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AN-NAJAH NATIONAL UNIVERSITY

Computer Engineering Department

Hardware Graduation Project

Plastic Bottles Recycling Machine

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Disclaimer

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Abstract

God Almighty created us for a noble purpose, which is to rebuild this universe, and God has blessed us with many blessings such as water and air, and we have to do our best to preserve these blessings, So we thought of a project that would serve us and our environment, our project is a plastic bottle recycling machine, and it aims to encourage people to throw it inside its own place and replace it with a purchasing value from the places we support, Instead of throwing it on the ground or mixing it with the rest of the waste, which makes it easier for us to recycle and produce new plastic bottles. The principle of this device is that the user inserts the plastic bottle into the slot designated for it and then scans the barcode. Each plastic bottle contains a special barcode that distinguishes it from other bottles. After that, by having the Ultrasonic and Force Sensitive Resistor in compliance with the instructions and the bottle has not been pulled out.a page for that bottle will appear on the touch screen showing the name of the bottle, the number of bottles and the price, and when you put another bottle the name. The number and price changes.Then he presses the Finish button for the user to take a picture of the QR code to buy it with its value from anywhere we support. Another feature of the project is to keep the number of plastic bottles that the user has inserted even after the device is turned off by adding EEprom,and the encryption feature so that no one can tamper with the QR code.

1 Introduction

Pollution often occurs as a result of throwing plastic bottles on the ground or throwing them in the garbage, where it is difficult to separate them from the rest of the waste. Therefore, we made a special machine for plastic bottles, which is easy to recycle and use again and encourage people to throw them in the designated place. This machine does not recognize and rejects : non-plastic bottles or plastic bottles that do not have a barcode, are filled with water or crushed. This machine contains several slots . slot for inserting plastic bottles, slot to collect the bottles inside it , slot for the touch screen , and slot that contains all the hardware components that we programmed.The principle of this device is that the user inserts the plastic bottle into the slot designated for it and then scans the barcode. Each plastic bottle has a special bar code that distinguishes it from other bottles. Then, through the presence of the ultrasonic resistor, we make sure that the bottle meets the conditions, which is that it is a plastic bottle and is not cruched, and it has a barcode and that the user put the bottle and It was not pulled out ,and through the Force Sensitive Resistor we make sure that the entered bottle is empty, then a page will appear For that bottle on the touch screen it shows the name of the bottle, the number of bottles and the price, and when you enter another bottle the name, number and price are change Then he presses the Finish button for the user to take a picture of the QR code to buy it with its value from anywhere we support. The touch screen also contains a Settings button, the principle of which is that when it is pressed, the owner of the box enters his password in order to open the box, close it, or end the attempt to remove the plastic bottles that have been entered. If the box is filled with the required limit, it appears on the screen that the box has been filled with the required limit and therefore the machine will stop working so that no one can insert the bottle into the machine and a message is sent to the owner until the box owner comes to empty it and from Then the confirmation button is pressed, and then the page that contains the open, close and end buttons appears and is opened and when it is finished, the close button is pressed and then returns to the first page , and then these bottles are collected in a box containing an electronic lock and a password to protect the box from theft. Another feature of the project is to keep the number of plastic bottles that the user has inserted even after the device is turned off by adding EEprom,and the encryption feature so that no one can tamper with the QR code.

2 Constraints, Standards/ Codes and Earlier course work

2.1 Constraints

2.1.1 mechanical parts

we Faced many problems , because We don't know much about mechanical parts like finding workshops that sell these parts, the difficulty of connecting these components and Finding the appropriate dimensions for the box.

2.1.2 Scanning The Barcode

The scanner does not read at great distances, it reads at a distance of less than a meter and must be read on the line of sight The user must keep moving the bottle and placing it in an appropriate position so that the scanner can read correctly.

2.1.3 Nextion Display

At first we used the Arduino Uno and the number of serial port was suitable, but when we added nextion display We needed the Arduino Mega because it has more serial port than the Uno.

