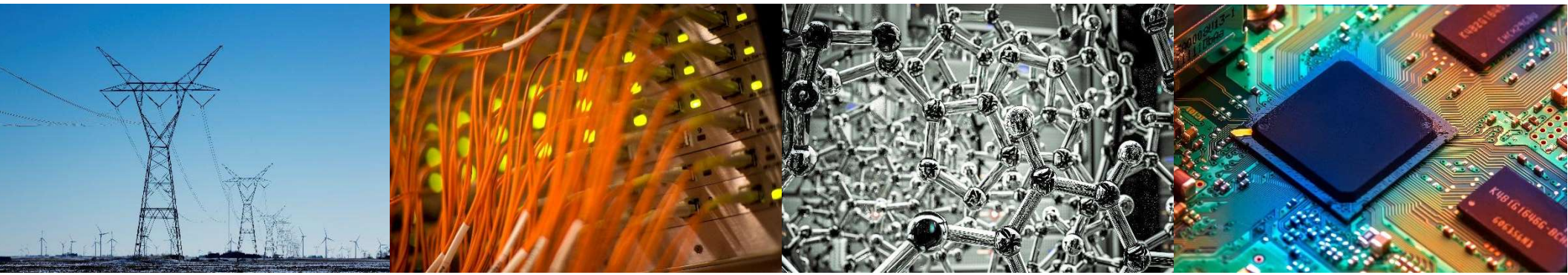
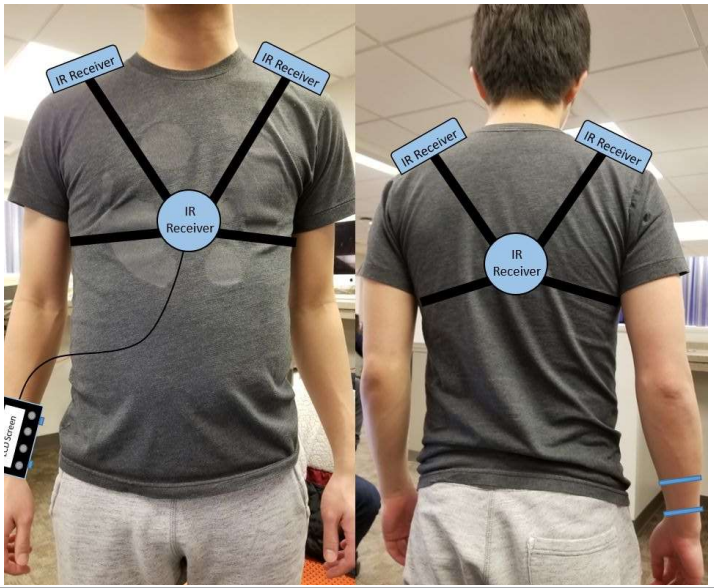
Team 8: Laser Tag Glove

Alex Korfel, Carlos Lara, Kengyan Lim



Project Introduction

- Each player gets a glove with a unique code and a vest that decodes the other players' pulses

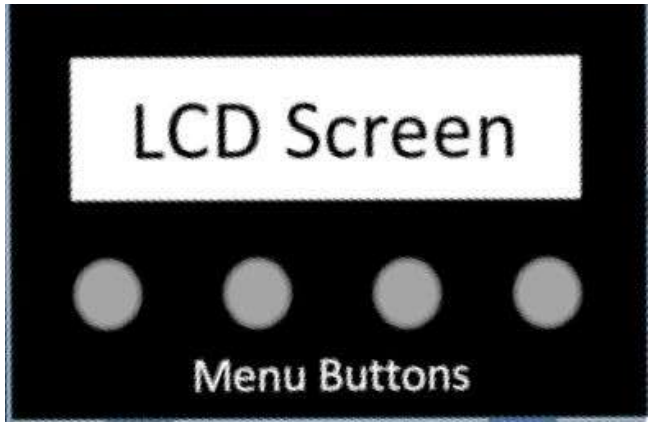


Project Introduction

- Wrist gauntlet displays the game information and allows for joining the game

Project Introduction

- Central hub offers a selection of gamemodes, syncs all players, and initiates the game

