Princess Sumaya University for Technology

Computer Engineering Department

Embedded Systems & Microprocessors

"Laser Gun Game"

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Abstract

This project aims to design a laser gun shooting game using one PIC16F877A microcontroller. The game has a laser emitting gun that aims at two moving targets controlled by servo motors. The main sensors and components used were two light dependent resistors and an ultrasonic sensor in addition to an LCD screen as well. The score is calculated by measuring the distance between the shooter and the target and is displayed by the LCD screen.

Table of Contents

I. Introduction

Many wonder what some of the 21st century industries that are having great economical impact in the world today. There are many major sectors that influence the market and investments of revolutionized economies. Whether it is depressing or unhealthy , the gaming industry might be the most lucrative of all. Gaming isn't mostly found in high school students or teenagers anymore, it is a growing phenomenon that is attracting all people from different backgrounds and different age gaps.

One way to look at innovation is as the accumulation of hundreds of small advancements and a few breakthrough leaps. With the emergence of 5G, IoT and many more cutting-edge technologies, the prospect of having an intelligent, efficient and interesting gaming experience has become an engrossing one. Now, the number of gamers is more than ever before. One underestimated part of the industry is the physical shooting games. In our case, the laser gun game.

Laser tag is a popular game that combines technology and entertainment. It involves players wearing special vests or targets that are equipped with infrared sensors, and using handheld devices that emit infrared beams. The objective of the game is to tag opponents with the infrared beam and accumulate points. Laser tag can be played indoors or outdoors and can be enjoyed by people of all ages. It offers a fun and exciting way to engage in physical activity, while also stimulating strategic thinking and team-building skills. In this modern era of technology, laser tag is a perfect example of how innovative technologies can create new and engaging experiences for people.

The main idea of the project is discussed in section I, a brief overview of the used components can be found in section II. Section III shows the electrical and circuit connections. Section IV discusses the software and code, and finally, section V draws conclusions and all challenges faced during the design of the project.

The Main Idea of the Designed Project

The designed project is a miniature-sized laser shooting game. It will contain two main components:

- A laser shooting gun that represents the player
- A target that is being aimed at for achieving points

The following are the main functionalities and sensors used in the project:

1. Two Light dependent (LDR) sensor modules which are placed on the target ducks and pointing downwards. Those sensors will ensure that the main player hits the target accurately.
2. An ultrasonic which is used to detect the distance between the shooter and the targets, and thus counting the score.
3. Two targets that are powered by two servo motors. Full-speed, Half-speed, or No- speed) depending on the difficulty of the game.

4. The LCD screen that lights and displays the score of the player.

When the target is hit, the receiver sends a signal to the servo motor to slow down and reset their movement. On the other hand, when the target is not hit, a signal is sent to keep moving the targets at full speed without stopping or lagging.

Figure 1 depicts the block diagram of the designed game.