2.1.4 Solenoid Electric Lock

The lock draws a high current, so it needs 12 volts, and when leaving the lock open for a long time may cause the lock to overheat, so do not leave the lock open for a long time.

2.1.5 A6 GSM Module

the problem was that messages were not sent unless it was supplied with sufficient power, and When purchasing a mobile sim, you will ask for a password for the sim (PIN) and if this sim is in gsm it does not call , and therefore a (PIN) is entered, which is four zeros.

2.2 Earlier Courses:

2.2.1 Arduino course:

The Arduino course helped us a lot because our work in the project was about Arduino and this course taught us how to use a lot of the pieces that we used in most parts of the project.

2.2.2 CPU lab:

This lab teaches us that we must check every piece before working with it and when we have any trouble at work we check it inside the lab, and learn how to connect and solder these pieces together.

2.2.3 Microcontroller

The microcontroller provides basic information about the concept Microcontroller and how to program electronic parts, as well this course introduces how to download code on a PIC Microcontroller and how to understand each pin and their feature. So, it is one of the the most important articles that helped you understand how to deal with Arduino Mega while working on the project, by our knowledge how to deal with the microcontroller as a laboratory for this material and thus he contributed mainly to helping start work on the project.

2.2.4 electronic circuits:

This course mainly helped with how to deal with electrical circuits and contacts as a result of this training course that helps to get Basic information about how to work with many different circuits and how to wire circuits.

3 Literature Review

Plastic recycling machine is a machine that anyone can use and exist in different places and may be located in public places or in institutions, Whether it is government or private and its idea is to replace the plastic bottle Various sizes with QR code After scanning its barcode, it gives us all the information about the bottle, including the name of the manufacturer and the price, and This is shown through a special screen placed on this machine, The information is translated with the purchase value shown on the screen, and The user takes a picture of the QR code through his mobile phone and takes it anywhere we support it to exchange its value for the things he wants. When the machine is filled with the specified number of plastic bottles, a text message is sent to the person responsible for it to empty it.as we saw this way it is the best way to maintain a clean and pollution-free environment, in addition to encourage people by exchanging the bottle for something physical Help them meet their needs. There are also many projects related to This theme, but they use different tools or different designs, but what distinguishes our project is the replacement of the bottle with a purchase value in In order for the benefit to be more general and comprehensive.

4 Design and Implementation

we designed a specialized machine only to throw plastic bottles inside, so we built this special machine in two stages, starting with the stage of assembling the parts of the devices and controlling them using Arduino, and then we built and designed the shape and the outer body of the machine, which is A machine with dimensions 35, 35 and 60, which contains several slots.