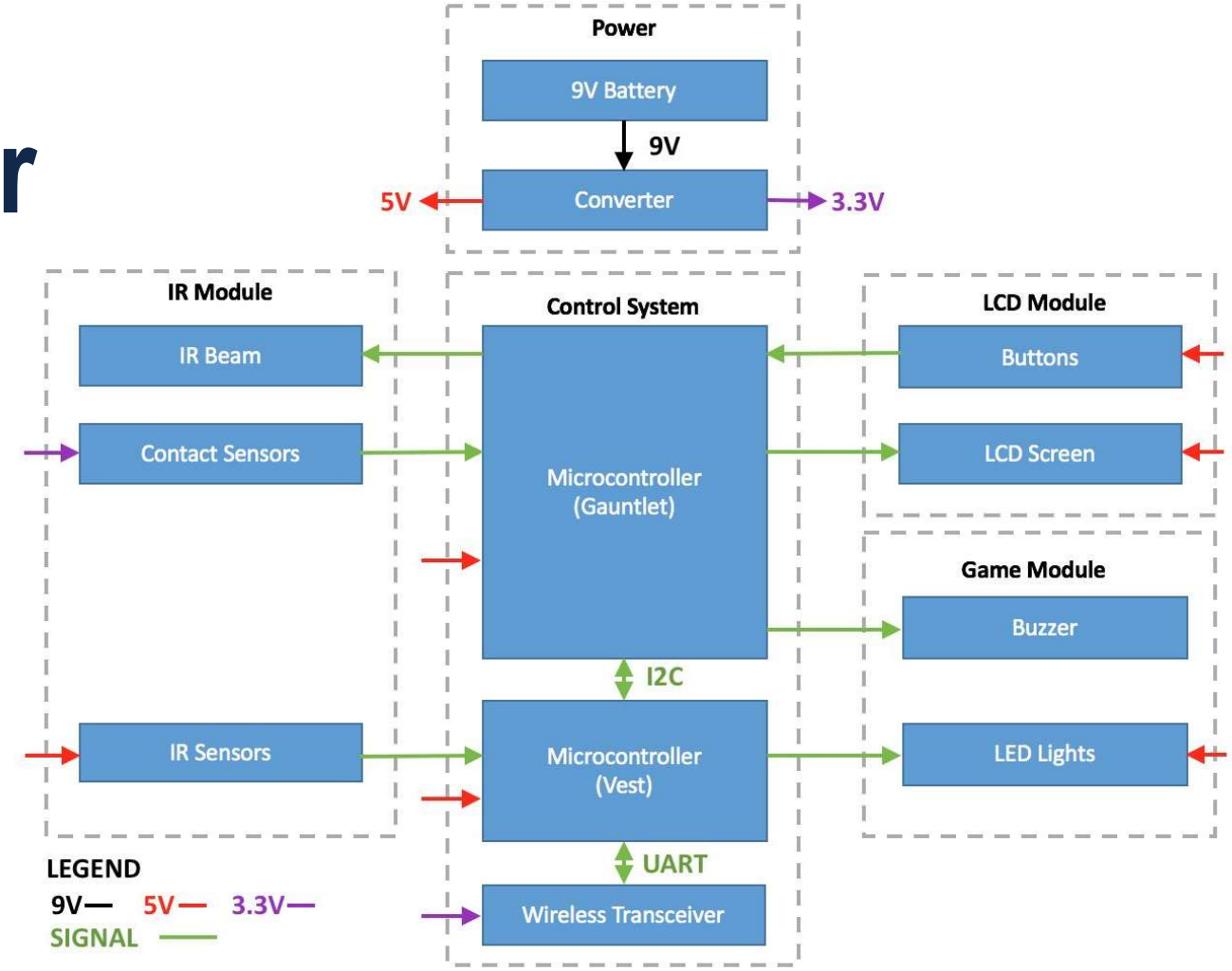


Objective

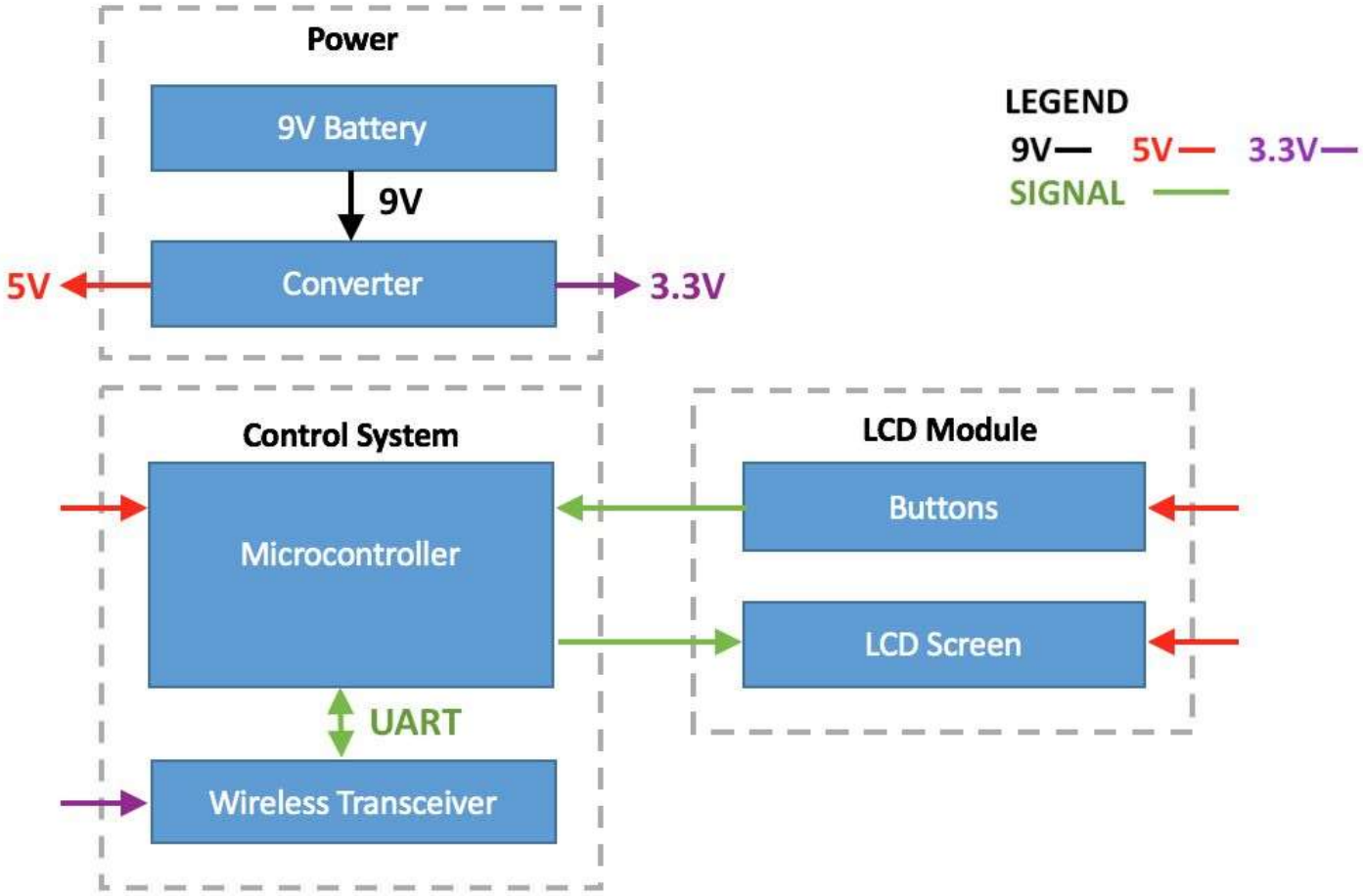
- Laser tag is most often played at facilities containing the proper equipment
- Our goal was to create a portable game of laser tag that is quick and easy to join
- Enhance the experience by implementing a “finger gun” action