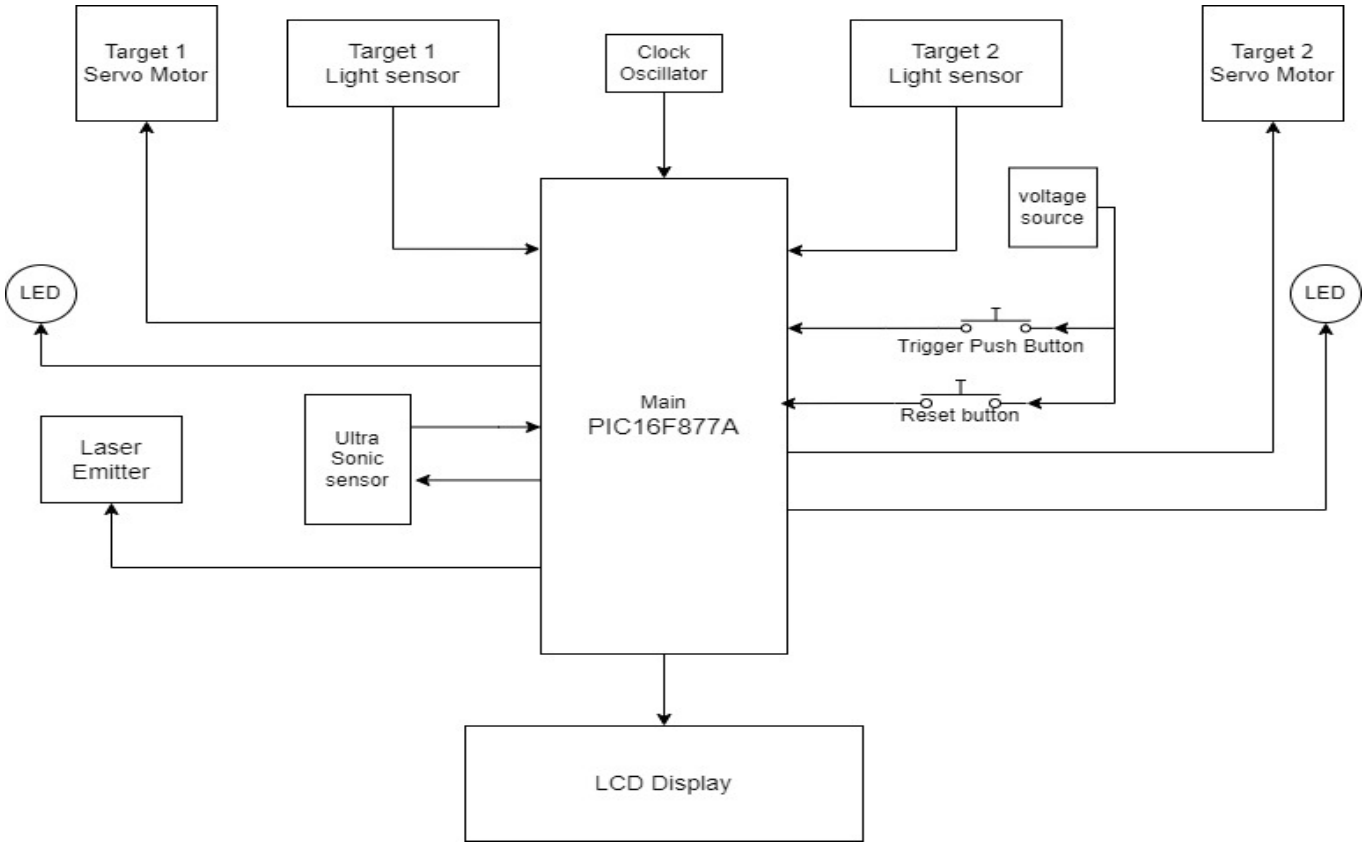

Figure 1

II. An Overview of the Used Components

This section will briefly discuss the components we used in our project and how we were able to implement them..

A. The Microcontroller PIC16F877A[1]

The PIC16F877A is a microcontroller that has 40 pins. It is widely used across many fields such as electronic applications, industrial control, and in the automotive industry. It consists of 35 I/O pins and has many built-in functions such as Timers, ADC, PWM. It also has 8K of program memory and 368 bytes of RAM. It is extremely easy to use hence the reason its a popular choice

Figure 2 depicts the PIC16F877A and its output pins.