4.1 the Machine design

Figure 4.1.1: Machine design

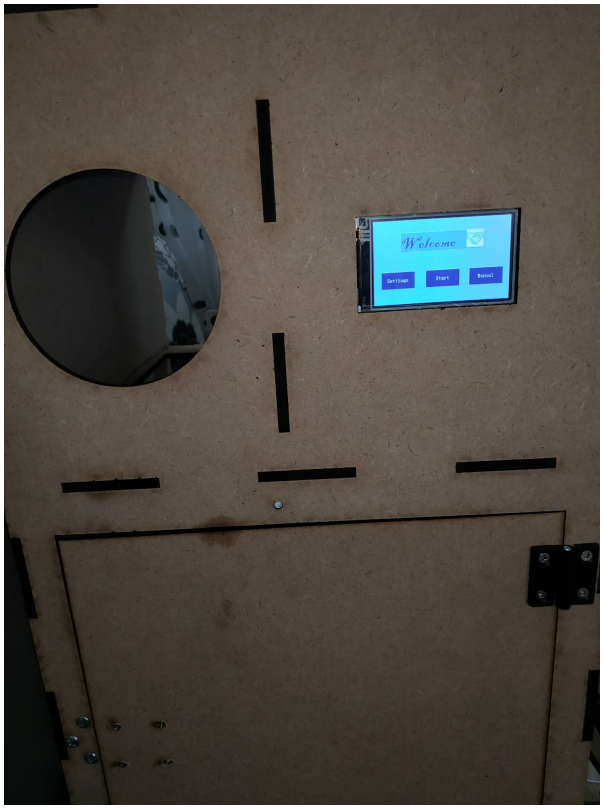

Figure 4.1.2: Machine design

a slot through which the user inserts the bottles and scans them, and if it is confirmed that they meet the conditions and that they are plastic, the door of the box is opened from the inside, which we collect the bottles inside, and a slot for the screen that contains several pages It has been programmed and designed in the appropriate way and contains all the information on the bottel, and an opening for the box from the outside so that the owner of the box can empty it when it is full,and a slot that contains all the hardware components that we programmed.

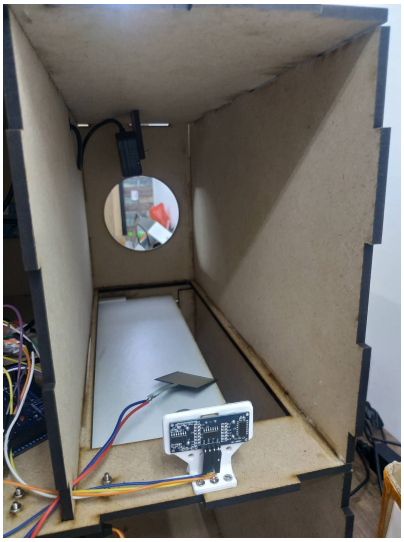

Figure 4.1.3: Slot for inserting the plastic bottle

Figure 4.1.4: A slot for electronic parts and a slot for collecting plastic bottles

4.2 Hardware and Software Specifications

4.2.1 Hardware Components

Hardware components for the machine:

For this part, we have used an Arduino Mega, A6 GSM /GPRS Module, 400 TTL 2D Barcode And QR Scanner, Ultrasonic Sensor Module HC-SR04,5V 1-Channel Relay Module Active High/Low,12V 2A Power Supply,Solenoid Electric Lock L54mm ,Nextion NX4827T043 intelligent LCD Touch Display Module,MG996R Metal Gear High Torque Servo Tower Pro,LM2596 ,Force Sensitive Resistor .

• Arduino Mega

Figure 4.2.1: Arduino Mega

Arduino Mega is a microcontroller based on the ATmega2560; it is designed for experimentation. it has 54 digital input/output pins 16 analog inputs, 4 UARTs (hardware serial ports), a USB connection, a power jack, and a reset button. Here, we used it to program our machine . it connected with the A6 GSM Module, the Ultrasonic Sensor Module , the Servo motor,the Relay,the Scanner, and the Nextion LCD Touch Display. It shown in Figure 4.2.1.

• A6 GSM Module

Figure 4.2.2: A6 GSM Module

A6 GSM/GPRS module is a miniature GSM modem, which can be integrated into a great number of IoT projects. You can use this module to accomplish almost anything a normal cell phone can; SMS text messages, Make or receive phone calls, connecting to internet through GPRS, TCP/IP, and more! To top it off, the module supports quad-band GSM/GPRS network, meaning it works pretty much anywhere in the world.Here, we use it to send a message to the owner of the box when it is full to empty it. It shown in Figure 4.2.2.

• Barcode And QR Scanner

Figure 4.2.3: Barcode And QR Scanner

A barcode scanner scans digitally convert printed barcodes. It then decodes the data and sends the data to a computer. It consists of a lens, a source of light, and a light sensor that can translate optical impulses into electrical signals. A barcode scanner contains a decoder that analyses the image data provided by the sensor and sends it to the output port. After scanning an image, it links to a host computer to pass along the captured information.here, We use it to scan for the bar code on plastic bottles, as there is a special bar code in the plastic, so we can distinguish whether it is plastic or not, as the machine receives only plastic, and find out all the information about the bottle from the name of the manufacturer and the price.It shown in Figure 4.2.3.