Block Diagrams

Player


Power
9V Battery
9V
5V
Converter
3.3V
IR Module
IR Beam
Contact Sensors
IR Sensors
Control System
Microcontroller
(Gauntlet)
I2C
Microcontroller
(Vest)
UART
Wireless Transceiver
LCD Module
Buttons
LCD Screen
Game Module
Buzzer
LED Lights
LEGEND
9V
5V
3.3V
SIGNAL

Hub


Power
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9V
5V
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SIGNAL
Control System
Microcontroller
UART
Wireless Transceiver
LCD Module
Buttons
LCD Screen

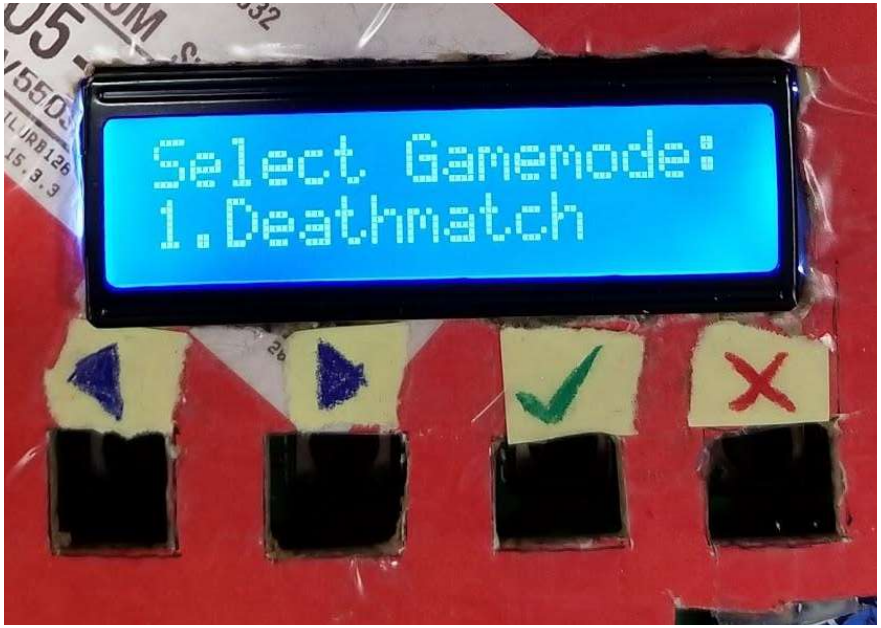
Central Hub

Design – End Product

Central Hub - Gamemodes

- Deathmatch
  - Aim for highest score within a set time limit
  - Time limit is adjustable
  - Hub sends time remaining to players and reports final scores
- Last Man Standing
  - Aim to be the last one alive
  - Starting Number of Lives is adjustable
  - Hub keeps track of dead players

Central Hub - Gamemodes



Central Hub - Flowchart

Choose Gamemode and set parameters

Confirm to start game

Wait for players to be ready

Start Game

Central Hub - Successes/Failures

- Able to set gamemodes and start/stop the game
- Players are synced with common time in Deathmatch
- Kept track of final scores (DM), dead players(LMS)

