EEL 4924 Electrical Engineering Design
(Senior Design)

Preliminary Design Report

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Project Name: Laser Tag Gaming System

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Project Abstract:

Our project consists of building a laser tag game that will keep track of scores in real-time. The system will consist of individual hand-held devices and a central console functioning as a scoreboard. Each hand-held device will be able to emit a unique modulated laser beam containing player identification, decode other player's data beams, and send data wirelessly to the scoreboard. Each player's device will use a laser emitter diode to send the beam and a set of photoresistors to receive them. The data will be sent to an onboard PIC microcontroller which will then determine if the player was hit by an opposing player or from stray interference. The PIC will then send the information to the central console through an XBee, which will then update the scoreboard accordingly. In addition to these core functions, each hand-held device will keep track of the player's health and display it on an LCD screen and will also alert the player that they have been hit through LEDs and audio speakers.

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Project Features:

The main objective of our project is to design a standalone laser tag gaming system that people can play anywhere. The hand-held devices will transmit and receive data using laser beam modulation and communicate with the scoreboard through radio signals. Our design will allow you to play anywhere, inside or outside, have real time scoring,

- When the hand-held laser device is activated it will emit a unique string of data from the laser diode through a modulated carrier wave. The data will be unique to each device and will contain information to identify from where the beam originated.
- Each player will be fitted with multiple photo-resistive decoder circuits that will recognize the received signal. The data will be sent to the on board microprocessor which will determine if the signal came from one of our laser tag devices and not from an outside source.
- Once the microprocessor has determined that the player was hit, the on board LCD will update to show the current health of the player and alert the player by flashing LEDs and playing audio.
- The XBees will be used to communicate game data between the user and the base station. When a player is hit, the hand-held device's XBee will transmit the player's remaining health and the ID of the attacking player.
- The scoreboard will consist of several large 7-segment LEDs that will be easily visible to both the players and spectators. When it receives communications using the XBee mentioned above it will update the display consisting of possible the players scores and health in real-time.

Figure 1: Commercial laser tag product utilizing IR which includes laser gun and vest

Concept/Technology Selection:

Laser Based Data Communication:

- We chose to implement the emitter of our handheld device using a laser diode. We will be able to modulate the laser beam to create unique signals for each device. Using a laser diode will allow for much easier testing and debugging during our design process since we will be able to actually see the beam. Due to safety concerns with eye injuries, the laser output power will be kept to a maximum 5mW.
- The use of a laser beam will also allow for a much simpler receiver design. We will be able to photoresistors to determine if a hit has occurred.
- We chose to use a laser diode in place of an infrared LED. One of the problems with the IR LED implementation is that we would not be able to see the emitted data signals. This would make debugging and testing our circuitry and code much harder. The IR implementation would also have to be designed to reduce the dispersion of the IR signal. We would have needed to find a way to focus the beam so that the player would not be able to hit the receiver without being accurate.

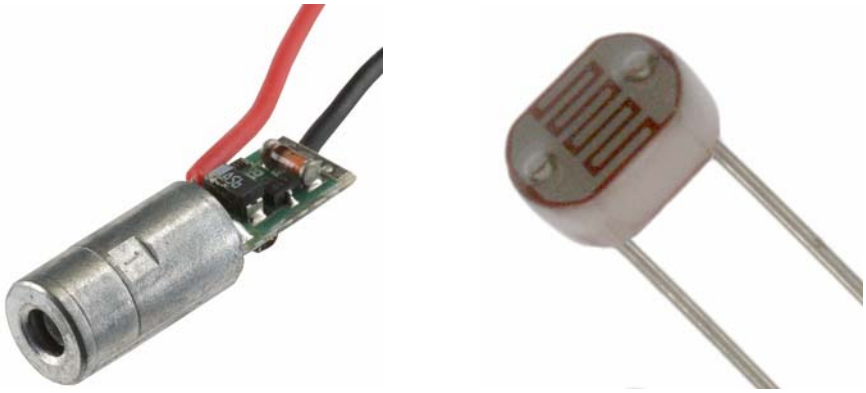

Figure 2: 5mW laser emitting diode on the left, photoresistor on the right

Radio Frequency Data Communication:

- We chose to use XBee for our wireless data transmission from the player to the base station. We will be able to purchase individual Xee modules to put in to place on the handhelds and the base station. We will configure the XBees so that one module acts as a central coordinator and the other modules would act as end devices.