• Ultrasonic Sensor Module

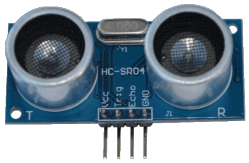

Figure 4.2.4: Ultrasonic Sensor Module

An ultrasonic sensor is an electronic device that measures the distance of a target object by emitting ultrasonic sound waves, and converts the reflected sound into an electrical signal In order to calculate the distance between the sensor and the object, the sensor measures the time it takes between the emission of the sound by the transmitter to its contact with the receiver.here, We use it to see if the barcode has been read correctly and the bottle is still in front of it, not pulled out, after that the door opens and the bottle goes into the box .It shown in Figure 4.2.4.

• 5V 1-Channel Relay Module Active High/Low

A relay is a type of switch that has magnetic coil that can be controlled with an electrical signal. It is a way to open or close a circuit in this case via a

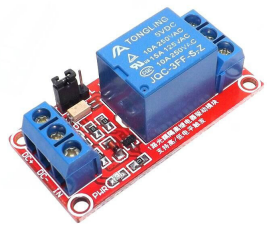

Figure 4.2.5: 5V 1-Channel Relay Module Active High/Low

signal from the connected microcontroller. The relay isolates the circuit on the device you want to control from the device that's controlling it. We use it here, where we connect it with solenide lock so that when it is supplied with electricity, the electricity is connected to the solenide lock 12 volts, and when we turn off the 5 volt logic, the relay turns off the electricity from the solenide lock. It shown in Figure 4.2.5.

• 12V Power Supply

Figure 4.2.6: 12V power supply

Its principle is that the power supply is an ideal replacement for a missing or damaged 12V 2A power adapter and can provide a 12V DC power supply that is supplied to power our electronic devices used in the project and has

been connected to a LM 2596 Ad-ustable and then connected to the relay The unit shown in Figure 4.2.6

•Solenoid Electric Lock

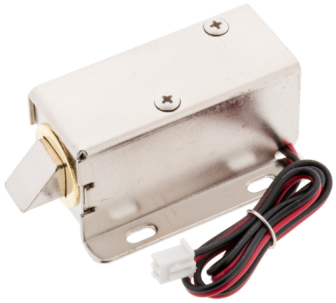

Figure 4.2.7: Solenoid Electric Lock

The working principle of the electronic lock is that it can be used to open cabinets and doors using a 12V power supply. These locks are basically electromagnets. The natural lock is positioned (in the absence of a power supply) because the lock tongue is outward and fully extended . When 12V power is used, the electromagnetic lock coil is energized and the lock tongue is pulled to be pushed into the lock and the door opens .This lock was used to control open and close the machine, and to protect the box from being exposed to any theft. The unit shown in Figure 4.2.7.

• Nextion Display Module

Nextion screen is a screen that combines a built-in processor and a memory touch screen with Nextion Editor to develop a HMI GUI project using the Nextion editor The HMI can be developed by dragging and dropping components (graphics, text, buttons, etc.) and we used this screen in our project and this screen contains It has several buttons through which to display sufficient information about the plastic bottle that was entered and it also contains a QR code to be photographed by the person who placed the

Figure 4.2.8: Nextion Display Module

plastic bottle in the designated place and this screen was connected to the Arduino Mega piece The unit shown in Figure 4.2.8.

• Servo Tower Pro

Figure 4.2.9: Servo tower pro

The TowerPro MG996R digital servo motor rotates 90° in Each direction makes it 180 degree motor as a digital servo motor receives and processes PWM signal faster and better and it was used in our project that when the ultrasonic confirms the information of the plastic bottle entered as correct,

servo opens the inner door to insert the bottle The plastic is inserted into the box, and this servo is connected to the Arduino Mega and connected to a 12-volt voltage The unit shown in Figure 4.2.9.

