EE 474 Fall 2016 Lab5 Report
Group 21: Robot Laser Tag

Introduction

In this lab, our group combined the knowledge that we obtained throughout the quarter to create a robot laser tag system where one player controls the robot with a controller while the other can attempt to attack the robot with an inferred gun.

The build consists of three parts: A controller, the robot tank and a modified light gun. Both the controller and the robot tank uses a beaglebone board to control its behavior while the light gun is just simply an analog device.

Hardware

Controller

The controller is a beaglebone board with multiple interface devices connected to it, as shown in figure 1 below. The controller is designed to be able to communicate with a device directly via Bluetooth and be programmable to fit different purposes.

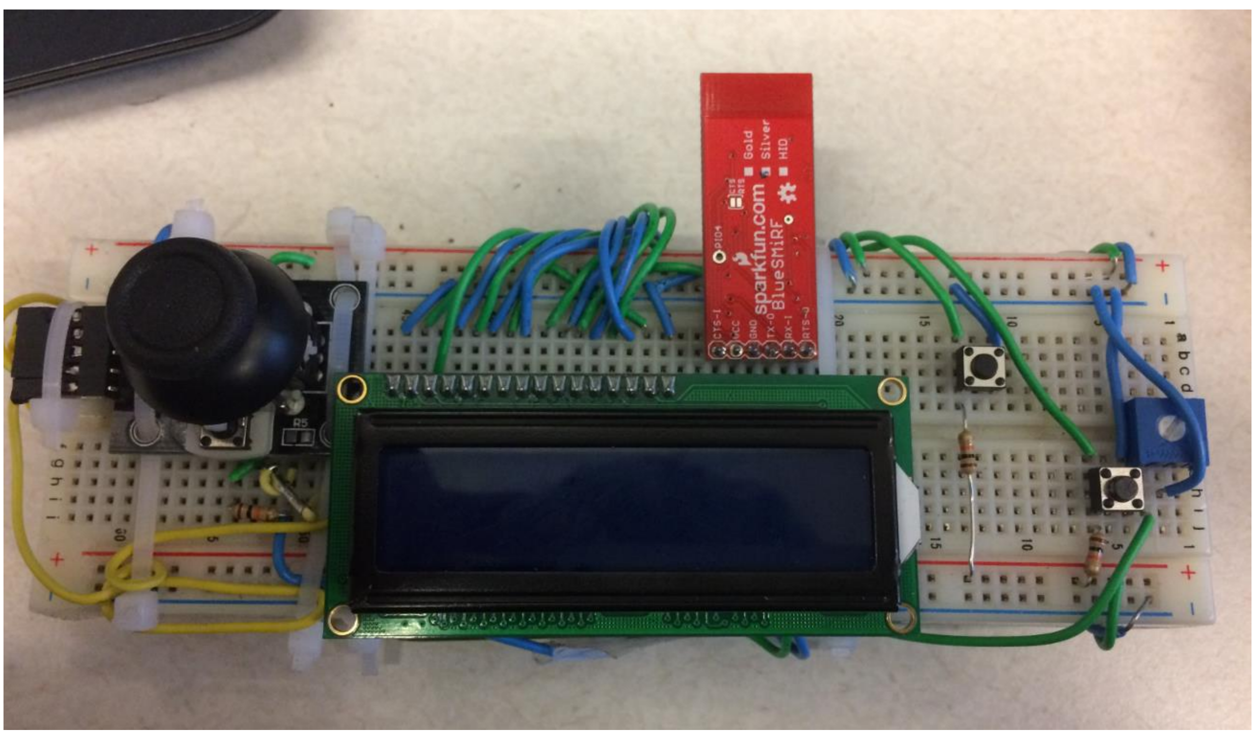

Figure 1. The controller

Input devices

The input devices are the buttons on the right and the analog joystick on the left. The joystick has two potentiometers that change their input voltage while the joystick is moved which represents the x and y coordinates of the joystick. The two coordinates are attached to two ADC pins for the beaglebone board to read. The two buttons and the push button on the joystick are wired to be active low and connected to GPIO pins that are set to input mode.