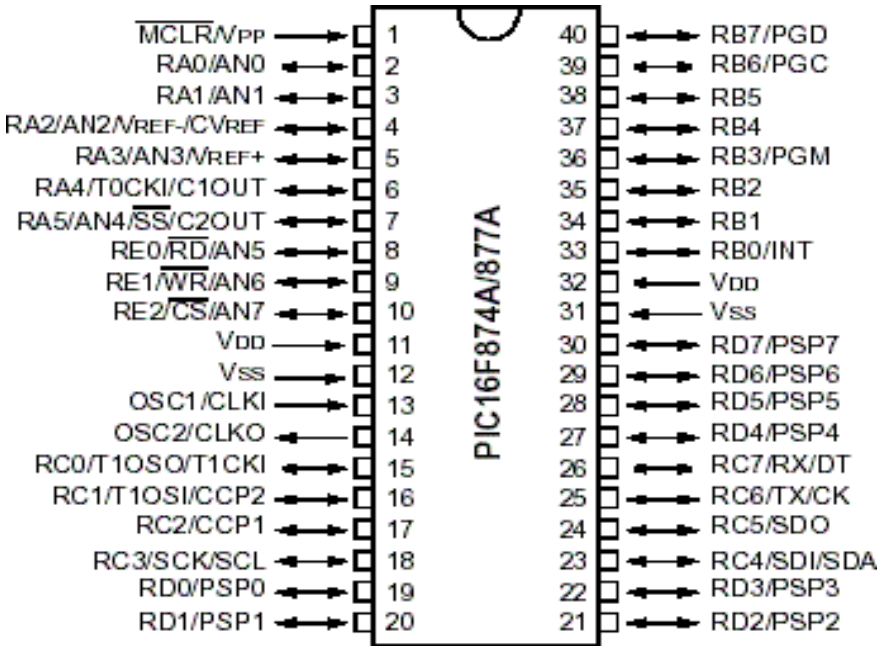

Figure 2: PIC16F877A Pins

The following table shows the pins used in each microcontroller.

Table 1

Pin Number	Port Name	Use	Connected to
1	$\bar{M}\bar{C}\bar{L}\bar{R}$	Master Clear	+5 V
3	RA1	Red LED	330 Ohm & LED
9	RE1	Ultrasonic Sensor	Echo pin
10	RE2	Ultrasonic Sensor	Trigger pin
11	V_{DD}	High Voltage Source	+5 V
12	V_{CC}	Low Voltage Source	Ground, 0 V
13, 14	OSC1, OSC2	Oscillator	8 MHz Oscillator
17	RC2	Red LED	330 Ohm & LED
19	RD0	LCD	D4 on LCD
20	RD1	LCD	D5 on LCD
21	RD2	LCD	D6 on LCD
22	RD3	LCD	D7 on LCD
24	RC5	Laser emitter	Laser emitter
25	RC6	Servo Motor	PWM pin
26	RC7	Servo Motor	PWM pin
27	RD4	LCD	RS pin
28	RD5	LCD	Enable pin
33	RB0	Push button	Push button
34	RB1	LDR	Digital Pin
35	RB2	LDR	Digital Pin

B. LDR [2]

A light dependent resistor (LDR) can be used to detect light in a closed room. The resistance of the LDR increases as darkness increases and decreases as the intensity of light increases. The LDR has 2 pins, one of which is connected to the ground and the other is connected to the MCU analog pin along with a resistor and a Voltage source. This acts as a voltage divider, so we are able to measure the Voltage across the LDR and thus determine the intensity of the light.

The LDR's were connected to the arms of the servo motors, and once they detected the laser an LED would light up depicting that the target was hit.

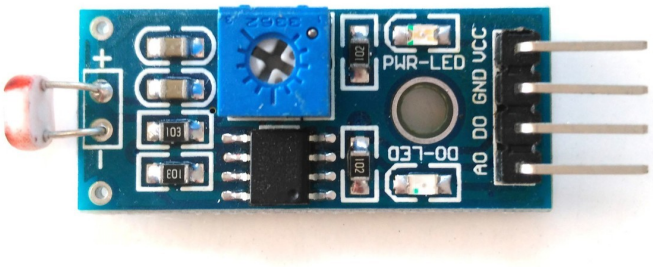

Figure 3: LDR [1]

C. Ultrasonic Sensor[3]

Ultrasonic sensor (HC-SR04) is a sensor that can be used to detect the distance from a certain object. This sensor has 4 pins two of which are connected to a power source and ground. The trigger pin is interfaced to port RB0(for example) which is configured to be an output pin and the echo pin to RB1 which in turn needs to be an input pin. The MCU will trigger the TRIGGER signal with a 10 μS high level signal which will make the sensor transmit 8 ultrasonic bursts. These signals will reflect off an object and return to the sensor. This will cause the Echo will output high to the MCU for the duration of time it took for the signal to come back.

