logical Decision Layer

The system uses:

- Logical AND block to combine isNear AND motionDetected, creating greenCondition.
- Logical NOT block to invert greenCondition, producing redCondition.

This simple decision logic ensures mutual exclusivity:

- If near + motion → Green LED ON
- Otherwise → Red LED ON

4. LED Output Layer

Two Digital Output blocks drive:

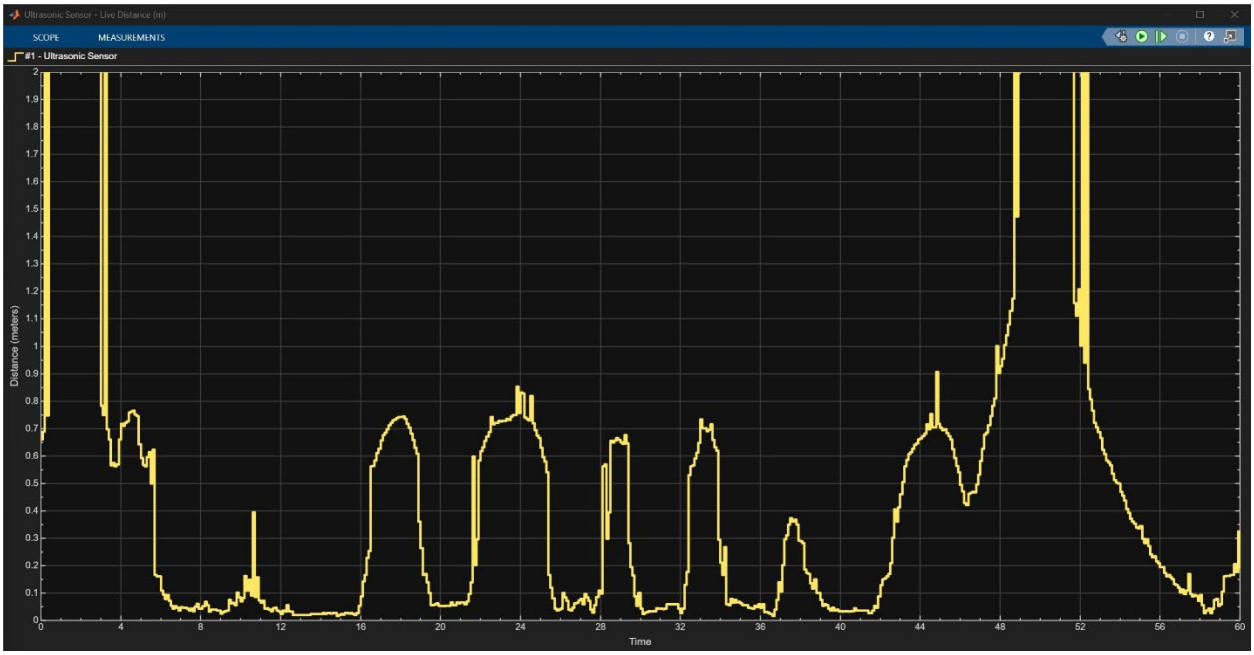
- Green LED on Pin D9
- Red LED on Pin D10

Each LED is wired in an active-HIGH configuration using 220 Ω resistors, as specified in the hardware wiring instructions.

Behavior of the System:

When deployed in external mode, Simulink streams live sensor values back to the graphing scope. The logic operates at a 0.1 s sample time, providing smooth and stable detection behavior. When an object enters the threshold distance and motion is detected simultaneously, the system switches illumination from red to green in real time.

Data Collected (Ultrasonic Sensor Live Distance Plot):



The recorded distance dataset (shown in the provided Scope screenshot) demonstrates how the ultrasonic sensor measures object positions over ~60 seconds of testing. The plotted data shows:

- Multiple approach-and-retreat cycles, with distances ranging from near-zero to ~2 meters.
- Sharp spikes or drops associated with angle changes or reflective surfaces—normal behavior for HC-SR04.
- Stable low-noise tracking in the 0.2–0.8 m range, ideal for threshold-based decision logic.
- Periods where distance abruptly increases to max range, indicating the object left the field of view.

This dataset validates that the model correctly captures continuous distance readings and supports reliable triggering of LED indicators based on the 0.3 m threshold.

Conclusion:

The completed model successfully integrates distance sensing, motion detection, and logic-based LED output control into a single Simulink-generated application. The hardware mapping, wiring, and software logic follow the structured design outlined in the project documentation and step-by-step guide. The data collected confirms that the system operates dynamically and responds accurately to real-world object movements. This project demonstrates hands-on mastery of embedded sensor integration, Simulink hardware modeling, and real-time signal processing using Arduino.