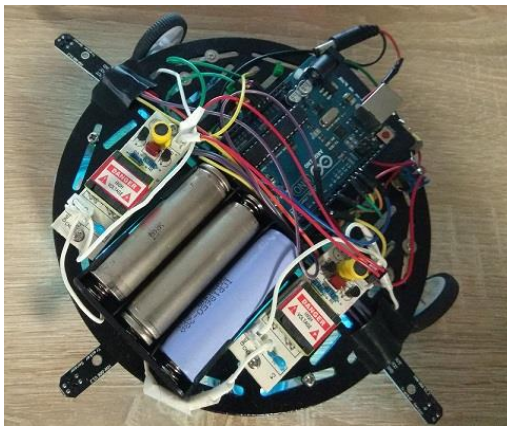
UNIVERSITY OF WEST ATTICA

ENGINEERING SCHOOL

DEPARTMENT OF INDUSTRIAL DESIGN AND PRODUCTION

SUBJECT WORK

Development of robotic platform for sterilizing spaces by radiation UVC.



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ABSTRACT

The present thesis focuses on the design and development of a robotic platform with the purpose to fully automate the sterilization process of spaces by UVC (Ultra Violet radiation Type C) radiation.

The robot is made up of a base with drive mechanism, position sensors, motion detectors and UVC light sources.

The robot is fully automated using a smart Arduino microcontroller while the user will be deposited to the space which wants to sterilize and implemented with an intelligent algorithm.

Future improvements could be the installation of better drive mechanisms so that the robotic platform can sterilize harder surfaces or install smarter position sensors for better perception of space to be sterilized.

KEYWORDS

Robot, Robotic platform, Microcontroller, Arduino, UVC Radiation, Sterilization.

INTRODUCTION

Many times in our lives we are confronted with many problems, one of which is proper cleanliness on vulnerable surfaces that humans or even pets have direct contact with. (bathroom, bed, mattress, bed sheets, floor, bathroom basin, aquariums, water etc).

While many of us think that by cleaning all these surfaces with cleaning products (chlorine, washing machine etc) stay clean, we are wrong, there are always residues of germs, mites and other bacteria where the naked eye cannot see, which multiply and can sometimes be harmful to the human body.

This phenomenon usually occurs mainly in hotels or in houses that we just have rent or buy and in our already own house when we have a lot of visitors or even from our shoes and cloths which have carried from outside a lot germs and bacteria.

So we are faced with the question of how can we deal these outbreaks of infection?

The answer can be as simple as this: using ultraviolet radiation so we are 99% sure that after properly cleaning and using the proper radiation all the germs and bacteria will have disappeared and that is why we created the following robotic platform that we'll see in the next chapters how it works.

METHODOLOGY

Initially to design the robotic platform, some key questions had to be answered - among other things - questions such as:

- How to move to a disinfection/sterilization space;
- In which way (mechanic, chemical, natural or combination ways) will the disinfection/sterilization process be implemented;
- How long will the robot run;
- How will secure robots autonomy;
- How the robot control will be implemented;

The methodology that we followed was the above:

1. Searching related research in bibliographic databases of scientific journals, conferences and websites.
2. Choose a disinfection/sterilization way.
3. Defining technical specifications of the robotic platform.
4. Software design and implementation of program code.

Following up our research, we came up with the design of a fully automated robotic platform, powered by suitable DC motors and fitted with a UVC emitter to sterilize the germs.

The autonomous movement will be achieved by the use of position and motion sensors, so that it can be moved into the space to be sterilized and avoid any obstacles it may face. For its autonomous movement, the robotic platform will use a suitable Arduino microcontroller, which is a processor that with the necessary programming will be able to manage and drive the motors by real-time controlling the position and motion sensor data for the purpose of avoiding obstacles.

The robotic platform will move in space with random lines (depending the obstacles that will find) and that because the equipment that we already have does not allow the movement in perfect straight lines.

Each sterilized area needs its own time to sterilize, the larger the surface is the longer the time needs. A typical sterilization time for a surface about as long as a double mattress (1.50m * 2.00m) is 30 minutes.

This will allow the user to do something else if wants instead of disinfect/sterilize.