Once the target has been hit, the ultrasonic will measure the distance and add it to 100 points and display it on the LCD screen

The following figure shows the ultrasonic sensor and its pins.

Figure 4 Ultrasonic Sensor

D. Servo Motor[4]

A servo motor can be used to move an arm from 0 to 180 degrees. The servo motor works based on PWM, this means that the angle that it rotates is controlled by the width of the pulse applied to its control pin. The MCU will output the angle via the control pin.

Both servo motors were given a timer based PWM and they would rotate between the angles 0 and 120 degrees simultaneously.

Figure 5 Servo Motor

E. Laser Emitter

The laser Emitter module was connected through 2 pins. One is connected to the ground and the other is connected to the MCU.

We connected it to pin RC5 and whenever the external interrupt PB0 was pressed, the laser emitter was given a logic ‘1’.

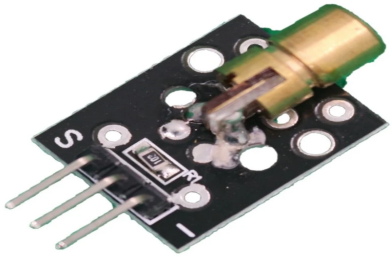

Figure 6 Laser emitter

Software Design

Figure 7 depicts the flowchart that describes the designed project. The attached codes have all the detailed information and comments about the ports and functionality of the designed system.