Output devices

The output devices are the LCD screen shown in the middle of the joystick in Figure 1. and a pager motor attached to the back of the breadboard. The LCD screen is connected to power and GPIO pins set to output mode as same as we did in lab 2. The pager motor is also connected to an output mode GPIO pin. When the corresponding GPIO pin is set to high, the motor spins and vibrates the controller.

Communication

Besides being able to communicate with a computer via microUSB, the controller also has a Bluetooth module that can directly connect to a device and communicate with it (in this case the robot tank). The Bluetooth module is connected to the beaglebone board via UART serial ports. To avoid possible conflicts receiving data, the Bluetooth module uses two UART serial ports for its TX and RX. One UART port receives data from the Bluetooth module while the other sends data to the module. (In this case UART1 sends data and UART4 receives.) One thing to keep in mind is that the TX pins needs to be wired to RX pins and vice versa instead of connecting TX to TX and RX to RX.

Robot tank

The Robot tank is a modified version of our tank from Lab4, as shown in Figure 2 below. In addition to the basic motor control with the h-bridge we used in Lab4, we added modified distances sensors and an LED as “hit detectors” and a Bluetooth module to communicate with other devices.

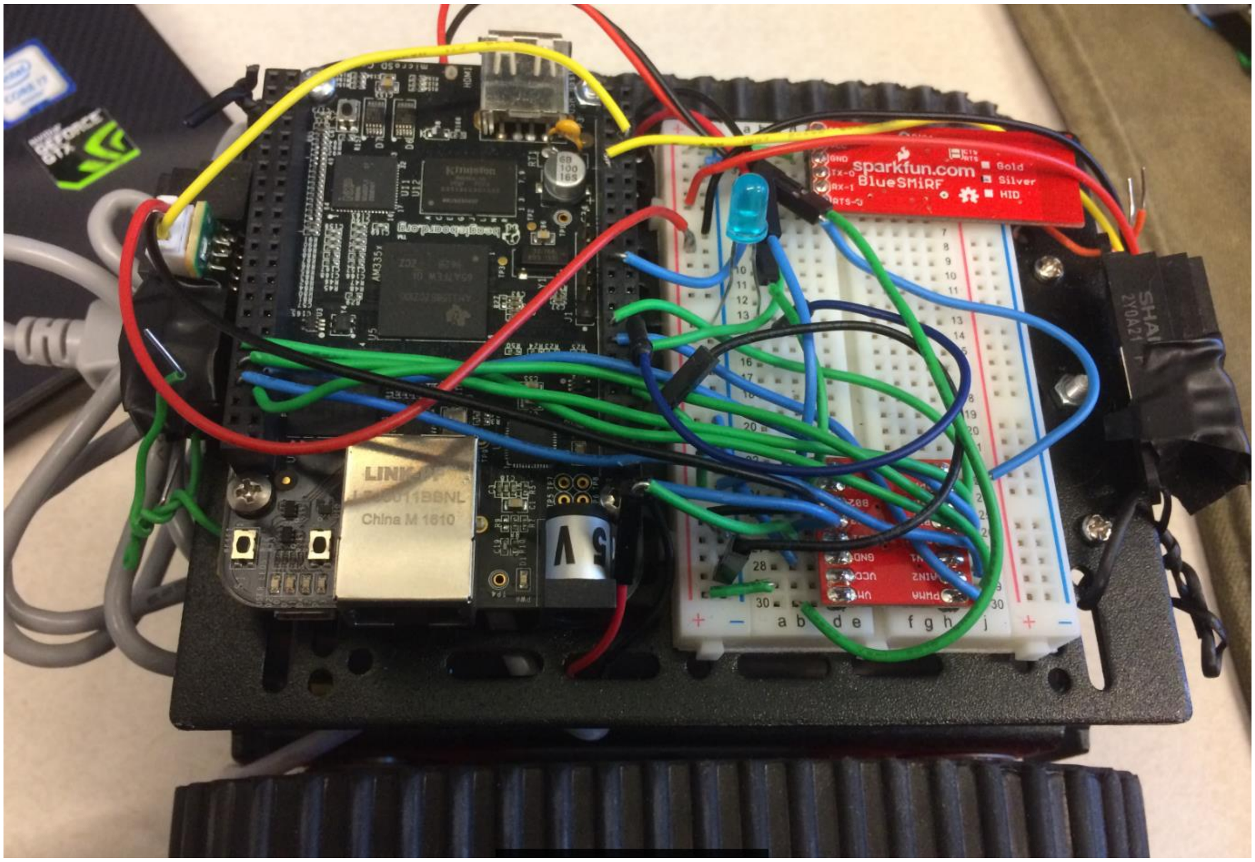

Figure 2. The robot tank.