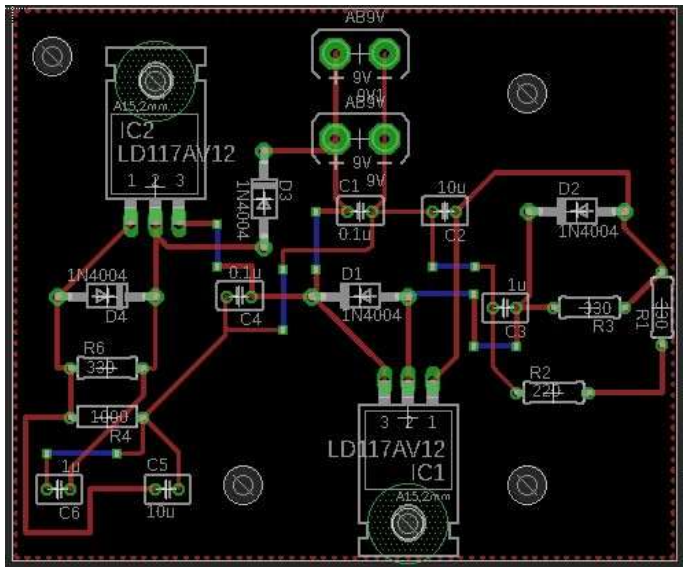
Power

Power Module - Power

- 9V Alkaline Battery powers glove and vest
- Connected through wires bundled with heat shrink
- Energizer Battery with 400mAh capacity
  - 162.3 mA current for one glove/vest pair
  - 2.46 Hour Battery Life

Power Module - Voltage Regulators

- Electrical Components Require 3.3V and 5V
- Successfully Output Voltage within ±5% requirements
  - 5.16V
  - 3.36V



Power Module - Successes/Failures

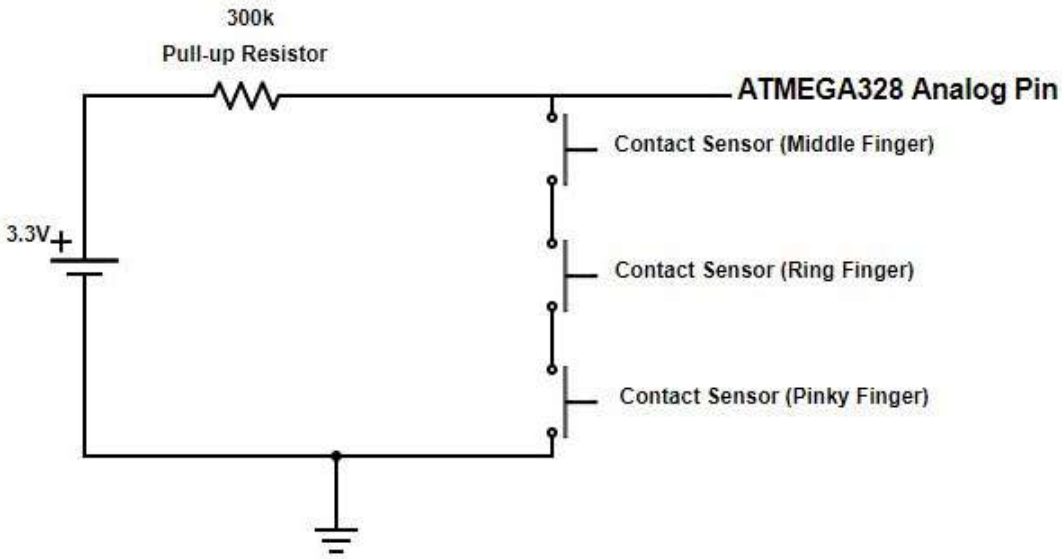
- At first used SOT-23 Package Converters
  - Soldering was challenging
  - Inconsistent Output Voltage Results
- Switched to TO-220
  - Larger and easier to work with
  - Complied with voltage requirements

Glove

Glove - End Product

Glove - Contact Sensor Circuit

- 300kΩ pull-up resistor
  - Stays within microcontroller's 9mA pin rating
- Fingers act as switches
- Microcontroller receives logical low all switches close



Glove - Successes/Failures

- Proper finger placement fired Red Laser
- Conductive fabric allowed current to run through conductive thread
- Poor Sewing Skills
  - Conductive thread frays and shorts circuit
  - Conductive fabric patches loosen through use
  - PCB integration with thread

Laser Module/IR Emitter

IR Module - Red Laser Module

- Class 2 Laser
  - Less than 1mW Optical Power
- Used as sight for IR emitter
  - On when three fingers make contact

Parameter	Min	Typ	Max	Unit
Optical Power	0.6	0.8	0.9	mW
Operating Voltage	2.7	3.0	3.5	V
Operating Current	-	12	35	mA
Wave Length at Peak Emission	640	650	660	nM
Operating Temp Range	-10	25	50	°C
Storage Temp Range	-40	-	80	°C
Beam Size at 10m	-	7X12	8x14	mm