• LM2596

Figure 4.2.10: LM2596

LM2596 DC to DC step-down regulator, adjustable from +1.23 to 35vdc, 2A output.Ideal for battery-operated projects that require a regulated power source, and it was used as regulating the special power source in our project by connecting it to the power supply piece and the Arduino mega piece to control the power source, in addition, it reduces the voltage from 12 to 5 volts so that the controller can operate on it . The unit shown in Figure 4.2.10.

• Force Sensitive Resistor

The force-sensitive resistor with a square sensing area, 1.75 x 1.5 inches. The FSR will change its resistance depending on the amount of stress that is applied to the sensing area. The higher the force, the lower the resistance. It was used in our project to distinguish if the bottle is full or empty so that if it is empty it is allowed to enter otherwise it is not entered. It contains two inputs, an input that is connected with a resistance of 10 kilos, the second

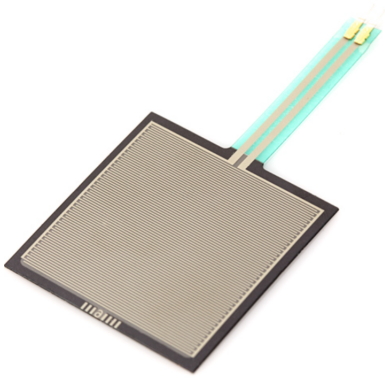

Figure 4.2.11: Force Sensitive Resistor

end of the resistance with a ground for the Arduino, and the second end is a force-sensitive resistor with a vcc with the Arduino Mega The unit shown in Figure 4.2.11.

4.2.2 Software Components

To make our machine work first we connected hardware components to make Scanning to the barcode on the plastic bottle to make sure it is plastic bottle , Also, we connected Ultrasonic sensor to make sure that the user, after scanning the bottle, placed it and did not pull it out,and we programmed the Force Sensitive Resistor to sense the weight of the plastic bottle if it is full or empty,We have also programmed the eeprom memory to keep the number of plastic bottles that the user has inserted even after the device is turned off , And we made an encryption of the barcode so that no one can cheat and tamper with it , Then we programmed all these by using Arduino ide. Last thing we used Nextion Editor to programmed screen pages that show information about plastic bottles and a place to enter the password of the owner of the box.

Arduino IDE

The Arduino Integrated Development Environment (IDE) is an open-source software that helps with code editing, compilation, and debugging. The Arduino IDE runs on the Java Platform. It's for writing and uploading code

to Arduino-compatible boards. We write the code using it then .The IDE application is suitable for different operating systems such as Windows, Mac OS X, and Linux. It supports the programming languages C and C++.

Nextion Editor

as we need a Nextion Display LCD To display the information on it and also to open and close the box by entering the password of the machine owner We downloaded the Nextion Editor which is a development software used for visual building of graphic interface for embedded GUI-intensive devices with various types of TFT displays and Touch Panels.

4.3 Arduino Code

We use Arduino IDE to write three codes:
Scanner code:
We used the following example code to read the barcodes on the plastic bottles, such as the name of the manufacturer, the price and the barcode, and thus we can distinguish the plastic bottles from other non-plastic bottles,where we made 3 strings, one for the barcode, one for the manufacturer and one for the price.When we scan the entered bottle, it compares the information you have with the information in the array string. If they agree, the bottle will be accepted.

```
#define NxSerial Serial1  // nextion LCd
#define BCSerial Serial2 //BarCode
#define gsmSerial Serial3 //GSM
//-------------- variables ------------------
int MAXb = 20;
String BCbottle[20] =  { "5449000151490", "5449000161482", "5449000151513", "90377679","90375675","6281100
String BCcompany[20] = {  "Cappy Orng 1.5L","Cappy Grape 1.5L","Cappy Mango 1.5L","Cappy Grape 330","Cappy
float BCprice[20] = {0.5, 0.5, 0.5, 0.25, 0.25, 0.5, 0.5, 0.25, 0.25, 1};
String BCdataIn = "";
float bottles_counter = 0;
float tot_price = 0;
String company = "";
int z = 0;
void setup() {

  Serial.begin(115200);
  BCSerial.begin(115200);
  gsmSerial.begin(9600);
  BCSerial.setTimeout(100);
}
void loop() {
  if (BCSerial.available() > 0 ) {
    BCdataIn = BCSerial.readString();
    Serial.print("BCdataIn:");
    Serial.println(BCdataIn);
    BCdataIn.trim();//remove the \n
```

