IOT liquid level monitoring system

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Ahmed Kh Ahmed
Salahaddin University - Erbil

زانكۆى سەلاحەدين- هەولێر
Salahaddin University-Erbil

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Research Project
Submitted to the department of (Electrical Engineering) in partial fulfillment of the requirements for the degree of B.A or BSc. In (Electrical Engineering)

By:
Onel Fahmi
Mohamad Isam
Mohamad Khalil
Havana Afram

Supervised by:
Mr. Ahmad Khalid

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SUPERVISOR'S CERTIFICATION

I certify that this Project, titled 'IOT liquid level monitoring system' and presented by 'Onel Fahmi ,Mohamad Isam, Mohamad Khalil and Havana Afram' was prepared under my supervision at the University of Salahaddin – Erbil as a partial requirement for the degree of Bachelors of Science in Electrical Engineering.

Signature:
Name: Mr. Ahmed Kh. Ahmed
Date: 5/20/2019

Acknowledgment:

Special thanks to our supervisor Mr. Ahmed Khalid for everything he did for us. And we would like also to thank our families and colleagues for all the supports to create this project.

Abstract:

Our project describes leak detection in liquid transmission system to detect and avoid the unnecessary loss of liquid such as water, milk and oils. In order to detect the leakage in the water tank, volumetric sensors are kept in the water tank for the detection of the leakage and further a reserved tank is present underneath the main tank to store the leaked liquid with the assistance of electric valve

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Chapter One

1.1 Introduction

Internet of Things (IOT) is a concept that encompasses various objects and methods of communication to exchange information. Today IOT is more a descriptive term of a vision that everything should be connected to the internet. IOT will be fundamental in the future because the concept opens up opportunities for new services and new innovations. All objects will be connected and able to communicate with each other, while they operate in unprotected environments. This later aspect leads to major security challenges.

Today, IOT is in great need of standardization and clear architectures that describe how this technology should be implemented and how IOT devices interact with each other in a secure manner. The security challenges are rooted in the technology and how information is acquired and manipulated by this technology.

Fig 1.1 (A description about how IOT works)

The Internet of Things (IOT), sometimes referred to as the Internet of Objects, will change everything including ourselves. This may seem like a bold statement, but consider the impact the Internet already has had on education, communication, business, science, government, and humanity. Clearly, the Internet is one of the most important and powerful creations in all of human history. Now consider that IOT represents the next evolution of the Internet, taking a huge leap in its ability to gather, analyze, and distribute data that we can turn into information, knowledge, and, ultimately, wisdom. In this context, IOT becomes immensely important. Already, IOT projects are under way that promise to close the gap between poor and rich, improve distribution of the world's resources to those who need them most, and help us understand our planet so we can be more proactive and less reactive. Having a common set of standards, and developing energy sources for millions even billions of minute sensors. However, as businesses, governments, standards bodies, and academia work together to solve these challenges IOT will continue to progress. [5]

1.2 Advantages [2]

Here are some advantages of IoT:

1. Data: The more the information, the easier it is to make the right decision. Knowing what to get from the grocery while you are out, without having to check on your own, not only saves time but is convenient as well.

2. Tracking: The computers keep a track both on the quality and the viability of things at home. Knowing the expiration date of products before one consumes them improves safety and quality of life. Also, you will never run out of anything when you need it at the last moment.

3. Time: The amount of time saved in monitoring and the number of trips done otherwise would be tremendous.

4. Money: The financial aspect is the best advantage. This technology could replace humans who are in charge of monitoring and maintaining supplies.

1.3 Disadvantages [2]

Here are some disadvantages of IoT:

1. Compatibility: As of now, there is no standard for tagging and monitoring with sensors. A uniform concept like the USB or Bluetooth is required which should not be that difficult to do.

2. Complexity: There are several opportunities for failure with complex systems. For example, both you and your spouse may receive messages that the milk is over and both of you may end up buying the same. That leaves you with double the quantity required. Or there is a software bug causing the printer to order ink multiple times when it requires a single cartridge.

3. Privacy/Security: Privacy is a big issue with IoT. All the data must be encrypted so that data about your financial status or how much milk you consume isn’t common knowledge at the work place or with your friends.

4. Safety: There is a chance that the software can be hacked and your personal information misused. The possibilities are endless. Your prescription being changed or your account details being hacked could put you at risk. Hence, all the safety risks become the consumer’s responsibility.

1.4 Internet of Things Principle and Paradigms

The Internet of Things (IOT), sometimes referred to as the Internet of Objects, will change everything including ourselves. This may seem like a bold statement, but consider the impact the Internet already has had on education, communication, business, science, government, and humanity. Clearly, the Internet is one of the most important and powerful creations in all of human history.