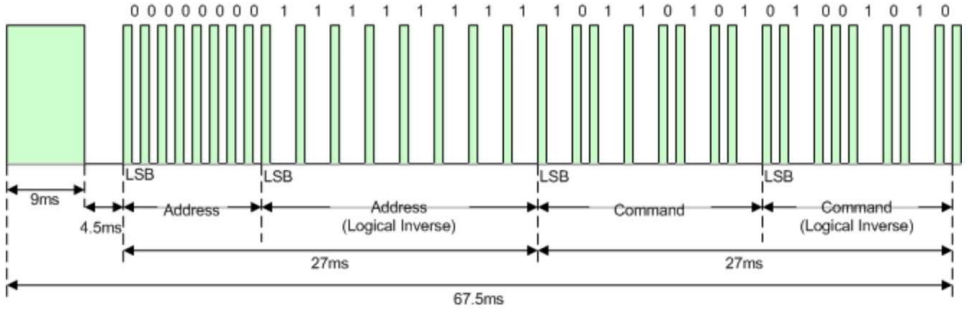
IR Module - IR LED

- Emits at 950nm
  - Peak sensitivity with IR Receivers
- Wide Beam Length
  - Spot size of 16cm at 10m
  - Beam focused with plano-convex lens tube

IR Module - Success/Failures

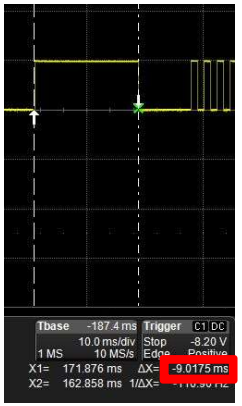
- Achieved desired range of 20ft
  - Maximum reliable distance of 32ft
- Red Laser works with proper hand placement
- Did not implement IR Laser Module
  - Beam size was too precise
  - Little reliability past 10ft
  - Class 3R Laser

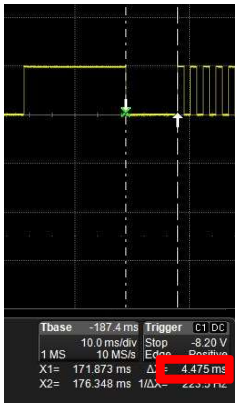
IR Module - NEC Protocol

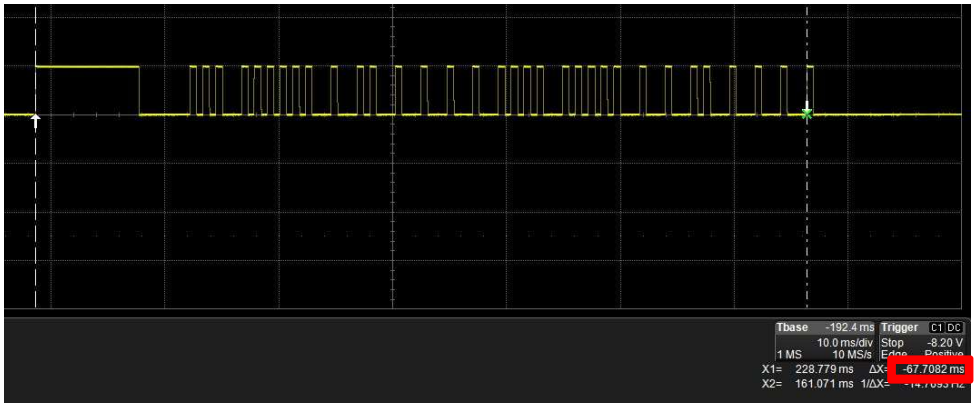


Max Transmission Distance: 55ft

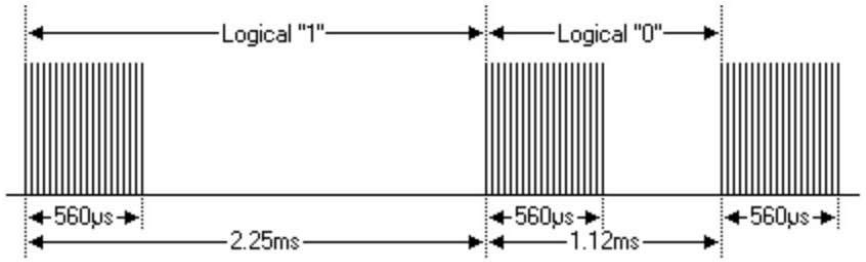
Max Reliable Transmission Distance: 32ft