Figure 3: XBee RF module for hand-held devices and scoreboard

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Player Feedback System:

- We plan on using LCD displays on each handheld to display player stats. We want to choose an LCD display that is visible in all different lighting conditions. We may look for a display with back lighting for low light situations.
- Each handheld will also be equipped with a variety of LEDs and audio circuitry. We chose to add these peripherals to create a more immersing gaming experience for the player.
- For the scoreboard display we will be using large 7-segment LEDs. We decided that the LEDs would be the best implementation for visibility. We have researched LEDs that are 4''. These will be easily viewable by spectators and players. We considered displaying the score on an LCD, but the cost of a display that would be viewable from a large distance would be out of our budget.

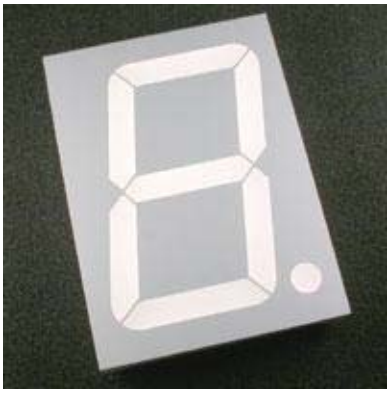

Figure 4: 4'' 7-Segment LED display for the scoreboard

Microprocessor:

- Each hand-held device will utilize a PIC microcontroller for data processing and peripheral controls. We chose the PIC over other processors due to our previous experience with them and their low cost and availability. PIC processors also have the advantage of being available in a wide range of sizes since we will need to conserve as much space as possible when fitting the circuit board.

Figure 5: PIC18F microcontroller

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Gun/Housing Materials:

- Each handheld device will need a housing that will hold and protect the circuitry that will be necessary for game operation. The housing will also need to have a trigger device integrated into the housing to operate as an input to the circuitry. We are thinking about using a Nerf gun as the foundation for our housing. We plan to remove the inner workings of the Nerf gun and replacing them with out circuitry and peripheral devices. We could also add some form of protective materials inside to help prevent damage during game play.

Figure 6: Nerf Dart Gun, perfect for housing circuitry due to relative open space and form

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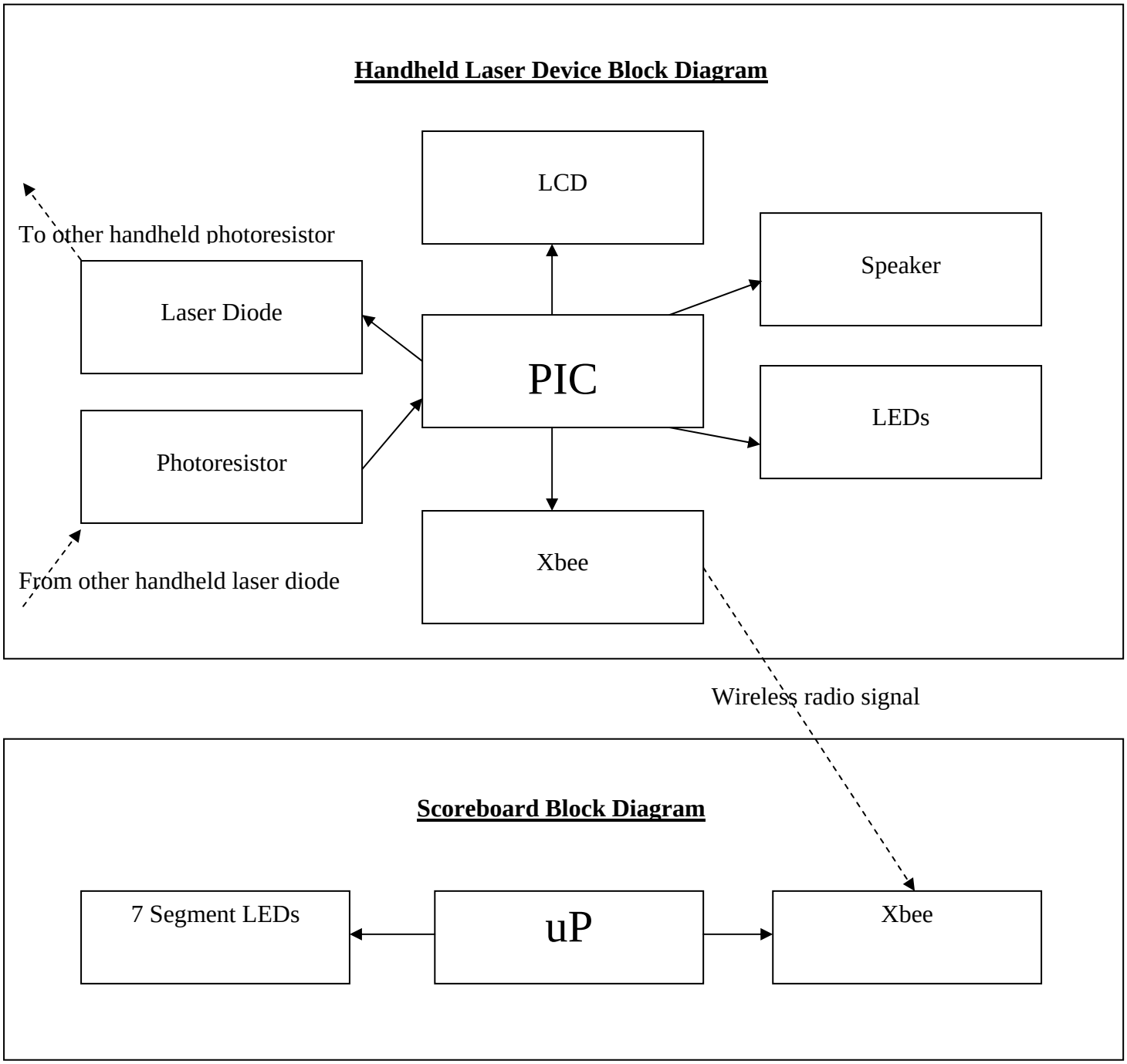