Already, IOT projects are under way that promise to close the gap between poor and rich, improve distribution of the world’s resources to those who need them most, and help us understand our planet so we can be more proactive and less reactive. Even so, several barriers exist that threaten to slow IOT development, including the transition to IPv6, having an common set of standards, and developing energy sources for millions even billions of minute sensors.[4]

1.5 Internet of Things Applications

The range of IOT application domain is wide and encapsulates applications

From home automation to more sophisticated environments, such as smart cities and e-government. Industry-focused applications include logistics and transportation, supply-chain management, fleet management, aviation industry, and enterprise automation systems.

Healthcare systems, smart cities and buildings, social IOT, and smart shopping are a few examples of applications that try to improve the daily life of individuals, as well as the whole society. Disaster management, environmental monitoring, smart watering, and optimizing energy consumption through smart grids and smart metering are examples of applications that focus on environment. [1]

Chapter two

2.1 INTERNET OF THINGS DEFINITION EVOLUTION

IOT EMERGENCE

Kevin Ashton is accredited for using the term “Internet of Things” for the first time during a presentation in 1999 on supply-chain management .He believes the “things” aspect of the way we interact and live within the physical world that surrounds us needs serious reconsideration, due to advances in computing, Internet, and data-generation rate by smart devices. At the time, he was an executive director at MIT’s Auto-ID Center, where he contributed to the extension of RFID applications into broader domains, which built the foundation for the current IOT vision.[5]

INTERNET OF EVERYTHING

Since then, many definitions for IOT have been presented, including the definition that focuses mostly on connectivity and sensory requirements for entities involved in typical IOT environments. Whereas those definitions reflect IOT’s basic requirements, new IOT definitions give more value to the need for ubiquitous and autonomous networks of objects where identification and service integration have an important and inevitable role. For example, Internet of Everything (IOE) is used by Cisco to refer to people, things, and places that can expose their services to other entities.[5]

INDUSTRIAL IOT

Also referred to as Industrial Internet, Industrial IOT (IIOT) is another form of IOT applications
Favored by big high-tech companies. The fact that machines can perform specific tasks such as data acquisition and communication more accurately than humans has boosted IIOT’s adoption. Machine to machine (M2M) communication, Big Data analysis, and machine learning techniques are major building blocks when it comes to the definition of IIOT. These data enable companies to detect and resolve problems faster, thus resulting in overall money and time savings. For instance, in a manufacturing company, IIOT can be used to efficiently track and manage the supply chain, perform quality control and assurance, and lower the total energy consumption. [5]

SMARTNESS IN IOT

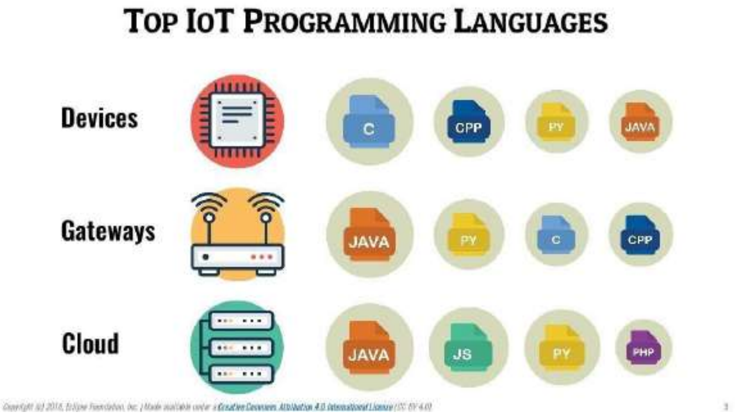
Another characteristic of IOT, which is highlighted in recent definitions, is “smartness.” This distinguishes IOT from similar concepts such as sensor networks, and it can be further categorized into “object smartness” and “network smartness.” A smart network is a communication infrastructure characterized by the following functionalities:

• Standardization and openness of the communication standards used, from layers interfacing with the physical world (ie, tags and sensors), to the communication layers between nodes and with the Internet;

• object addressability (direct IP address) and multifunctionality (ie, the possibility that a network built for one application (eg, road-traffic monitoring) would be available for other purposes (eg, environmental-pollution monitoring or traffic safety).[5]

2.2 Top IOT Programming Languages

Developers are using several different programming languages for IOT such as C, C++, Java, JavaScript, Python, and PHP to name a few. The image above (fig 2.3) shows the preferred languages based on the given subdomain of IOT development.[1]


TOP IOT PROGRAMMING LANGUAGES
Devices
C
CPP
PY
JAVA
Gateways
JAVA
PY
C
CPP
Cloud
JAVA
JS
PY
PHP
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3

Fig 2.3

2.3 INTERNET OF THINGS APPLICATIONS

IOT promises an interconnected network of uniquely identifiable smart objects. This infrastructure creates the necessary backbone for many interesting applications that require seamless connectivity and addressability between their components. The range of IOT application domain is wide and encapsulates applications from home automation to more sophisticated environments, such as smart cities and e-government.