DESIGN AND CONSTRUCTION PART (HARDWARE)

The core of our robotic platform is made up by:

- A round chassis (Picture 1),
- 2 motors 6v 1000RPM 30:1 (Picture 2) which gives the movement in chassis,
- 2 free rotating balls (Picture 3) which offers balance and soft movement.

Picture 3: Rotating ball

Picture 1: Round robotic chassis

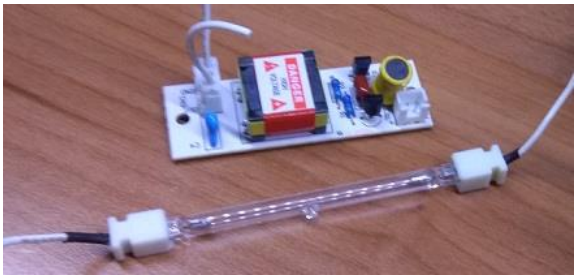
Picture 2: Motors 6v 30:1

The main parts in our construction are:

- A microcontroller Arduino UNO (Picture 4) which will receive and give orders to the whole system.

Picture 4: Arduino UNO

- 2 lamps UVC along with Blasters voltage 220v (the specific lamps works exclusively at voltage of 220v) (Picture 5).



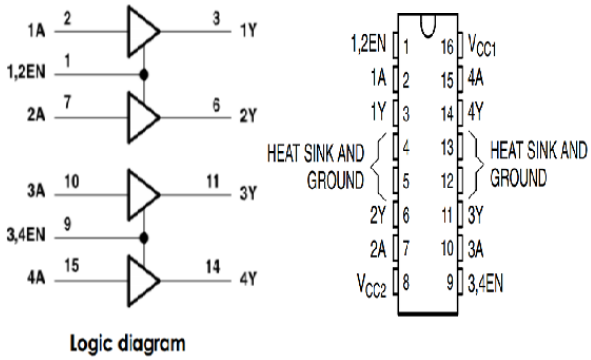
Picture 5: UVC lamp with Blaster 220v

- 3 position sensors (Picture 6).

Picture 6: Position sensor

- An integrated circuit L293DNE half-bridge (Picture 7,8) which will lead the 2 motors depending the orders of Arduino,

Pin	Name	Function
1	Enable1,2	Enable pin to control 1,2 driver
2	Input 1A	Input to control 1Y
3	Output 1Y	Output,connect to motor
4	GND	Ground and heat sink
5	GND	Ground and heat sink
6	Output 2Y	Output,connect to motor
7	Input 2A	Input to control 2Y
8	Vcc2	Output supply voltage
9	Enable3,4	Enable pin to control 3,4 driver
10	Input 3A	Input to control 3Y
11	Output 3Y	Output,connect to motor
12	GND	Ground and heat sink
13	GND	Ground and heat sink
14	Output 4Y	Output,connect to motor
15	Input 4A	Input to control 4Y
16	Vcc1	Supply voltage(7 max)



Picture 7: Table which explains IC outputs, logical diagram and diagram outputs

Picture 8: Integrated Circuit L293DNE Half-Bridge

- 2 batteries: one for the platforms function (12v) and one exclusively for the UVC lamps (4v) (Picture 9,10).

Picture 9: Lithium batteries type 18650

Picture 10: Lithium battery 4v

- A breadboard (Picture 11).

  For the end we used many mechanical and electric parts like switch, cables, motor mounts, battery mount, screws etc (Picture 12,13,14,15,16,17).

