I. Introduction:

A. Problem Description

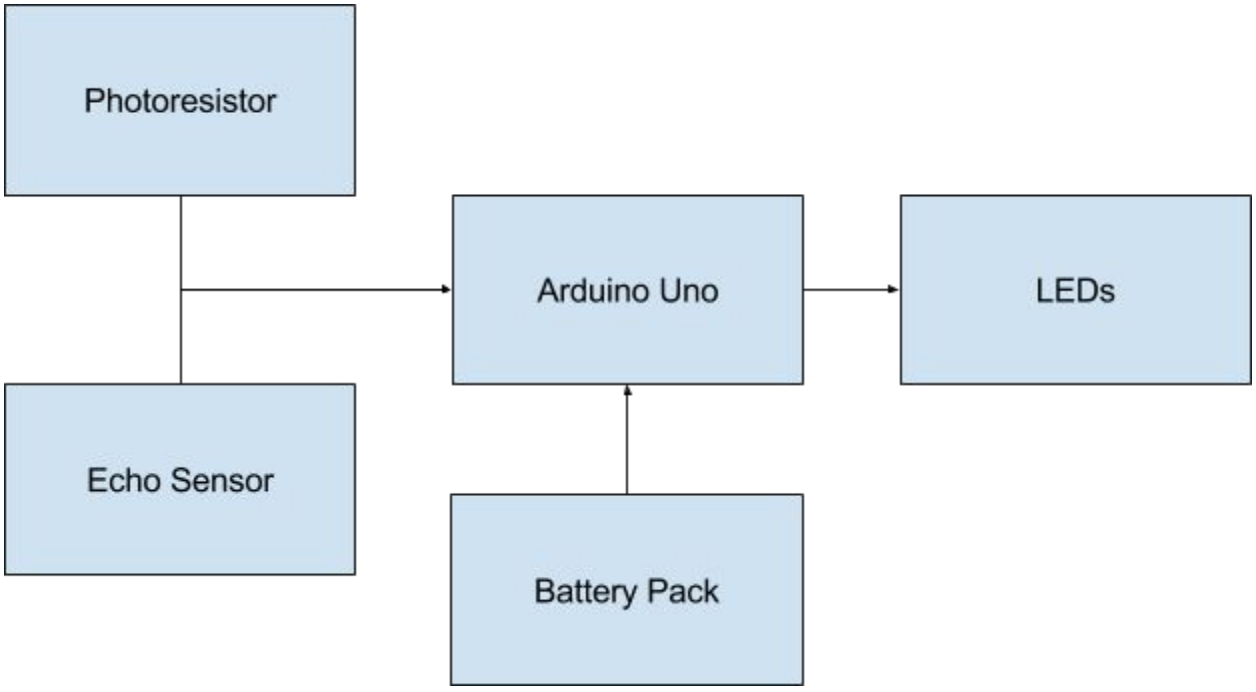
We decided to create a study light that only turns on when someone is present and adjusts its brightness according to the brightness of it's surroundings.

B. Basic Overview of Proposed Solution

By learning about and incorporating an echo sensor, a photoresistor, and an Arduino Uno we can accomplish these tasks. More specifically we can use the Arduino to read the light levels from the photoresistor and adjust our LEDs accordingly. We can also detect a person's presence with the echo sensor and use this information to either turn the LEDs off or on.

II. Design:

A. Block Diagrams



B. Written Descriptions of Blocks

The photoresistor block consists of a photoresistor in a voltage divider circuit with a resistor of known resistance. As the amount of light hitting the photoresistor increases, its resistance decrease. So, by measuring the voltage of the node in between the photoresistor and the known resistance, we can determine the brightness of the light's surroundings.