Industry-focused applications include logistics and transportation, supply-chain management, fleet management, aviation industry, and enterprise automation systems. Healthcare systems, smart cities and buildings, social IOT, and smart shopping are a few examples of applications that try to improve the daily life of individuals, as well as the whole society. Disaster management, environmental monitoring, smart watering, and optimizing energy consumption through smart grids and smart metering are examples of applications that focus on environment.

In a broader magnitude, Gascon and Asin classified 54 different IOT applications under the following categories: smart environment, smart cities, smart metering, smart water, security and emergencies, retail, logistics, industrial control, smart agriculture, smart animal farming, domestic and home automation, and eHealth. For further reference, Kim et al. Have surveyed and classified research about IOT applications based on application domain and target user-groups. In this section we present categorization of enterprise IOT applications based on their usage domain. These applications usually fall into the following three categories: (1) monitoring and actuating, (2) business process and data analysis, and (3) information gathering and collaborative consumption. The rest of this section is dedicated to characteristics and requirements of each category.[4]

Chapter three

Liquid level monitoring system using IOT

IOT (Internet of things) based liquid level monitoring system is an automatic system that gives the intimation message or signal to the user about liquid level in certain tank and prevent the liquid tank to overflow. If we talk about at domestic or industrial level, then we can see mostly we save the liquid such as water or any chemical material in a cylindrical or any other type of a tank. To fill out this tank a motor pump is attached with this. Somewhere it is controlled manually and somewhere it is controlled automatically. Where it is controlled manually then there an operator must be required to operate this motor pump. Which is much so mostly solution and beside this, sometime due to operator negligence so much costly liquid material or water is wasted. So this IOT based liquid level monitoring system is very useful for home based applications.

On other hand, if we use an automatic motor control pump then they are also so much costly as well as they do not display the liquid level on any display. On concentrating these issues here, we have designed a system that is called IOT liquid level monitor system that controls the liquid level automatically. It is more efficient more reliable and less costly as compared to other systems as well as it also displays the liquid level on LCD display. This system has designed with the help of Esp8266 NodeMCU Microcontroller, ultrasonic sensor, LCD display, Motor pump and relay.

These ultrasonic sensors sense the water level from the container and then send the logic high signal to microcontroller. The microcontroller which is interfaced with ultrasonic sensors, WiFi modem and LCD display, it sends the logic high signal or data to WiFi modem and LCD display. Then this WiFi modem sends this data to user dedicated webpage, shown in (fig3.1), where the user can easily understand the water or liquid level of the tank. This dedicated webpage displays this data with graphical view of container and high light the water level. Similarly, the microcontroller also displays this data on system LCD display.

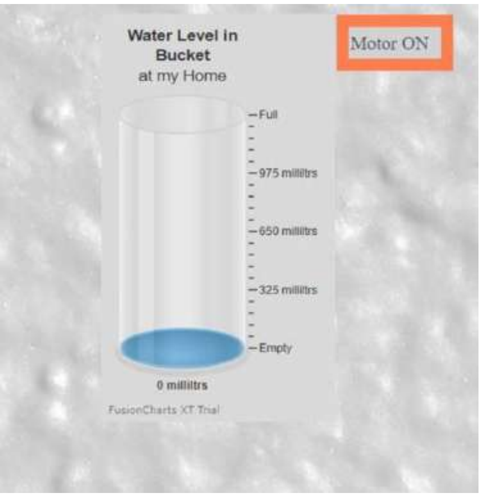


Fig3.1 (webpage showing the level of liquid in the tank)

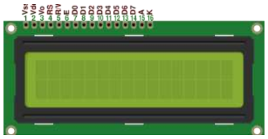
Materials that are used

3.1 Ultrasonic Distance Sensor

Ultrasonic sensors provide a measurement of the time it takes for sound to bounce off an object and return to the sensor. The “ping” sound pulse is generated when the pingPin level goes HIGH for two micro-seconds. The sensor will then generate a pulse that terminates when the sound returns. The width of the pulse is proportional to the distance the sound traveled and the sketch then uses the pulseIn() function to measure that duration. The speed of sound is 340 meters per second, which is 29 microseconds per centimeter. The formula for the distance of the round trip is:
RoundTrip = microseconds / 29.
So, the formula for the one-way distance in centimeters is:
Microseconds / 29 / 2. [6]

3.2 Serial I2C LCD (16x2)

Is a kind of character LCD display. The LCD has a parallel interface, meaning that the microcontroller has to manipulate several interface pins at once to control the display.
The process of controlling the display involves putting the data that form the image of what you want to display into the data registers, then putting instructions in the instruction register. The LiquidCrystal Library simplifies this for you so you don't need to know the low-level instructions.[6]

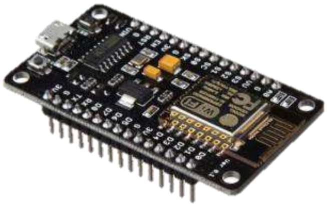


3.3 Esp8266 NodeMCU

NodeMCU is an open source LUA based firmware developed for ESP8266 WIFI chip. By exploring functionality with ESP8266 chip, NodeMCU firmware comes with ESP8266 Development board/kit i.e. NodeMCU Development board. [3]