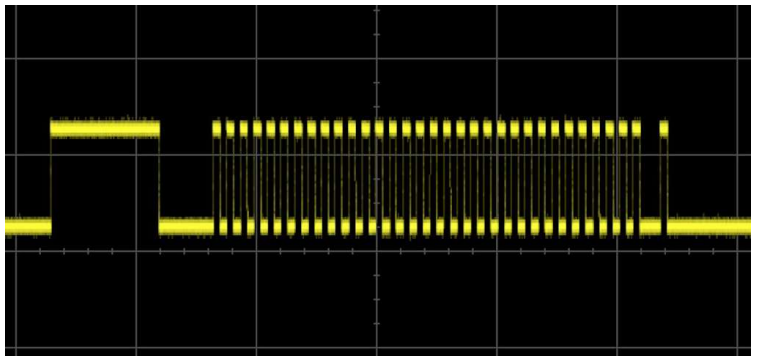


IR Module - NEC Protocol

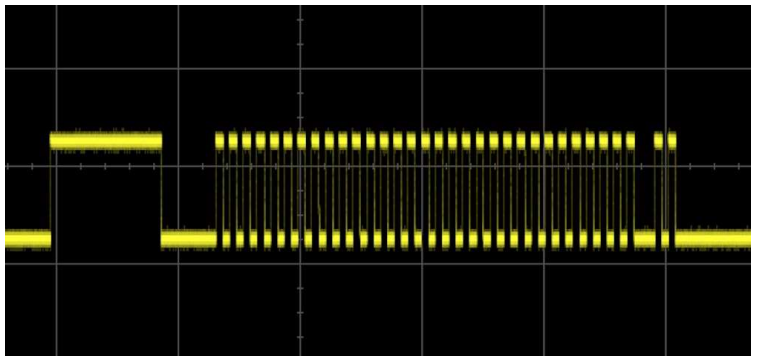


Bit count transmission: 32bits

Total possible players: 2^{32}



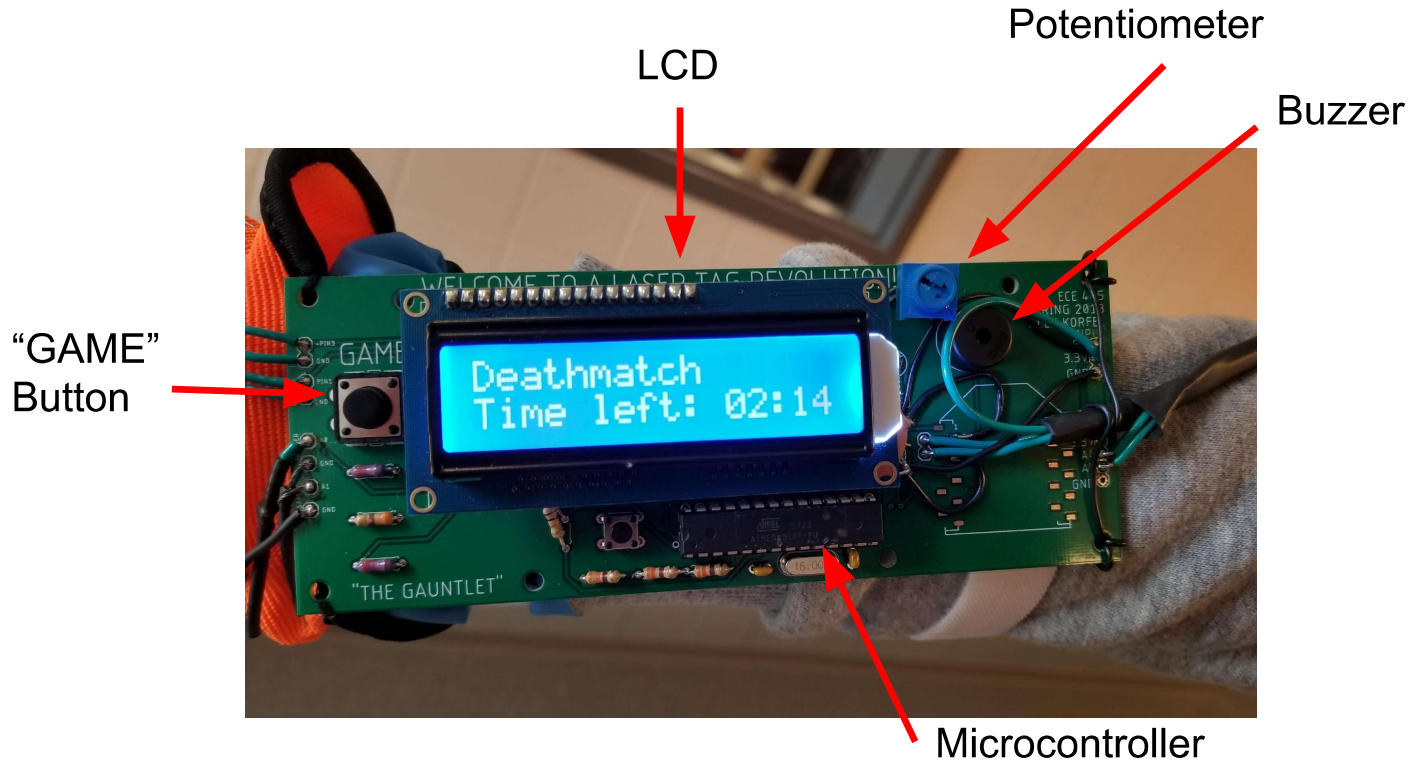
NEC Pulse – Player 1



NEC Pulse – Player 2

Gauntlet

Gauntlet - End Product



Gauntlet - States

- Player presses “GAME” button to sync once a prompt from the central hub is sent
- Screen displays:
  - “Press Button to Start”
  - Time left in “Deathmatch”
  - Lives remaining in “Last Man Standing”
  - “GAME OVER” at game termination