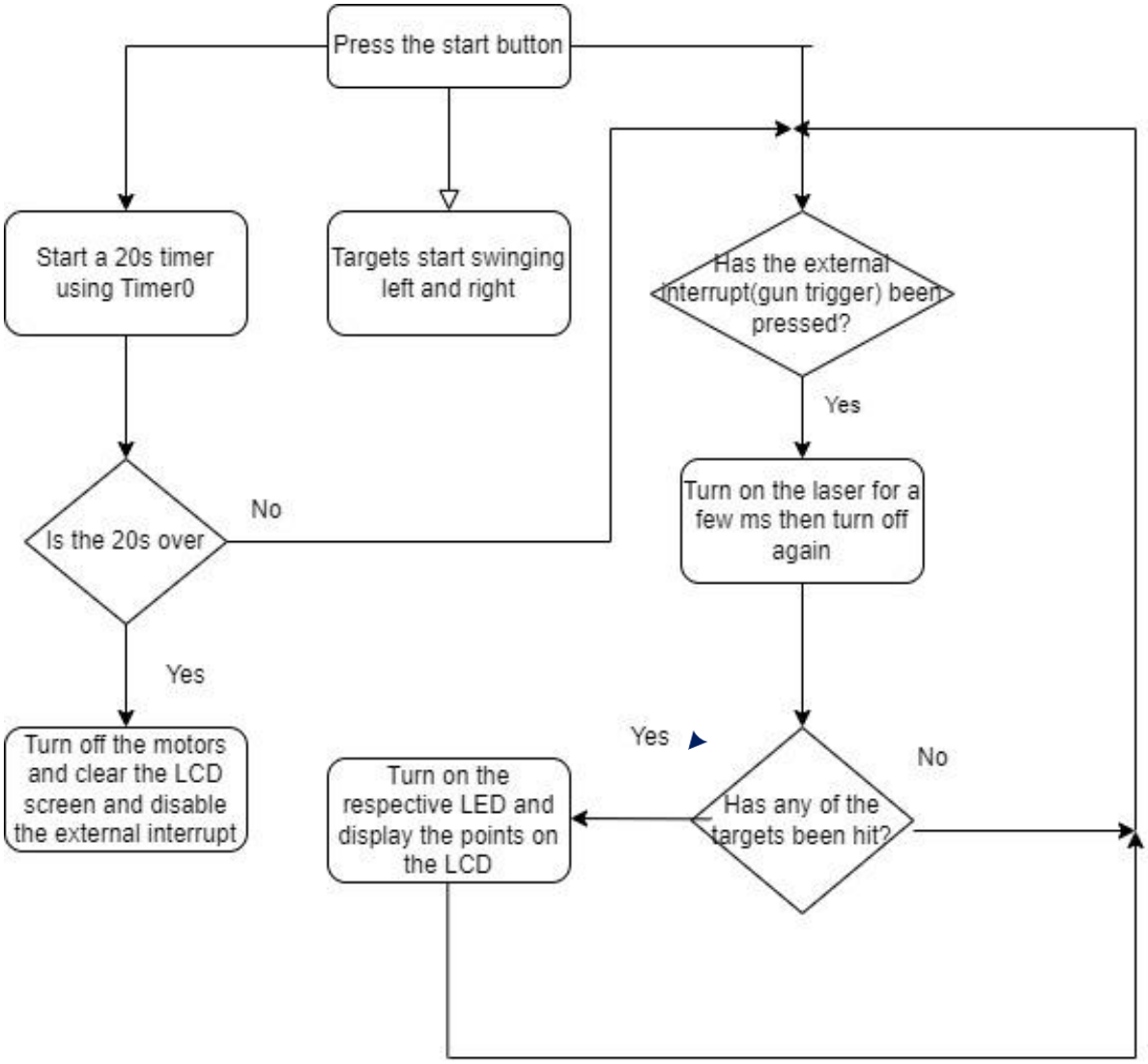

Figure 7 Flowchart of the designed system

III. Electrical Design and Results

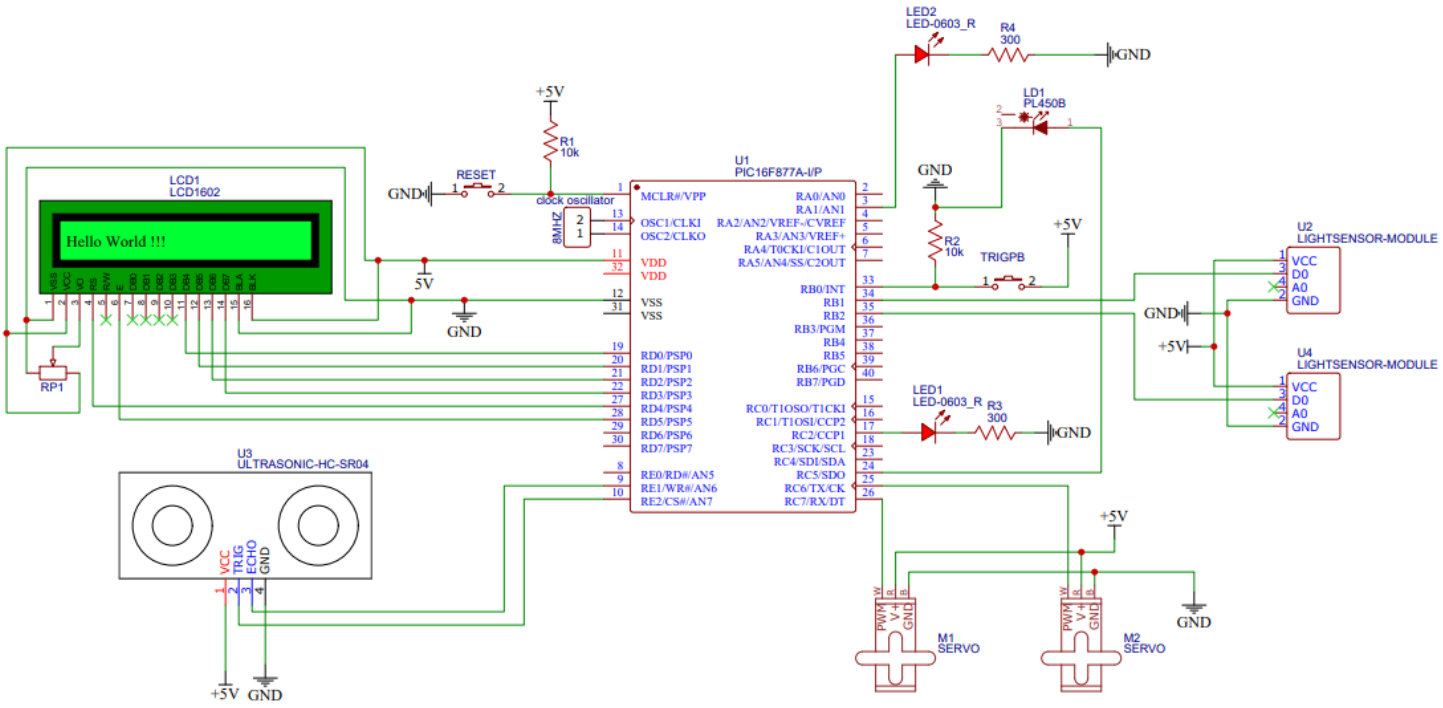

Figure 8 Laser Gun Game Hardware Design

After designing the circuits and testing the code this is what the final project looks like.

Figure 9 Final Result

Figure 10 Side view

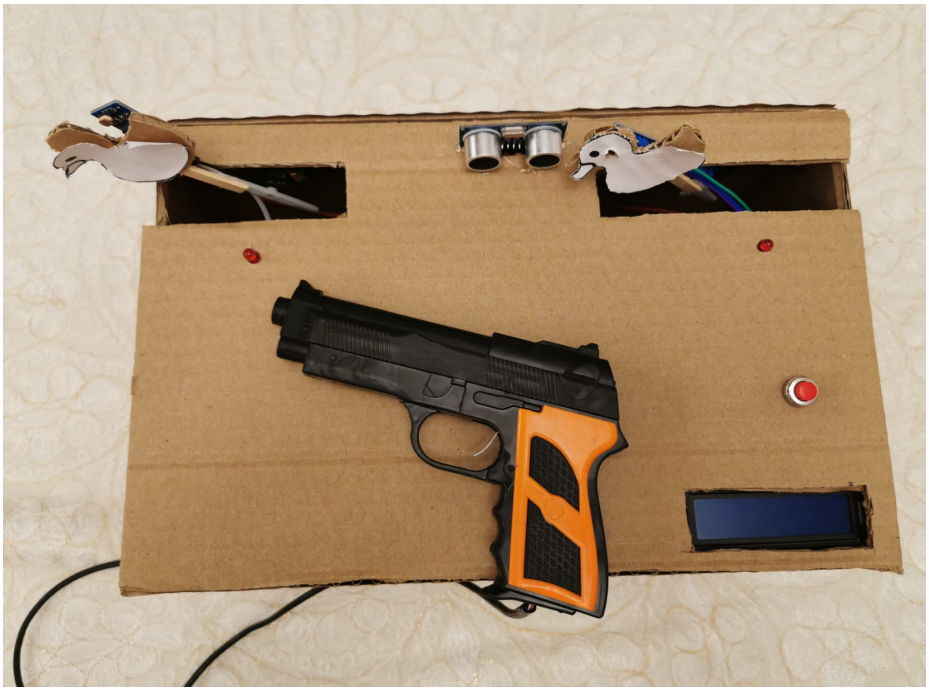

Figure 11 Top view

IV. Conclusion and Problem Identification

After designing this project, the followings are the main points that were concluded:

1. We wanted to keep displaying the high score of the game on the bottom corner of the LCD, but the problem was that we needed to keep it stored in the EEPROM and after each game we had to check if the current score is higher than the high score so we faced some problems programming wise.
2. Once we connected all the components and tested them at once, the game didn't function properly due to the high power consumption. So we had to connect the 2 servo motors on a different Voltage source in order for it to work properly.
3. The project cost around 50 JD's and some components that we bought were not used such as lithium batteries and a 12C module in addition some components were broken and had to be bought again.

In conclusion, this project was really amazing and fun to do and we learned a lot working on it both on the hardware and the software side.

References

[1] "PIC16F877A | Microchip Technology." https://www.microchip.com/en-us/product/PIC16F877A (accessed Jan. 23, 2023).

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