Developer	ESP8266 Opensource Community
Type	Single-board microcontroller
Operating system	XTOS
CPU	ESP8266 (LX106)
Memory	128kBytes
Storage	4MBytes
Power	USB

[3]



3.4 Relay

Is a switch which is electrically operated by an electromagnet. The electromagnet is activated with a low voltage/current, for example 5 volts from a microcontroller and it pulls a contact to make or break a high voltage/current circuit. It plays a role of automatic regulation, security protection and circuit switch.[6]

3.5 Water pump

A water pump is any device for moving water.[6]

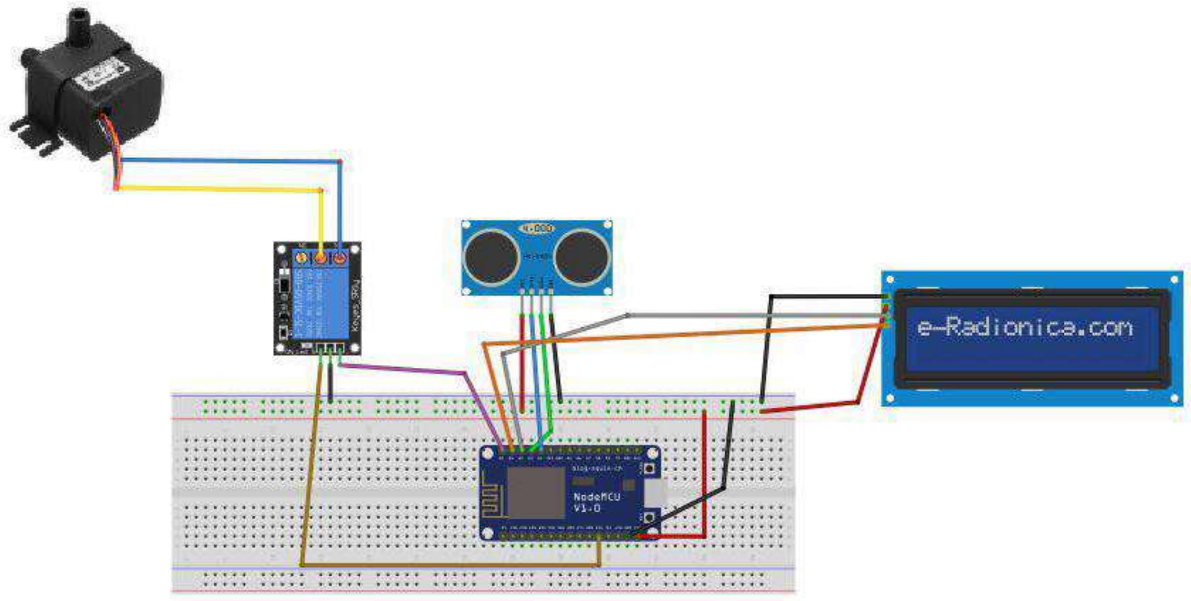


Fig 3.2 (the circuit diagram of IOT liquid level monitoring system)