Communication

The Bluetooth module is set up identically to the controller, where two UART serial ports are used for sending and receiving signals.

Motor Control

The motor control is set up identically to how we did in Lab4, where the beaglebone board controls an h-bridge that is hooked up to the motors and a battery pack with higher voltage. The h-bridge the adjusts the motor speed and directions depending on the input from the beaglebone board.

Hit detection

To detect whether the tank has been hit or not, two modified distance sensors from the lab kit is a attached to both the front and back of the tank. The sensors are powered up and attached to two ADC pins to read the analog values. There is also a blue LED attached to a GPIO output mode pin to light up when the tank is hit, visually indicating the hit detection. See section “Laser Tag System” below for more information of how the hit detection system works.

Laser Tag System

The Laser Tag System is one of the key creativities of this project. By utilizing the distance sensors from the lab kit and modifying an NES zapper, we created a relatively responsive laser tag system that can detect hits from the NES zapper remotely.

The Hit detectors

The distance sensors work by sending out IR(inferred) waves via an IR LED and receives the reflection from an IR sensor. The IR wave travels to an obstacle in front of the sensor and reflects to the sensor thus based on the intensity of the IR wave detected via the sensor, the distance from an object can be estimated. We blocked the IR led on the hit detectors so that it can only receive IR waves from other sources (In this case the light gun), as shown in Figure 3. below.

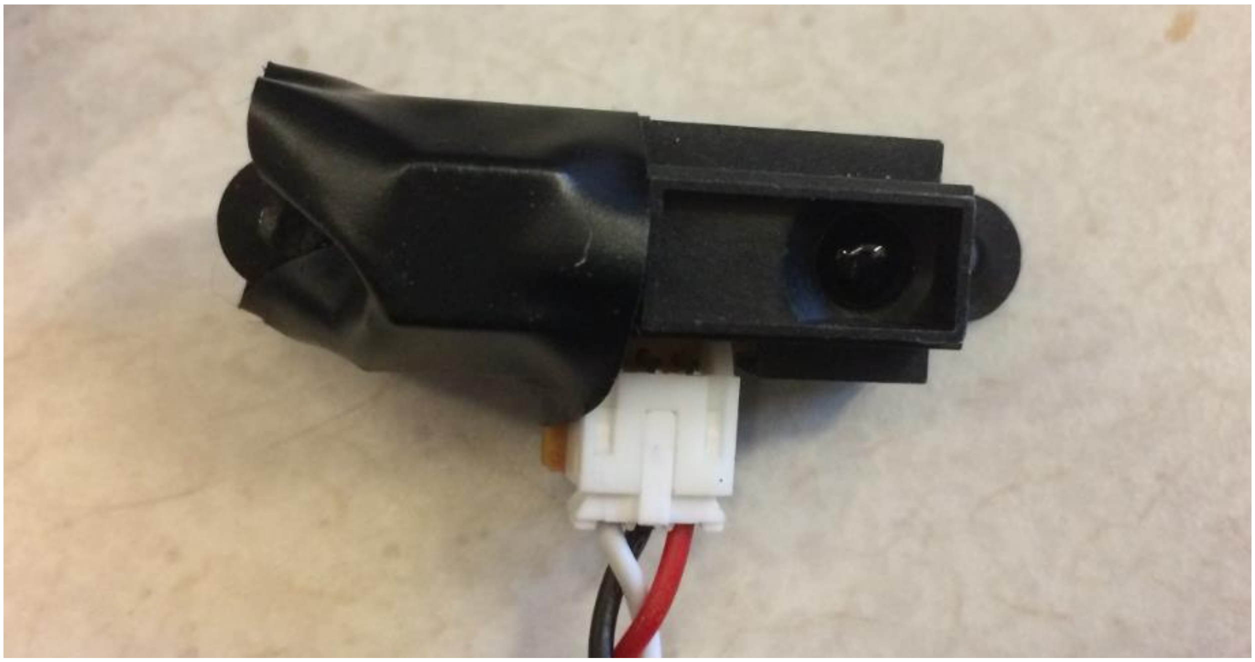

Figure 3. The modified distance sensor.