Picture 11: Breadboard

Picture 12: Motor Mount

Picture 13: Motor wheels

Picture 14: Battery mount 18650

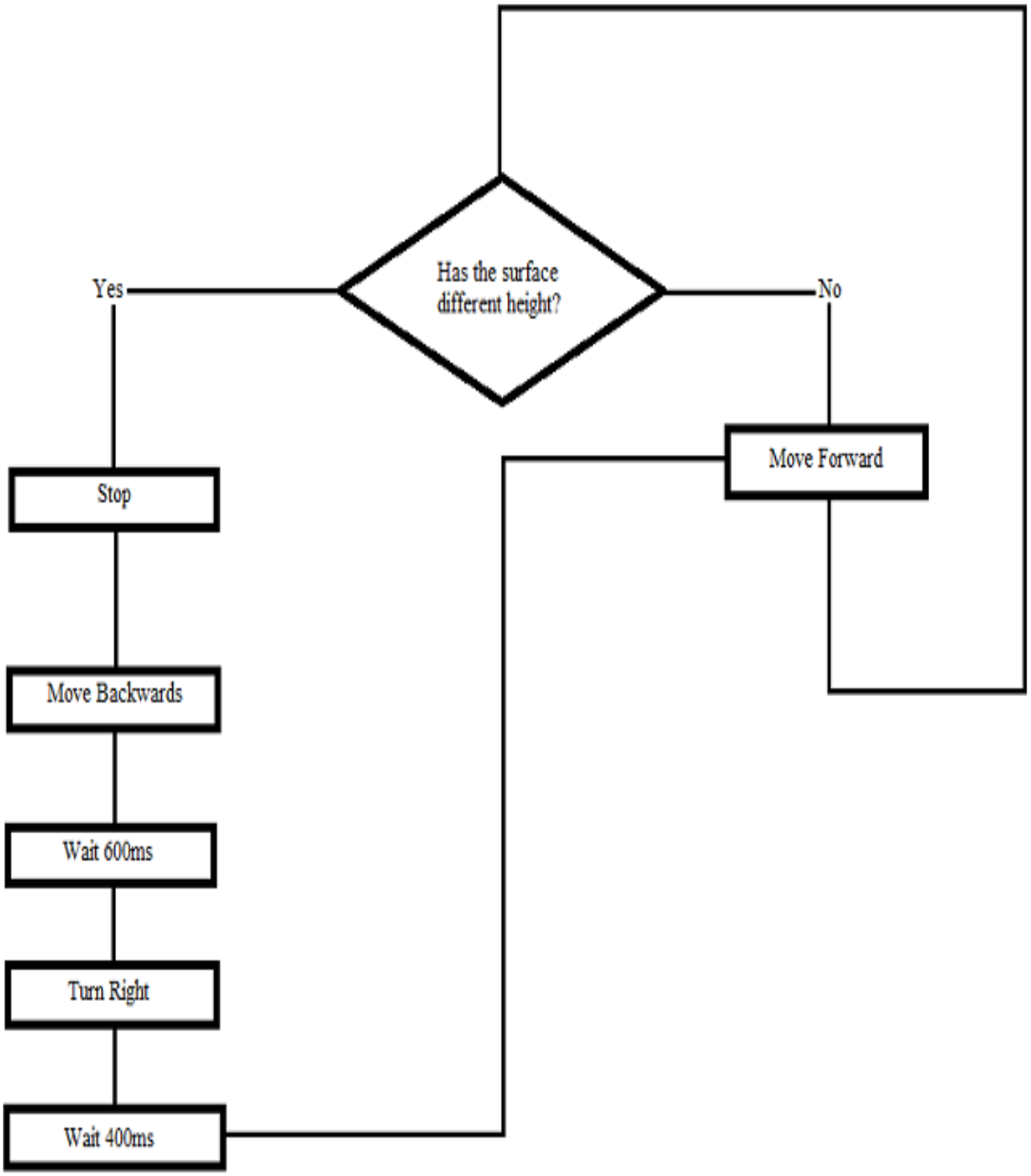
Picture 15: charging board for lithium battery 4v

Picture 16: Activation switch

Picture 17: Power plug Arduino UNO

DEVELOP AND DESIGN SOFTWARE

Before we start first we have to design a flow chart so we understand how the platform has to work.



Picture 18: Flow Chart

Source Code

Our code has designed and developed with the program Arduino IDE which is the develop environment for each microcontroller Arduino.

Program header

```
/********** Robotic Platform For Sterilizing spaces by radiation UVC
 * Purpose
 * The microController (Arduino) give orders to the Left and Right Motors of
 * our robotic platform wherever to go
 * Forward, Backwards or turn Right depending
 * of the situation on 3 Line trackers.
 * Hardware
 * The OUTPUTS of the Line Trackers connects to
 * Arduino Pins 12, 2 and 3
 * and the 4 OUTPUTS of Half-Bridge L293DNE connects to
 * Arduino PWM Pins 10,11 for Right Motor
 * and 6,9 for Left Motor.
 * The 5volt OUTPUT of Arduino Connects to
 * Half-Bridge L293DNE voltage INPUT
 * which gives the whole Robot the Voltage of 5Volt
 * Software
 * Uses Arduino Standard library calls
 * digitalRead(), digitalWrite(), pinMode() and delay()
 * Reference
 * v1.0 L. Grammatikos Sept. 2019
 **********/
```