The program of practical work

```
#include <LiquidCrystal_I2C.h>
#include <ESP8266WiFi.h>
#include <HCSR04.h>
#include <ESP8266WebServer.h>
#include "Adafruit_MQTT.h"
#include "Adafruit_MQTT_Client.h"
#include <Wire.h>
LiquidCrystal_I2C lcd(0x3F, 16, 2);

        const char index_html[] PROGMEM = {"<!DOCTYPE html>\n"
        "<html>\n"
        "<head>\n"
        "<title> Water Level Monitoring </title>\n"
        "<script type=\"text/javascript\" src=\"http://static.fusioncharts.com/code/latest/fusioncharts.js\"></script>\n"
        "<script type=\"text/javascript\" src=\"http://static.fusioncharts.com/code/latest/themes/fusioncharts.theme.fint.js?cacheBust=56\"></script>\n"
        "<script src=\"https://cdnjs.cloudflare.com/ajax/libs/zepto/1.2.0/zepto.min.js\"></script>\n"
        "<script src=\"https://simeydotme.github.io/jQuery-ui-Slider-Pips/dist/js/jquery-plus-ui.min.js\"></script>\n"
        "<script src=\"https://simeydotme.github.io/jQuery-ui-Slider-Pips/dist/js/jquery-ui-slider-pips.js\"></script>\n"
        "<link rel=\"stylesheet\" href=\"https://simeydotme.github.io/jQuery-ui-Slider-Pips/dist/css/jqueryui.min.css\">\n"
        "<link rel=\"stylesheet\" href=\"https://simeydotme.github.io/jQuery-ui-Slider-Pips/dist/css/jquery-ui-slider-pips.min.css\">\n"
        "<link rel=\"stylesheet\" href=\"https://simeydotme.github.io/jQuery-ui-Slider-Pips/dist/css/app.min.css\">\n"
        "<style>\n"
        ".raphael-group-7-background rect {\n"
        "fill: rgb(218, 218, 218) !important;\n"
        "}\n"
        "[id*=flat-slider].ui-slider.ui-slider-vertical {\n"
        "\theight: 220px;\n"
        "\tmargin-top: 90px;\n"
        "    margin-right: 15%;\n"
        "    margin-bottom: 90px;\n"
        "    margin-left: 15%;\n"
        "}\n"
        "$bg: #434d5a;\n"
        "[id*=flat-slider].ui-slider,\n"
        "[id*=flat-slider].ui-slider .ui-slider-pip .ui-slider-line {\n"
        "    background: lighten($bg, 15%);\n"
        "}\n"
        "[id*=flat-slider].ui-slider .ui-slider-handle .ui-slider-tip:after {\n"
        "    border-left-color: #434d5a;\n"
        "}\n"
        "[id*=flat-slider].ui-slider .ui-slider-handle.ui-state-hover, \n"
        "[id*=flat-slider].ui-slider .ui-slider-handle.ui-state-focus, \n"
        "[id*=flat-slider].ui-slider .ui-slider-handle.ui-state-active {\n"
        "      border-color: white; }\n"
        "body {\n"
```

```
"    font-family: \"Roboto\";\n"
"}\n"
".stuff {    \n"
"    padding: 10px 5px 5px;\n"
"    max-width: 150px;    \n"
"\tmax-height: 550px;    \n"
"}\n"
"div.inline { float:left; }\n"
".clearBoth { clear:both; }\n"
"\n"
"</style>\n"
"<script>\n"
"$(document).ready(function() {\n"
"            setInterval(\"get_motor_status()\", 2000);\n"
"        });\n"
"\t\t\t\t\n"
"        function get_motor_status() {\n"
"            var someUrl = \"/motor_status\";\n"
"            $.ajax({url: someUrl,dataType: \"text\",success: function(response) {\n"
"                    if (response == \"on\")\n"
"                        $(\"#status\").html(\"Motor OFF\")\n"
"                    else\n"
"                        $(\"#status\").html(\"Motor ON\")\n"
"                   }})}\t\t\n"
"\t\t\t\t\n"
"    </script>\n"
"\t\n"
"<script type=\"text/javascript\">\n"
"    FusionCharts.ready(function(){\n"
"    var fusioncharts = new FusionCharts({\n"
"    \"type\": \"cylinder\",\n"
"    \"dataFormat\": \"json\",\n"
"    \"id\": \"fuelMeter\",\n"
"    \"renderAt\": \"chart-container\",\n"
"    \"width\": \"200\",\n"
"    \"height\": \"350\",\n"
"    \"dataSource\": {\n"
"        \"chart\": {\n"
"            \"theme\": \"fint\",\n"
"            \"caption\": \"Water Level in Bucket\",\n"
"            \"subcaption\": \"at my Home\",\n"
"            \"lowerLimit\": \"0\",\n"
"            \"upperLimit\": \"1300\",\n"
"            \"lowerLimitDisplay\": \"Empty\",\n"
"            \"upperLimitDisplay\": \"Full\",\n"
"            \"numberSuffix\": \" milliltrs\",\n"
"            \"showValue\": \"1\",\n"
"            \"chartBottomMargin\": \"25\"\n"
"        },\n"
"        \"value\": \"10\"\n"
"    },\n"
"    \"events\": {\n"
"    \"rendered\": function(evtObj, argObj) {\n"