Light Gun

The light gun used to send IR signals is a simply analog device where it turns on the IR led from a distance sensor when the trigger is pulled. The gun is modified from a classic NES zapper, giving it a retro feeling, as shown in Figure 4. below.

Figure 4. the Light gun.

The light gun utilizes the optics from the original NES zapper, concentrating the IR waves sent from the distance sensor so that the output waves are mostly parallel, making it possible to detect the signals sent from the gun from a remote distance, as shown in Figure 5. below.

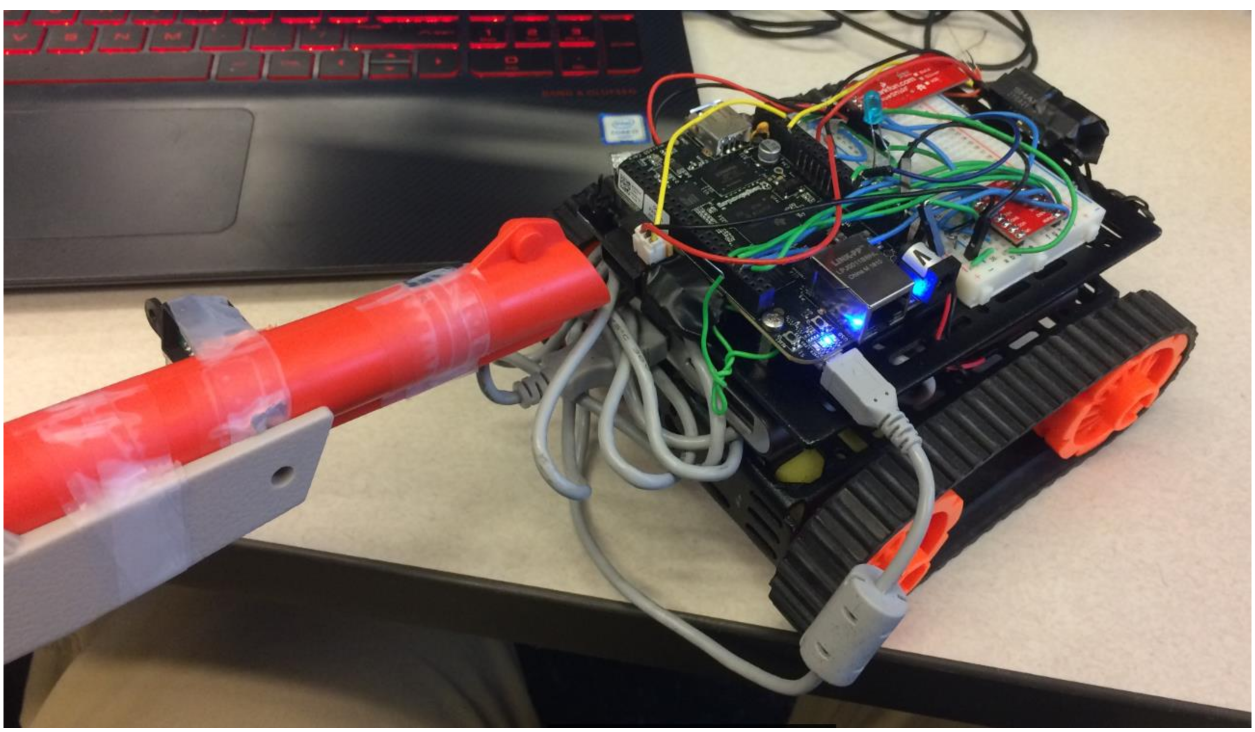

Figure 5. “Shooting” the distance sensors with the light gun.

Software

Overview

The overview of the architecture of the software setup is shown in Figure 6. below.