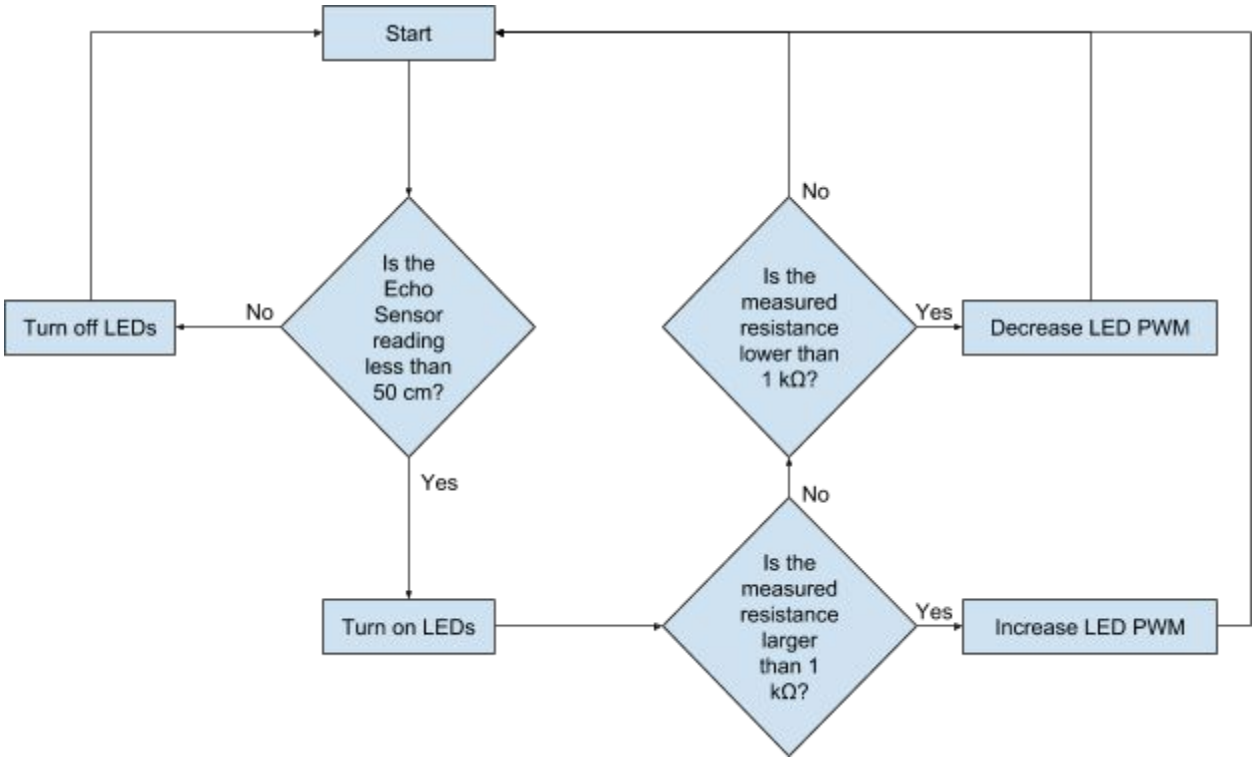
The echo sensor block consists of an HC-SR04 echo sensor that, when triggered with a high input voltage, outputs a sound wave. It then determines the amount of time for the sound wave to return to the sensor and outputs a signal based on this information. This information is then sent to the arduino, where we can determine whether someone is close enough to the light for it to turn on.

The Arduino Uno block is responsible for all of the calculations in the circuit and for controlling the brightness of the lights. The first thing it does is determine if something is close enough to turn on the light using information from the echo sensor. After that, it determines whether the light level of the area is above or below the desired level, and either increases or decreases the PWM signal to the LEDs to adjust their brightness.

The battery pack consists of four double A batteries that provide power to the arduino. The arduino then provides the power necessary for the other blocks to function.

The final block is the LED block, which consists of four white superbright LEDs. These LEDs receive a PWM signal from the arduino that controls their brightness. They are directed at the photoresistor so that changing their brightness changes the light level detected by the circuit.