Gauntlet - LCD Response Time

- Filmed in 240fps
- Played back at 30fps or ⅛ speed
- Took 1.8s for playback

$$1.8\ seconds * \frac{30fps}{240fps} = 225ms$$

Gauntlet - Buzzer

- Piezo-buzzer
- Changed the duration of the 500Hz chirp to create blaster noise

```
for(int i=0;i<350;i++){
  tone(buzzerpin,500);
  delayMicroseconds(i);
  noTone(buzzerpin);
  delayMicroseconds(i);
}
```

Gauntlet - Successes/Failures

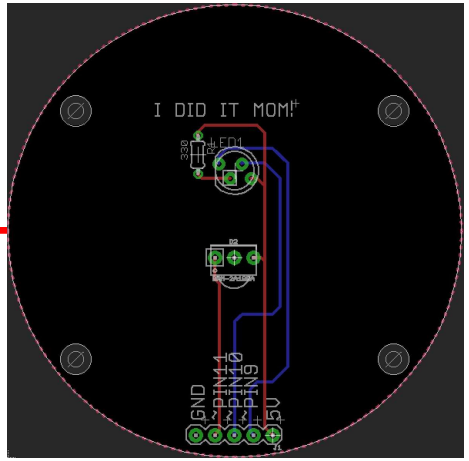
- Gauntlet functions as designed
- Re-wire traces due to shared timer in Arduino library
- Long wires from converter to gauntlet introduced an inductance and floating ground
  - Added 0.1μF capacitor to smooth out ripple

Vest

Vest - End Product

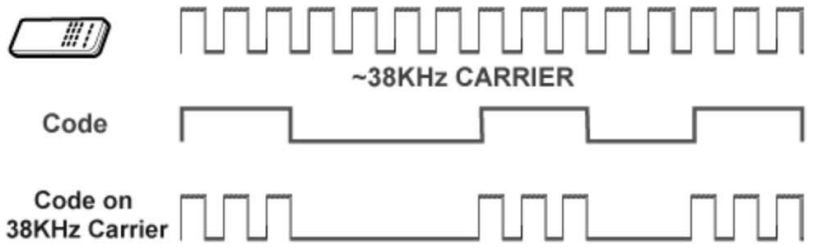
Receiver Units

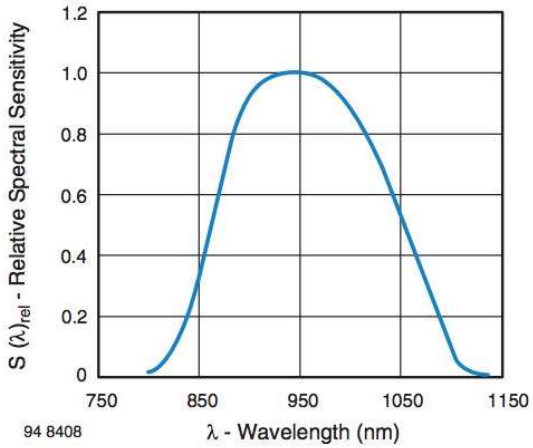
Power Unit



Vest - IR Receivers

- 38kHz carrier frequency
- Demodulated output for direct connection to microcontroller
- IR receivers peak at the IR emission wavelength of 950nm
- 1’ radial field of view from 4’ away, 6” radial field of view from 25’





Vest - LEDs

- RGB LED indicates location of player and individual IR receiver as well as player state
- Four states
  - All off: vest off/player not in game
  - Solid green: player is in game, active
  - Flashing yellow: player shot, 15s cool-down
  - Solid red: player out of game, dead

Vest - XBEE

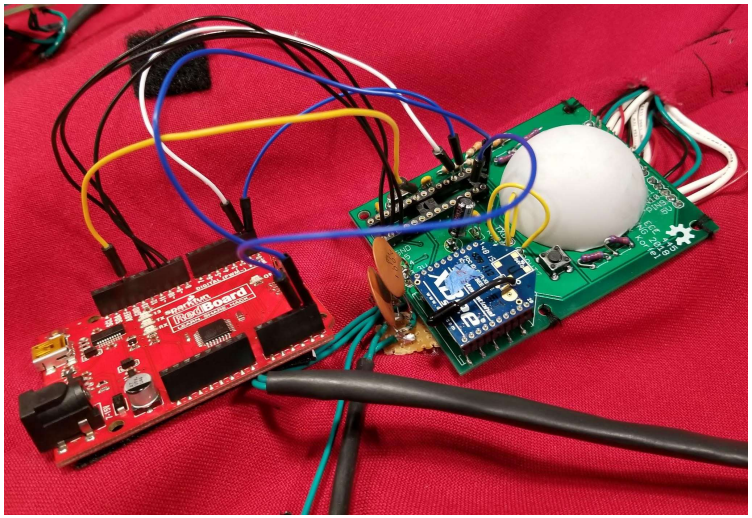
- Located on chest piece
- Microcontroller communicates with hub through RF
  - Receives
    - Gamemode
    - Game start/stop
    - Time remaining (deathmatch)
  - Sends
    - Ready signal
    - Death notice (last man standing)
    - Death count (deathmatch)