"\tsetInterval(function() {\n"
"\tvar someUrl = \"/level\";\n"
"\t\t\t\t\t$.ajax({\n"
"\t\t\t\t\t\turl: someUrl,\n"
"\t\t\t\t\t\tdataType: \"text\",\n"
"\t\t\t\t\t\t\tsuccess: function(response) {\n"
"\t\t\t\t\t\t\t\t evtObj.sender.feedData(\"&value=\" + response);\n"
"\t\t\t\t\t\t\t},\n"
"\t\t\t\t\t\t\ttimeout: 2000\n"
"\t\t\t\t\t\t})\t\n"
"\t\t\n"
"        }, 1000); \n"
"   }\n"
"}\n"
"});\n"
"    fusioncharts.render();\n"
"    });\n"
"</script>\n"
"</head>\n"
"<body>\n"
                 "<table border=0>\n"
                    "<tr>\n"
                      "<td width=225>\n"
                      "<img  src=\"https://scontent.febl4-1.fna.fbcdn.net/v/t1.0-9/32222288_1940777282634167_4529700783578415104_n.jpg?_nc_cat=104&amp;_nc_oc=AQmtUUTequ2xAbkxsXDBRocsm7FIo7aRsBUL5tqPAijUa0abPSx5lutLajEVSPRbYGs&amp;_nc_ht=scontent.febl4-1.fna&amp;oh=fbc342ef9a45b062fef9e61860c53fe8&amp;oe=5D3B0685\" width=\"225\" height=\"225\"  >\n"
                      "</td>\n"
                    "<td style=\"text-align:center;\">\n"
                    "Muhamed Isam <br>\n"
                    "Onel Fahmi <br>\n"
                    "Muhamed Khalil <br>\n"
                    "Havana Afram <br>\n"

                    "</td>\n"


                      "<td width=225 >\n"
                      "<img  src=\"https://scontent.febl4-1.fna.fbcdn.net/v/t1.0-9/22366265_1483845651663213_2336512078600181005_n.jpg?_nc_cat=103&_nc_oc=AQnW4qZSvrkcamxf0RfatRYPcp_0a8VYCDWadyTFTrNENyNjAnN8XornMFs11q2bo1o&_nc_ht=scontent.febl4-1.fna&oh=f58f3d933fa20648a7f27f170e2297bb&oe=5D2ECC40\" width=\"225\" height=\"225\"  >\n"
                      "</td>\n"
                    "</tr>\n"
                "</table>\n"
"<div style=\"width:600px;margin:auto;\">\n"
"\n"
"<div class=\"stuff\">\n"
" \n"
"    <main>        \n"
"        <div class=\"inline\" id=\"flat-slider-vertical-1\"></div> \n"
"    </main>\n"
"    \n"
"</div>\n"
"    <div style=\"margin-left: 10px;\" class=\"inline\" id=\"chart-container\">AA</div>\n"
"\t<div class=\"inline\" id=\"status\" style=\"background-color: lightgrey;\n"
```

```
"    width: 100px;\n"
"    border: 10px solid;\n"
"\tborder-color: coral;\n"
"    padding: 2px;\n"
"    margin: 1px;\">Motor OFF</div>\n"
" </div>\n"
"\n"
"<script>\n"
"$.extend( $.ui.slider.prototype.options, { \n"
"    animate: 300\n"
"});\n"
"\n"
"\n"
"$(\"#flat-slider-vertical-1\")\n"
"\t\t\n"
"\t\tslide: function( event, ui ) {\n"
"\t\tconsole.log(ui.values);\n"
"\t\tvar someUrl = \"/configRange?lower=\" + ui.values[0]+\"&upper=\"+ui.values[1];\n"
"            $.ajax(\n"
"\t\t\t{\n"
"\t\t\t\turl: someUrl,dataType: \"text\",success: function(response) {}\n"
"\t\t\t})                \n"
"        }\n"
"    })\n"
"    .slider(\"pips\", {\n"
"        first: \"pip\",\n"
"        last: \"pip\"\n"
"    })\n"
"    .slider(\"float\");\n"
"</script>\n"
"\n"
"\t</body>\n"
"</html>"
  };
//create new adafruit IO feed and name it as 'waterLevel'
//uncomment these two lines and write your wifi ssid/password
const char* ssid = "Muhamed Barzanji";//type your ssid
const char* password = "abc1234567";//type your password
//also uncomment and write here your own adafruit IO username and key.
#define AIO_USERNAME    "Muhamedbarzanji"//replace it with your username
#define AIO_KEY         "d3d150d9c7b148ccb02510fa58ae0eba"//replace it with your key
//uncomment these lines as well, write radius of tank and total height in units of inches,
#define RADIUS 2.17
#define MAX_HEIGHT 5.67
//modify this line if you have to connect relay to some pin other than D4
#define MOTOR_CONTROL_PIN D0
//Connect trig of ultrasonic sensor at D1 and echo at D2, modify this line otherwise
const int trigPin = 2;
const int echoPin = 0;
UltraSonicDistanceSensor distanceSensor(trigPin, echoPin); //D1 trig, D2=echo
```

```
//these are default water level limits, these values will be applied until on reset until user sends new limits from webpage.
int waterLevelLowerThreshold = 100;
int waterLevelUpperThreshold = 900;


#define AIO_SERVER      "io.adafruit.com"
#define AIO_SERVERPORT  1883                   // use 8883 for SSL
float volume;
float liters, milliliters;