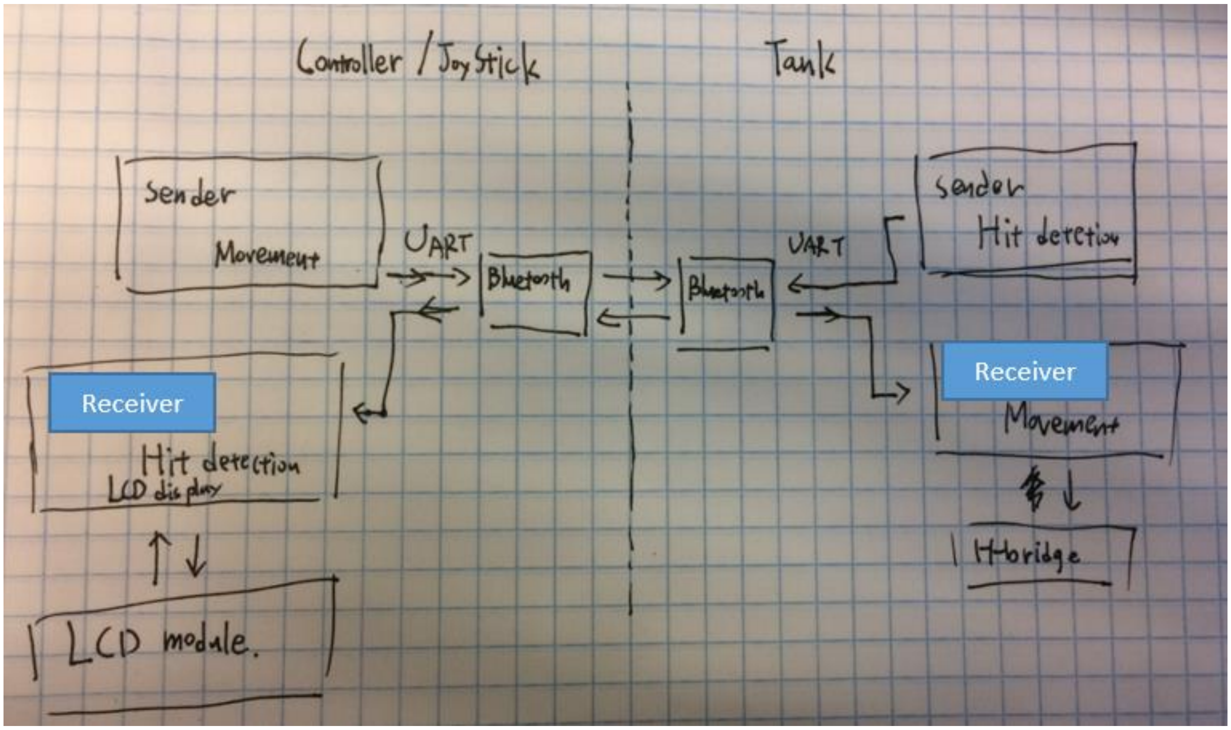

Figure6. Flow chart of software.

The both the controller and the robot tank has two programs running –the receiver and the sender. they communicate with each other via the Bluetooth modules. The GPIO, ADC and UART pins are all initialized and set up properly.

Controller

For the controller, the sender reads the joystick values and sends the movement command to the tank, and the receiver receives a “hit” signal whenever the tank is hit and deducts hit points and then alters the LCD display and turns on the vibration. The game logic is written in the receiver that keeps track of the game status and current hit points. The buttons on the right side of the controller do not have any function, but are programmed in so that it is possible to implement features with them in the future.

Tank

For the Tank, the sender sends a hit signal when the distance sensors detect a hit and lights up an LED attached to a GPIO pin to visually indicate it. The receiver receives movement commands from the controller/joystick sender and sends the corresponding signal to the h-bridge which drives the motors.

Bluetooth communication

The Bluetooth modules are pre-set to be automatically paired together when turned on and act like hard-wired TX and RX serial ports, thus when one sends data, the other immediately receives the data.

The Bluetooth modules communicate with the beaglebone board via UART ports. To minimize interference, we used two UART ports for sending and receiving data.

Conclusion

The robot laser tag system we built in this lab proven to function properly, after solving multiple challenging problems ranging from setting up direct communication between the Bluetooth modules to designing the laser tag system. The result is a playable robot laser tag game with responsive controls. We successfully created this system with minimum extra peripheral devices in addition to the lab kit. In the future, it is possible to reprogram the controller to other devices and possible set up a server that has multiple tanks and controllers to create a fun an interactive multi-player robot battle game.