Declaration of variables

```
int RMTR2 = 10;
int RMTR1 = 11; // Pins to which the 2 INPUTS of Half-bridge L293DNE
represents the Right Motor

int LMTR1 = 6;
int LMTR2 = 9;  // Pins to which the 2 INPUTS of Half-bridge L293DNE
represents the Left Motor

int Distance = 12; // pin for the OUTPUT information of Front Line Tracker
Sensor
int DistanceR = 2; // pin for the OUTPUT information of Right Line Tracker
Sensor
int DistanceL = 3; // pin for the OUTPUT information of Left Line Tracker
Sensor
```

Input and output declaration of Arduino

```
void setup()// We call setup() to execute once the above commands
{
pinMode(RMTR1, OUTPUT); // We set the 4 Arduino Pins 6,9,10,11
pinMode(RMTR2, OUTPUT); // as OUTPUTS so they can give orders to Half-Bridge
L293DNE how to control LEFT and RIGHT Motor
pinMode(LMTR1, OUTPUT); // to Half-Bridge L293DNE
pinMode(LMTR2, OUTPUT); // how to control LEFT and RIGHT Motor.
pinMode(Distance, INPUT); // We set the 3 Arduino Pins 2,3,12
pinMode(DistanceR, INPUT); // as INPUTS so they can read all the information
pinMode(DistanceL, INPUT); // that the 3 Line Trackers gives.
}
```

Main program

```
void loop() //We call loop() because we want the above programm executes
repeatedly
{
   if (digitalRead(Distance) == 1 && digitalRead(DistanceL) == 1 &&
digitalRead(DistanceR) == 1)
{
digitalWrite(RMTR1, LOW);   // digitalRead() reads the value of Pins 2,3,12
digitalWrite(RMTR2, HIGH);  // so after if statement can check the values
digitalWrite(LMTR1, LOW);   // we have set if they are TRUE or FALSE
digitalWrite(LMTR2, HIGH);  // in case of TRUE Arduino send signal to move
Forward
}
  else
{
digitalWrite(RMTR1, HIGH); // Otherwise if one of 3 conditions goes FALSE
digitalWrite(RMTR2, LOW);  // Arduino sends signal to move backwards for 600
miliseconds
digitalWrite(LMTR1, HIGH); // after that Arduino sends signal to Left motor
move Forward
digitalWrite(LMTR2, LOW);  // and Right motor move Backwards so the robotic
platform can turn right
delay(600);                // for 400 miliseconds
digitalWrite(RMTR1, HIGH); // and after that cause of the use of void loop(
digitalWrite(RMTR2, LOW);  // the if statement starts from the beginning
digitalWrite(LMTR1, LOW);
digitalWrite(LMTR2, HIGH);
delay(400);
}

}
```

CONCLUSION

After a few tests the results at first sight are not obvious, someone would expect with naked eye the results but as we mentioned before all these germs and bacteria are not visible. But we are sure for the results because only few seconds of expose in this radiation are enough.

As for this particular construction, as mentioned above the end user does not need to do anything at all, of course there are some disadvantages such that our construction only refers to mattress and not multiple surfaces because the speed of the motor due to a lot of friction on the mattress is increased so if we place our construction on a smooth surface the speed will be so high that the micro-organisms will not be prevented from being killed by UVC radiation.

Some improvements I would suggest to future colleagues who might want to deal with this issue would be a lighter chassis at first, it was a factor that I didn't figure out and when it came to my hands only realized that there might be a problem and unfortunately I used this chassis because I couldn’t afford more money. Maybe with the help of a Gyroscope and with proper planning we could achieve better results in scanning the space to be sterilized and of course with better motors and wheels to make our construction more friction resistant and able to sterilize more surfaces without difficulty.

If someone wants to improve the specific platform a good idea is that the sterilization mechanism to be moved on an automated vacuum cleaner (Rooba) where we will have double results cleaning and sterilizing.

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