// Create an ESP8266 WiFiClient class to connect to the MQTT server.
WiFiClient client;
// or... use WiFiFlientSecure for SSL
//WiFiClientSecure client;

// Setup the MQTT client class by passing in the WiFi client and MQTT server and login details.
Adafruit_MQTT_Client mqtt(&client, AIO_SERVER, AIO_SERVERPORT, AIO_USERNAME, AIO_KEY);
Adafruit_MQTT_Publish waterLevel = Adafruit_MQTT_Publish(&mqtt, AIO_USERNAME "/feeds/waterLevel");

/*************************** Sketch Code ************************************/

// Bug workaround for Arduino 1.6.6, it seems to need a function declaration
// for some reason (only affects ESP8266, likely an arduino-builder bug).
void MQTT_connect();


String inputString = "";         // a string to hold incoming data
String dataToSend = "";
int waterLevelDownCount = 0, waterLevelUpCount = 0;

ESP8266WebServer server(80);
void handleRoot() {
  server.send_P(200, "text/html;charset=UTF-8", index_html);
}

void handleLevelRequest() {
  server.send(200, "text", String(milliliters));
}

void handleNotFound() {
  String message = "File Not Found\n\n";
  server.send(404, "text/plain", message);
}
void handleStatus()
{
   if(digitalRead(MOTOR_CONTROL_PIN)==1)//MOTOR ON
  server.send(200, "text/plain", "on");
   if(digitalRead(MOTOR_CONTROL_PIN)==0) {server.send(200, "text/plain","off");}
}
void handleRangeSetting() {
  waterLevelLowerThreshold = (server.arg(0)).toInt();
  waterLevelUpperThreshold = (server.arg(1)).toInt();
  Serial.print(waterLevelLowerThreshold);
  Serial.print(":");
  Serial.println(waterLevelUpperThreshold);

  server.send(200, "text/plain", "");
}

void measure_Volume()
{
  float heightInch = 0.393701 * distanceSensor.measureDistanceCm();
  Serial.println(heightInch);
  if (heightInch > MAX_HEIGHT)
    heightInch = MAX_HEIGHT;
  if (heightInch < 0)
    heightInch = 0;
  volume = 3.14 * RADIUS * RADIUS * (MAX_HEIGHT - heightInch); //MAX_HEIGHT-distance will give actual height,
  liters = volume * 0.0164 ;
  milliliters = liters * 1000;
  Serial.println(milliliters);

  waterLevel.publish(milliliters);


  if (milliliters<= waterLevelLowerThreshold)
  { //TURN ON RELAY
    Serial.println("motor turned on");
            digitalWrite(MOTOR_CONTROL_PIN,LOW);//Relay is active LOW
             lcd.setCursor(12, 0);
  lcd.print("ON");

  }
  if (milliliters>= waterLevelUpperThreshold)
  { //TURN OFF RELAY
    Serial.println("motor turned off");
      digitalWrite(MOTOR_CONTROL_PIN,HIGH);//Relay is active LOW
       lcd.setCursor(12, 0);
  lcd.print("OFF");
  }
}
void runPeriodicFunc()
{
  static const unsigned long REFRESH_INTERVAL1 = 2100; // 2.1sec
  static unsigned long lastRefreshTime1 = 0;

  if (millis() - lastRefreshTime1 >= REFRESH_INTERVAL1)
  {
    measure_Volume();
    lastRefreshTime1 = millis();
  }
}

void MQTT_connect() {
  int8_t ret;

  // Stop if already connected.
  if (mqtt.connected()) {
    return;
  }

  Serial.print("Connecting to MQTT... ");

  while ((ret = mqtt.connect()) != 0) { // connect will return 0 for connected
    Serial.println(mqtt.connectErrorString(ret));
    Serial.println("Retrying MQTT connection in 5 seconds...");
    mqtt.disconnect();
    delay(5000);  // wait 5 seconds
  }
  Serial.println("MQTT Connected!");
}


void setup(void) {

  Wire.begin(D2, D1);

  lcd.begin();

  lcd.home();
  Serial.begin(115200);
  delay(100);
 pinMode(MOTOR_CONTROL_PIN, OUTPUT);
  WiFi.begin(ssid, password);
  Serial.println("");

  while (WiFi.status() != WL_CONNECTED) {
    delay(500);
    Serial.print(".");
  }
  Serial.print("IP address:");
  Serial.println(WiFi.localIP());

  server.on("/", handleRoot);
  server.on("/level", handleLevelRequest);
  server.on("/configRange", handleRangeSetting);
  server.on("/motor_status", handleStatus);

  server.onNotFound(handleNotFound);

  server.begin();
  Serial.println("HTTP server started");
}

void loop(void) {
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("Liquid");
  lcd.setCursor(0, 1);
  lcd.print(milliliters);
  lcd.setCursor(5, 1);
  lcd.println("ml             ");
  delay(250);

  runPeriodicFunc();

  MQTT_connect();
  server.handleClient();
```

```
    delay(25);
  }