Figure 4.3.1: Scanner code

Ultrasonic and Servo Code : We used the following example code to see if the barcode has been read correctly and the bottle is still in front of it, not pulled out, after that The inner door is opened by the servo motor and the bottle goes into the box .

```
dis1 = sonar[1].ping_cm();
Serial.print("dis : ");
Serial.print(dis1);
Serial.println("cm");
if ((dis1 < 1  || dis1 > 12 ) || analogRead(weightPin) > 500) {
  Serial.println("prob!");
  //error
  Serial.println("1 sec over");
  NX_go_to_page("6");
  delay(2500);
  send_qty_to_nex(bottles_counter);
  send_tprice_to_nex(tot_price);
  send_comp_to_nex("error!");
  goto Exit;
}
for ( int i = close_angle; i < open_angle; i++) {
  myservo.write(i);
  delay(10);
}
delay(1000);
for ( int i = open_angle; i > close_angle; i--) {
  myservo.write(i);
```

Figure 4.3.2: Ultrasonic and Servo Code

Solenoid lock and A6 GSM Code : We used the following example code to send a message to the owner of the box when it is full to empty it , and it is emptied when the owner of the box enters the password, as there is an electronic lock whose function is to protect the box from theft .

```
  index = NxdataIn.indexOf("open");
  if (index >= 0) {
    digitalWrite(relay_pin, 1);
    Serial.println("open");
    EEPROM.put(eeprom_storage_address, float(0));
  }
  index = NxdataIn.indexOf("close");
  if (index >= 0) {
    digitalWrite(relay_pin, 0);
    Serial.println("close");
  }
oid sendSMS(int buttles_in_storage ) {
 gsmSerial.print("AT+CMGS=0598289033;\r");    //Start accepting the text for the messa
 //to be sent to the number specified.
 //Replace this number with the target mobile number.
 delay(1000);
 gsmSerial.print("over bottles quantity :" + String(int(buttles_in_storage)) + "\nyou
 delay(1000);
 gsmSerial.write(0x1A);  //Equivalent to sending Ctrl+Z
```

Figure 4.3.3: Solenoid lock and A6 GSM Code

4.4 Circuit Layout

To control the programming and operation of the device, we use Arduino mega to program different parts first, we use a barcode scanner that reads the barcode of a plastic bottle, which has 4 inputs, Tx, Rx, VCC, GND connected to pin 17 (Rx) with TX for Arduino, pin 16 (TX) with Rx for Arduino, pin 22 (VCC) with VCC for Arduino, GND pin with GND for Arduino Mega, and the touch screen was used to display the information of the plastic bottle which has 4 inputs Tx, Rx, VCC and GND connected to pin 19 (RX) with TX for arduino, pin 18 (TX) with RX for arduino, pin (VCC) with VCC for arduino, pin (GND) with GND for arduino mega We used an A6 GSM clip that sends a message to the box owner. Pin 15 (Rx) with TX for Arduino, Pin 14 (TX) with RX for Arduino, Pin (VCC) with VCC for Arduino, GND pin with Arduino Mega and for powering the piece is connected to a USB to be connected to a computer and a piece of ultrasonic was used audio to make sure it's a bar code scanner to make sure all the information has been read correctly to open the interior door and