Figure 7: Hardware Block Diagram

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Distribution of Labor:

The following is a percentage breakdown of each team member's projected labor.

	Noah Stahl	Michael Schoen
Preliminary Research	50	50
Design Phase	50	50
Board Construction	50	50
Test & Debug	50	50
Physical Assembly	50	50

Table 1: Projected distribution of labor

Projected Timeline:

The following is a Gantt chart of the projected timeline for the project.

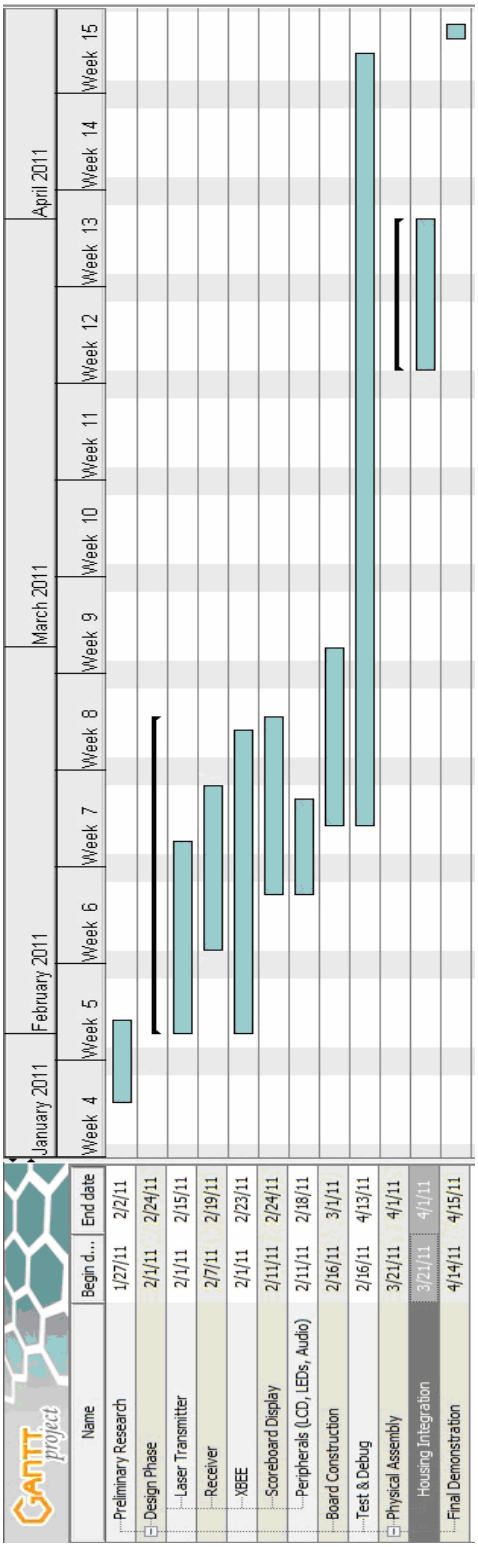

Table 2: Projected labor timeline displayed on Gantt Chart