C. Flowchart of software



D. Code Used

```
#include <NewPing.h>

int analogPin = A0;
int LED = 3;
int raw;
int Vin;
int LEDPWM;
int X;
float Vout = 0;
float R1 = 1000;
float R2 = 0;
float Y = 0;
#define LED 3
#define TRIGGER_PIN  12
#define ECHO_PIN     11
#define MAX_DISTANCE 200
NewPing sonar(TRIGGER_PIN, ECHO_PIN, MAX_DISTANCE);

void setup()
{
	Serial.begin(115200);
	pinMode(LED, OUTPUT);
	Vin = 5;
	LEDPWM = 0;
	X = 0;
}

void loop()
{
	unsigned int uS = sonar.ping();
	Serial.print("Ping: ");
	Serial.print(uS / US_ROUNDTRIP_CM);
	Serial.println("cm");
	unsigned int d = uS / US_ROUNDTRIP_CM;
	if (d < 50)
	{
		raw = analogRead(analogPin);
		Y = raw * Vin;
		Vout = Y/1024.0;
		Y = (Vin/Vout)-1;
		R2 = R1 * Y;
		Serial.println(R2);
		if ((R2 > 1000)&&(LEDPWM >= 0)&&(LEDPWM <= 199))
		{
			LEDPWM = X + 1;
```

```
                analogWrite(LED, LEDPWM);
            }
            if ((R2 > 1000)&&(X = 200))
            {
                analogWrite(LED, LEDPWM);
            }
            if ((R2 < 1000)&&(LEDPWM >= 1)&&(LEDPWM <= 200))
            {
                LEDPWM = X - 1;
                analogWrite(LED, LEDPWM);
            }
            if ((R2 < 1000)&&(X = 0))
            {
                analogWrite(LED, LEDPWM);
            }
            X = LEDPWM;
            Serial.println(X);
            delay(100);
        }
        if (d > 50)
        {
            digitalWrite(LED, LOW);
            delay(100);
        }
}
```

III. Results

A. Present Results

During our presentation the prototype we had worked extremely well. It showed how the basic concepts of our design combined and worked together to accomplish the original goal of our project. Both the systems, the echo sensor and the photoresistor, worked as they were supposed to.

B. Qualitative Analysis of results

The design worked exactly as intended. When there was something close to the echo sensor, the LEDs would turn on and would adjust their brightness until the light level the photoresistor was detecting reached what was desired. Then, if you decreased the light level by covering the the photoresistor the LEDs would gradually become brighter, and if you increased the light level by shining another light onto the photoresistor, the LEDs would gradually get dimmer until they would eventually turn off.

C. Quantitative Analysis of results

By looking at the readings from the photoresistor and the echo sensor that were printed by the arduino, we could tell the program was working as intended. The LEDs would only turn on and the arduino would only take measurements of the light level when the distance to the object in front of the echo sensor was smaller than the 50cm specified in the program. Then, the arduino would attempt to keep the resistance of the photoresistor at 1kΩ, which was the value we specified in the program. An increase to the LED PWM would cause the measured resistance value to decrease, and an increase to the PWM would cause the measured resistance to increase, which was what we expected.

IV. Future Work

A. Next Steps for Project

The next step for our project will be to prepare and enhance to present it at EOH. To enhance the project we will create a casing to mount the LEDs. The echo sensor will be placed at an appropriate height and mounted a little bit lower than the LEDs. To accomplish this tasks we will either have to buy or develop a casing and most likely have to solder LEDs to make the casing easier to work with.

V. Conclusion

A. What Worked?

The incorporation of the photocell and ultrasonic sensor together worked quite well. Both sensors were quite accurate and could be used over many different ranges. The code we developed worked quite well although it was a struggle to learn the arduino coding language at first.

B. What Didn't Work?

Nothing that we tried to implement did not work. We have the main idea of how our prototype could be made into a working product, now we just need to make it look like a actual study light.

C. What did you learn?

We learned valuable lessons about how to classify sensors and how to use multiple sensors together to accomplish more complicated tasks. Also, we learned how to use some basic and advanced arduino concepts. Lastly we also learned how to work effectively as a team and split tasks among group members.