Rajshahi University of Engineering & Technology

Department of Electrical & Computer Engineering

Course Name : Electronic Shop Practice
Course No : ECE 3100

Project Report

Submitted To	Submitted By
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Project Name: *UV-C Sterilizer Box*

Objective:

Ultraviolet (**UV**) is a form of electromagnetic radiation with from 10nm (30 PHz) to 400nm (750 PHz). There are several types of UV light depends on its wavelength. Short-wave ultraviolet light is called UV-C with the range of 200-280nm**. It can damage DNA and sterilizes surfaces with which it comes into contact.**
For humans, **suntan** and **sunburn** are familiar effects of exposure of the skin to UV light, along with an increased risk of **skin cancer**.

Objective of the of the project is to kill up to 99% germs & bacteria including COVID-19 & Flu virus within **5 minutes** by using UV-C wavelength. It is proven by research that though UV radiation is bad for human but it is effective for weak & harmful virus.

References: 1. https://en.wikipedia.org/wiki/Ultraviolet
2. https://www.healthline.com/health/does-uv-kill-coronavirus
3. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8107062

Usage:

1. It can be used as a home appliance for cleaning our daily stuffs like Phone, Laptop, some books etc.

2. Also can be implanted in shopping malls, doctor's chambers & other important entrances.

3. Can use to clean up any liquid's surface.

Hardware Components:

SL No.	Name	Rated Value	Quantity
1.	Arduino Nano	Input voltage: 7-12V Operating voltage: 5V Current per I/O pin: 40mA	1
2.	HC-SR04 Ultrasonic Sensor	Operating voltage: 5V Operating current: 15mA Measuring distance: 2-400cm	1
3.	SG-90 Servo Motor	Operating voltage: 5V Stall torque: 13kg/cm	2
4.	Buzzer	Operating voltage: 5V Operating current: < 32mA Resonate Frequency: $2300\pm300Hz$	1
5.	UV LED (5mm)	3.3 - 3.7V	20
6.	White LED (5mm)	3 - 5V	10
7.	Red LED (5mm)	1.4 – 2.6V	1
8.	Yellow LED (5mm)	1.4 - 2.6V	1
9.	Green LED (3mm)	1.4 - 2.6V	1
10.	Resister	220Ω	1
11.	Project Board (Mini)	-	1
12.	Jumper Wire	-	-
13.	Copper Wire	-	-

Project Overlook:

Real Life Circuit Connection:
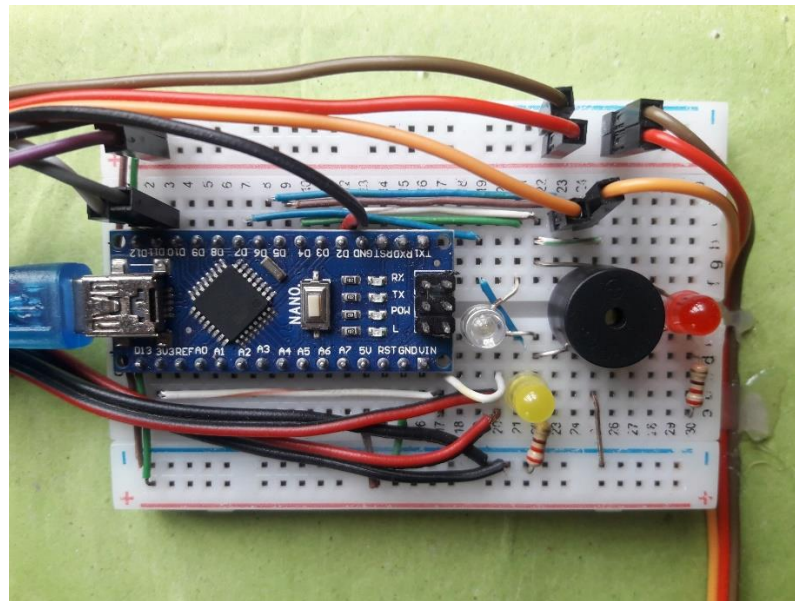
Circuit Diagram:

Operating Algorithm:

```
                    ┌──────────┐
                    │  Start   │
                    └────┬─────┘
                         │
                         ▼
              ┌────────────────────────┐
             / Taking 1st distance     /
            / with ultrasonic sensor  /
           └────────────┬─────────────┘
                         │
                         ▼
    No              ◇ Is it in ◇          Yes
  ◄─────────────────◇  range?  ◇──────────────┐
                    ◇          ◇               │
                                               ▼
                                  ┌────────────────────────┐
                                  │ Servo Motor 0 to 180    │
                                  │ delay 10 seconds        │
                                  └───────────┬─────────────┘
                                              │
                                              ▼
                          ◇ Is i>5? ◇  No   ┌──────────────────┐
                          ◇         ◇─────► │ Warning signal   │
                          ◇         ◇       │ i=i+1            │
                               │ Yes        └────────┬─────────┘
                               │                     ▼
                               │          ┌────────────────────────┐
                               │         / Taking 2nd distance     /
                               │        / with ultrasonic sensor  /
                               │       └────────────┬─────────────┘
                               │                    ▼
                               │         ◇ Is it in ◇   No
                               │         ◇  range?  ◇──────►
                               │              │ Yes
                               │              ▼
                               │   ┌────────────────────────┐
                               │   │ Time extension signal   │
                               │   │ delay 10 seconds        │
                               │   └───────────┬─────────────┘
                               │               ▼
                               ▼       Yes  ◇ Is j>5? ◇  No   ┌──────────────────┐
                              (○)◄──────────◇         ◇─────► │ Warning signal   │
                               │                              │ j=j+1           │
                               ▼                              └──────────────────┘
                    ┌────────────────────────┐
                    │ Servo Motor 180 to 0    │
                    │ UV on for cleaning       │
                    │ Done signal              │
                    │ Green LED on             │
                    └───────────┬─────────────┘
                                │
                                ▼
                          ┌──────────┐
                          │  Finish  │
                          └──────────┘
```
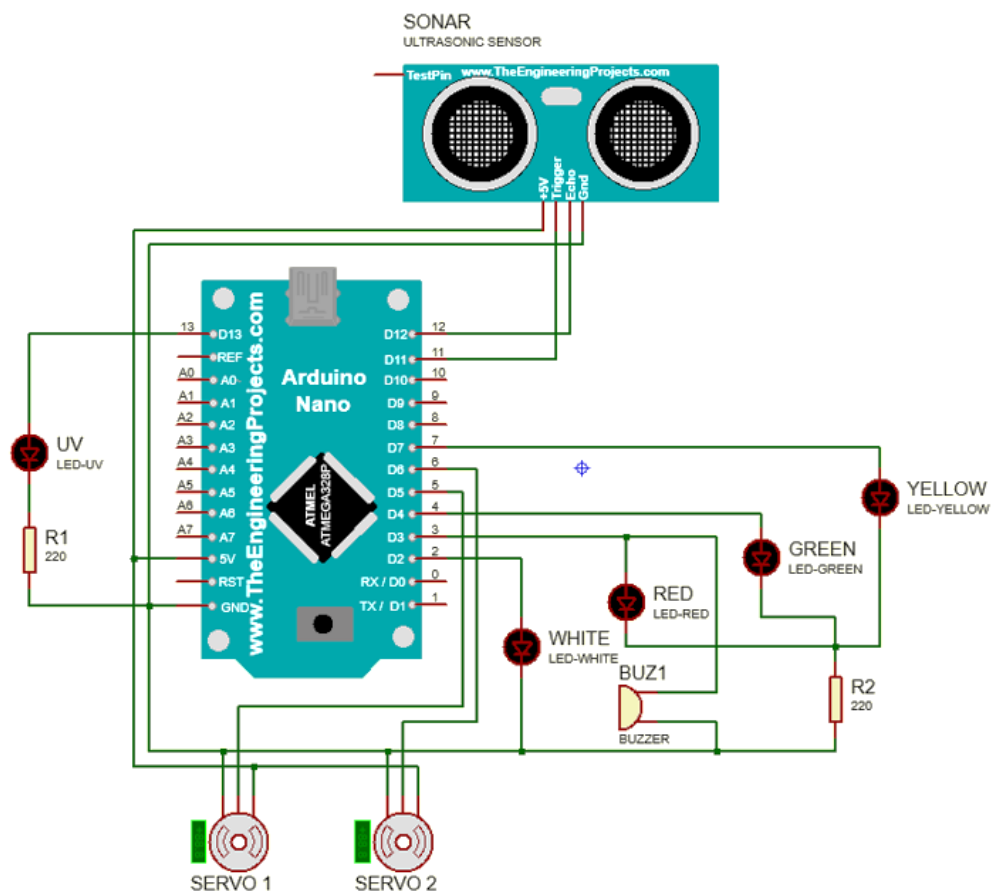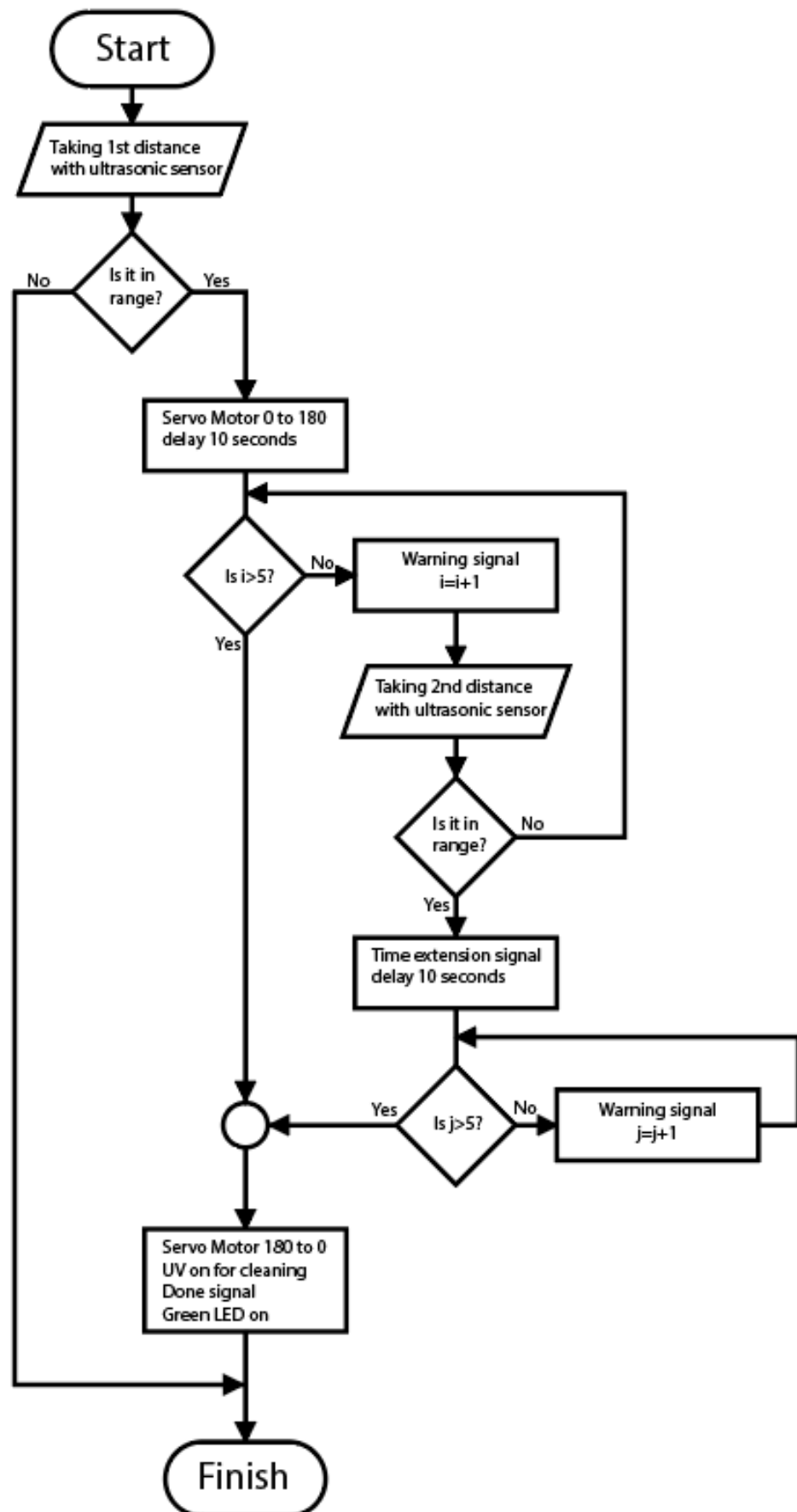
Software Program:

For coding the microcontroller, I've used "**Arduino IDE**". Which is an open-source text editor & compiler for Arduino. It can be downloaded form,
https://www.arduino.cc/en/software

Source Code:

```
#include <NewPing.h>              //Library for Ultrasonic Sensor
#include <Servo.h>

NewPing eye(11, 12, 40);          //Trig = Pin 11, Echo = Pin 12, Max distance = 40cm
Servo door_left, door_right;

int white = 2;                    //White LED to digital pin 2
int red = 3;
int green = 4;
int yellow = 7;
int uv = 13;

int cleaning_time = 30000;        //30 seconds
int n = 10;

void setup() {
  door_left.attach(6);            //Left servo to PWM pin 6
  door_right.attach(5);           //Right servo to PWM pin 5

  pinMode(white, OUTPUT);
  pinMode(red, OUTPUT);
  pinMode(green, OUTPUT);
  pinMode(yellow, OUTPUT);
  pinMode(uv, OUTPUT);
}


void delay_sec() {                  //function for certain seconds of delay
  for(int i=1; i<=n; i++) {
    digitalWrite(yellow, HIGH);
    delay(500);
    digitalWrite(yellow, LOW);
    delay(500);
  }
}
```

```cpp
void loop() {

  int distance = eye.ping_cm();     //taking distance by ultrasonic sensor

  if(distance <= 30 && distance > 10  && distance != 0) {

    digitalWrite(green, LOW);

    delay(1000);
    for(int i=5; i<=180; i++) {       //Door Open
      door_left.write(i);
      door_right.write(i);
    }
    delay(1000);

    digitalWrite(white, HIGH);
    delay_sec();


    for(int i=1; i<=5; i++) {                       //Primary Warning for 5 seconds
      digitalWrite(red, HIGH);
      digitalWrite(yellow, HIGH);
      delay(500);
      digitalWrite(red, LOW);
      digitalWrite(yellow, LOW);
      delay(500);

      int distance2 = eye.ping_cm();
      if (distance2 <= 10 && distance2 !=0) {        // If in second distance
        digitalWrite(red, HIGH);
        digitalWrite(green, HIGH);
        delay(1500);
        digitalWrite(red, LOW);
        digitalWrite(green, LOW);

        delay_sec();
        for(int i=1; i<=5; i++) {                    //Final Warning for 5 seconds
          digitalWrite(red, HIGH);
          digitalWrite(yellow, HIGH);
          delay(500);
          digitalWrite(red, LOW);
          digitalWrite(yellow, LOW);
          delay(500);
        }
        break;
      }
    }

    digitalWrite(white, LOW);

    delay(1000);
    for(int i=180; i>=5; i--) {                      //Door Close
      door_left.write(i);
      door_right.write(i);
    }
    delay(1000);

    digitalWrite(uv, HIGH);                          //Cleaning
    digitalWrite(yellow, HIGH);
    delay(cleaning_time);
    digitalWrite(uv, LOW);
    digitalWrite(yellow, LOW);

    digitalWrite(red, HIGH);                          //Done Signal
    delay(200);
    digitalWrite(red, LOW);

    digitalWrite(green, HIGH);
  }
}
```

Cost:

SL No.	Name	Cost (In Taka)
1.	Arduino Nano	650
2.	HC-SR04 Ultrasonic Sensor	90
3.	SG-90 Servo Motors	150
4.	Buzzer	15
5.	UV LEDs	500
6.	White LEDs	20
7.	Red LEDs	2
8.	Yellow LEDs	2
9.	Green LEDs	2
10.	Project Board	150
11.	Project Board (Mini)	75
12.	Resister	1
13.	Jumper Wires	50
14.	Copper Wires	20
15.	Cardboards	300
16.	Additional	100
	Total:	2127

Limitations:

The project is with some limitations. They are:

1. As the door of the box is heavy, the SG-90 servo barely able to open the door. Sometimes it's not possible by those small servo & it get damaged.

2. The box we've made by cardboard wasn't fully sealed. As we know, UV light is harmful for human health, unsealed box is harmful for using.

3. If we put the pile of things in the box, the inner surface of that thing is not in contacts with the lights & gets uncleaned.

Further Modifications:

There are some modifications that can make the project far more superior than now. They are:

1. 3D printed box can make the fully sealed & safe to use.
2. Bigger servo & power supply can automate the door more reliably.
3. Using more UV lights will increase the intensity & cleaning quality.
4. A rack & motor will help to rotate the things inside the box. Thus, the things inside won't get piled & the lights will get the every corner of the things.