has 4 inputs which are GND, echo, Triger and VCC, connected to pin GND with pct213 with GND for arduino and echo pin with pin 7 With arduino, pct214 with VCC with arduino mega, and the Force Sensitive Resistor piece was used to confirm whether the bottle is empty or filled to be inserted or not and it contains two inputs One input connects to a 10 kilo resistor wage to be connected with A0 and the other wages are connected to the ground with the Arduino and the second end of the piece connect with vcc with arduino mega, we used servo piece and have 3 pins connected orange with pin 9, red with pct214 with VCC with arduino, black with pct213 with GND with arduino mega and we used the relay piece used with lock to control the opening and closing of the box It contains two entrances : VCC, GND and GND connected to pct213 with arduino and VCC connected to pct214 with vcc with arduino and N pin connected to pin 22 with arduino mega The LM2596 is used in regulating the special power supply in our project and it has 4 inputs which are OUT (+), VCC , GND, OUT (-), VCC, connect to 12V power supply, connect to GND to 12V power supply, OUT (+) connect to pct214 with VCC with arduino, connect OUT (-) to pct213 with GND with Arduino Mega. A 12V power supply piece we used to supply the project with a 12V power supply has two inputs: the VCC input connected to OUT (+), and the GND input connected to the OUT (-) of the LM2596, which has a connection to a voltage (power) source. . The electric lock solenoid piece has two inputs, a VCC input connected to a 12V power supply and a GND input connected to a pct213 with GND to be connected to the Arduino Mega. To power the Arduino Mega, it is connected to a USB cable to be connected to a computer.

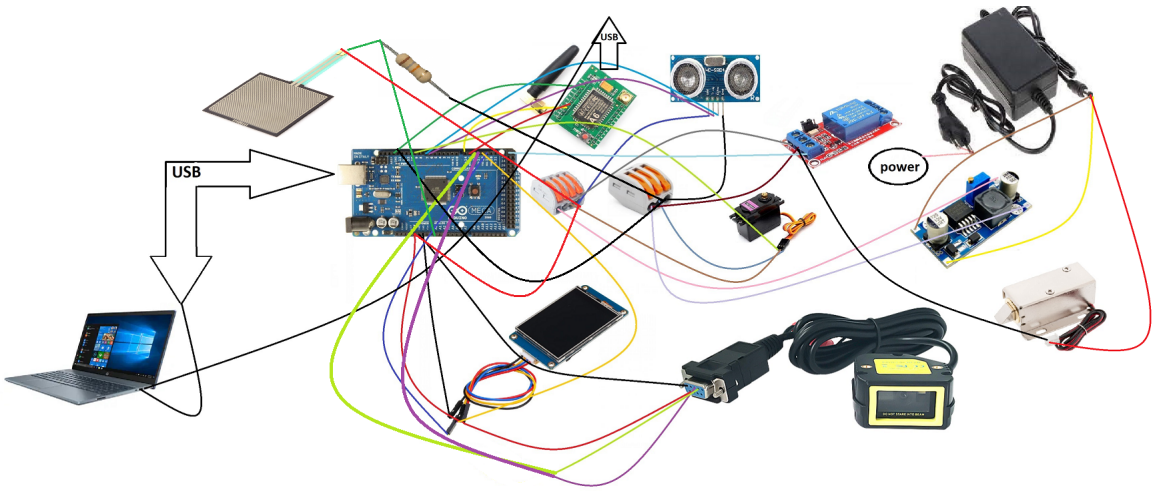

Figure 4.5.1: Machine implementation

5 Results and Analysis

We compiled the source code for each step and made sure that everything is working fine before moving on to the next step which helps us a lot in identifying the source of errors. In the final stage our project met the requirements related to it such as the barcode scanner was read correctly, the barcode was read where the special information about the plastic bottles appeared on the touch screen, in addition to the total number of bottles. Verify the correctness of the information that was read through the ultrasound piece so that the plastic bottle is inserted into the box and when it is full, a message is sent to the owner of the box that it is full, in order to empty it.

step1:After the user presses the start button on the touch screen, he inserts the plastic bottle into the slot to scan it

Figure 5.1: Inserting the plastic bottle into the slot for scanning

step2:After scanning it, it is placed in front of the ultrasonic and above the Force Sensitive to make sure that it is still there and has not been pulled out and that it is empty of fluid

Figure 5.2: It is placed in front of the ultrasonic and above the Force Sensitive,Then the servo motor opens the door

step3:After that, all information about the bottle, such as the name and price, will appear on the screen.