Vest - Successes/Failures

- IR sensors received pulses and LEDs transitioned through states properly
- Long wires from converter to gauntlet introduced an inductance and floating ground
  - Added 0.1μF capacitor to smooth out ripple

Vest - Successes/Failures

- Arduino was used for XBEE communication
  - Found 4.98V output from Arduino, 5.17V from converter to microcontroller
  - Adjusted converter output = correct transmission
  - Further tests = failed transmission
  - Due to TX/RX output
- Player 1 vest LEDs were dim
  - Larger measured resistance



Ethical Considerations

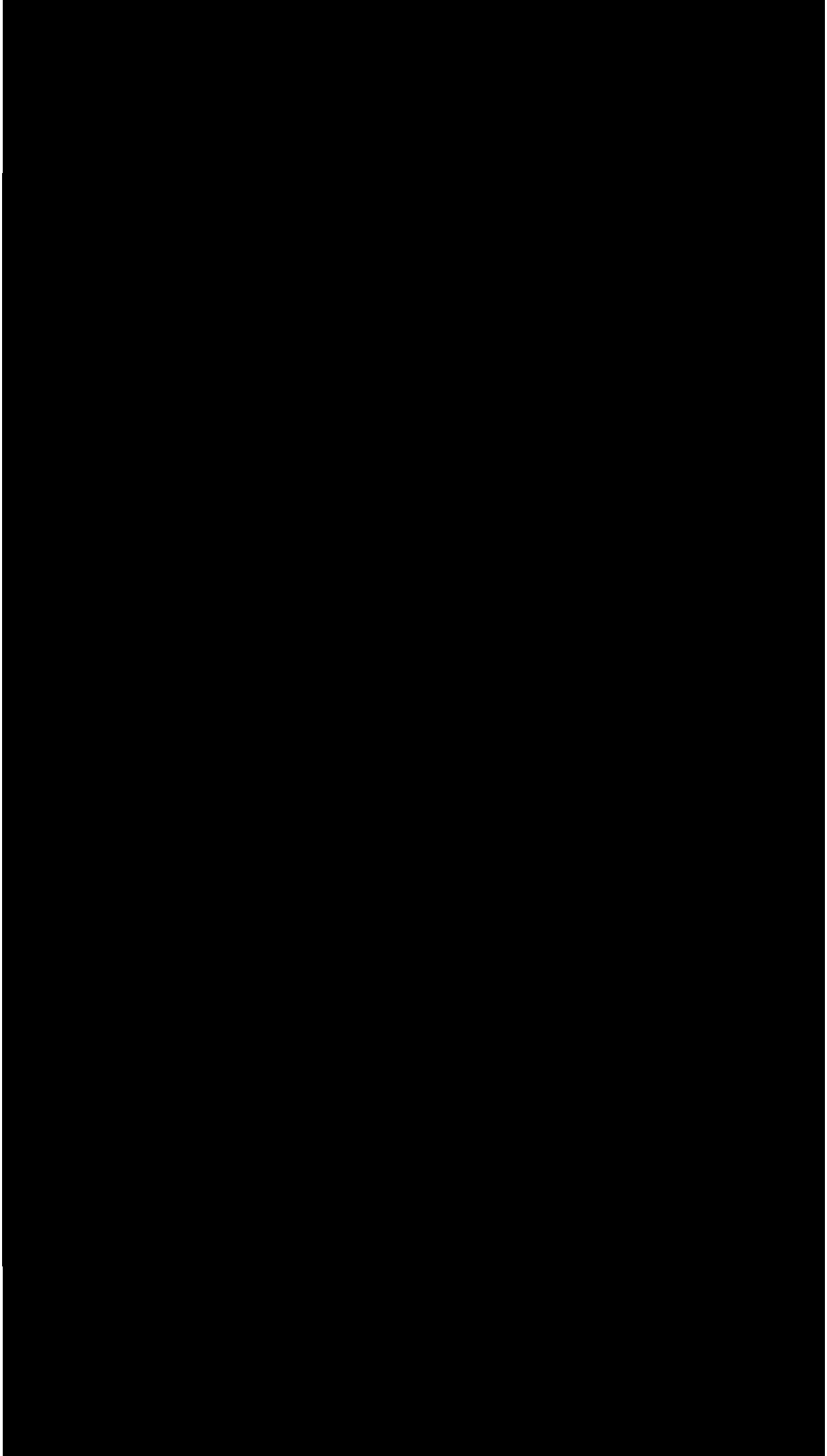
- Use of laser modules
  - Class 2 Visible Light Laser
  - 0.8-0.9 mW optical power
- Wearing electrical components
  - Want to avoid direct contact with skin
  - Second layer for insulation

Conclusion

- Our project worked successfully at the Final Demonstration
- We had to resort to using Arduinos for our XBEE Communication due to circuit stability connecting the microcontroller to the XBEE
- Future work includes
  - Fix the microcontroller-XBEE integration issue
  - Make player syncing smoother when starting a new game

Future Work

- Fix the microcontroller-XBEE integration issue
- Make player syncing smoother when starting a new game
- Improve portability by decreasing vest size
- Increase glove reliability by improving sewing or utilizing conductive paint
- More complex sounds



Thank You