Figure 5.3: Information about the inserted bottle

step4: When the user finishes entering all the plastic bottles he has, he presses the finish button, where a QR Code appears on the screen containing all the information and the price for the bottles, he photographs it to buy with its value from anywhere we support it

Figure 5.4: QR Code

step 5: After the user takes picture of the QR Code, he goes to any place we support, and the owner of the place scans the QR Code and shows him all the information in order to sell it as much as the bottles that have been placed

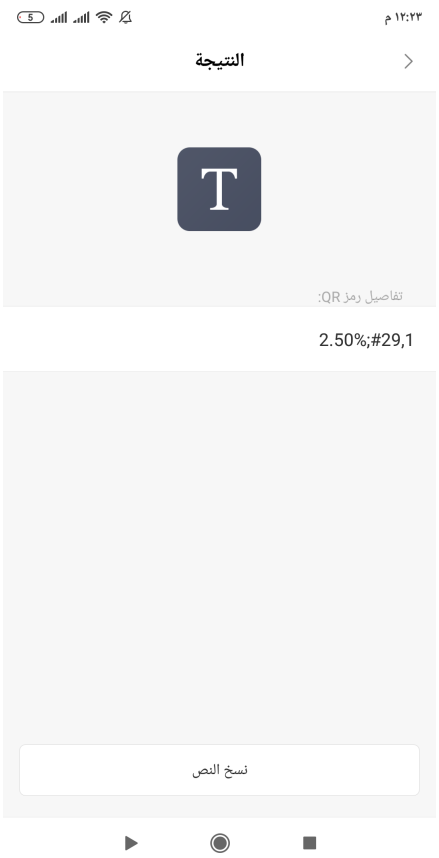

Figure 5.4: After scanning the QR Code

step 6: After the box is filled with the required amount of plastic bottles, a page appears for the owner of the box to enter the password and empty it

Figure 5.4: Enter the password

step 7: After the owner of the box presses the Confirm, 3 buttons appear to open and close the box and return to the first page

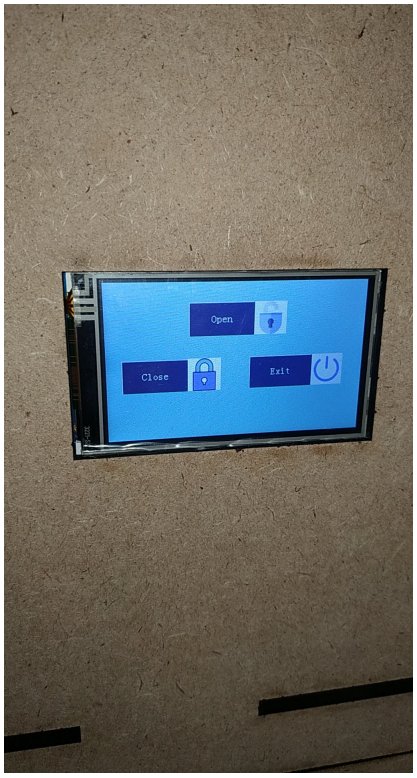

Figure 5.4: Buttons to open and close the box

step 8: Then the box opens after pressing the open button

Figure 5.4: open the box

6 Conclusions and Recommendation

In our project, we are trying to make a machine for recycling plastic bottles, in addition to that it encourages people to throw it in the place designated for it, as they get in return for what was put from the plastic bottles inside the box by photographing the QR code that appears on the touch screen and buying from anywhere we support , by scanning the bar code on plastic bottles. We can improve our project, instead of shooting a QR code, the paper for the total plastic bottles entered is drawn and shown to be spent in the places we support,and To solve the problem of how to insert the plastic bottle instead of moving it by hand in order for the barcode to be read correctly, it is developed by placing it directly inside the slot and reading it correctly.

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