```

Chapter four

Results and conclusion

4.1 Results

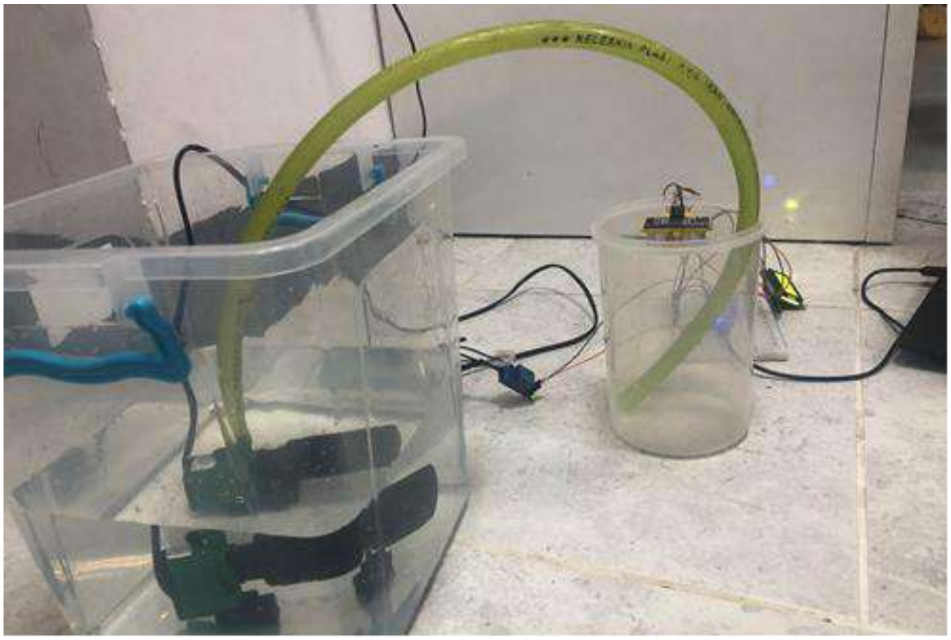


Fig 4.1 (The container is empty)

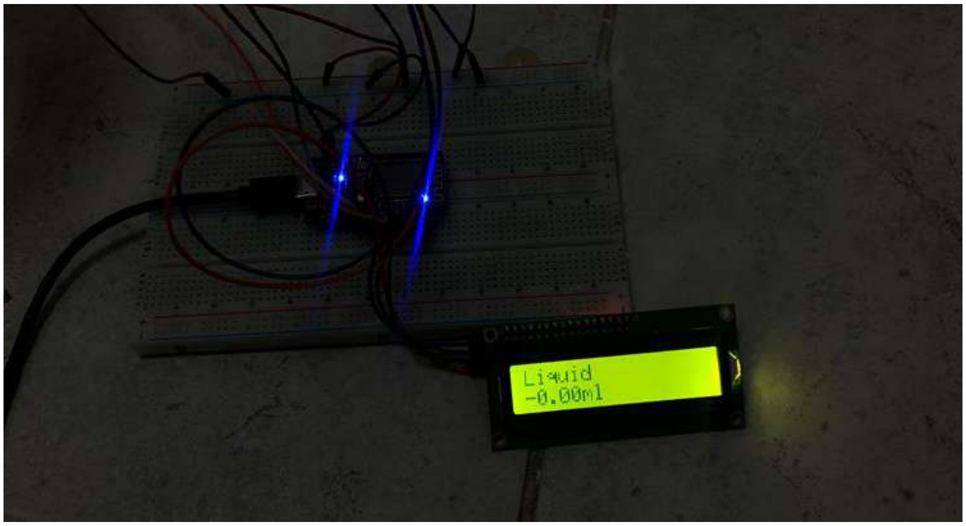


Fig 4.2 (LCD display shows the container is empty)

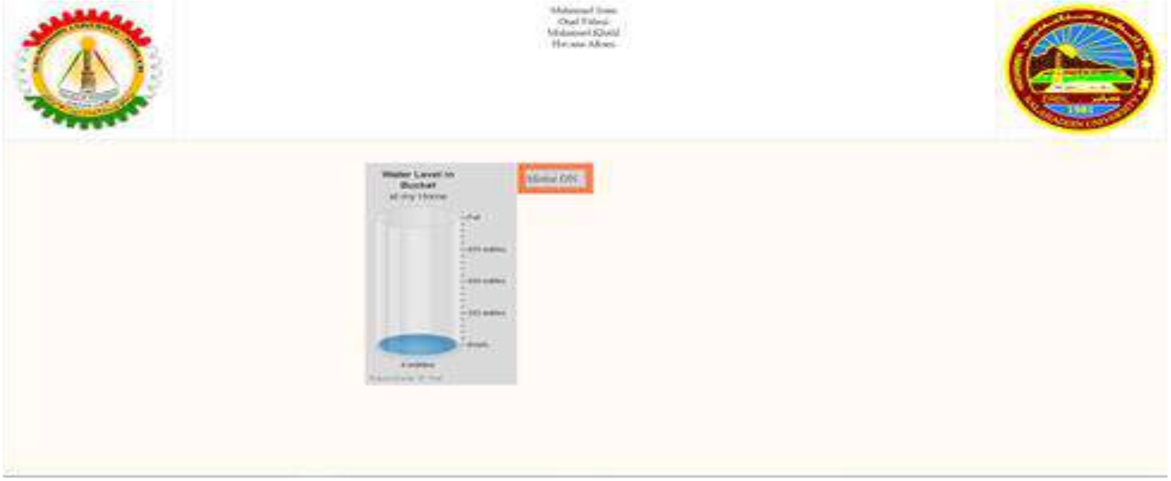


Fig 4.3 (The website showing the container is empty)

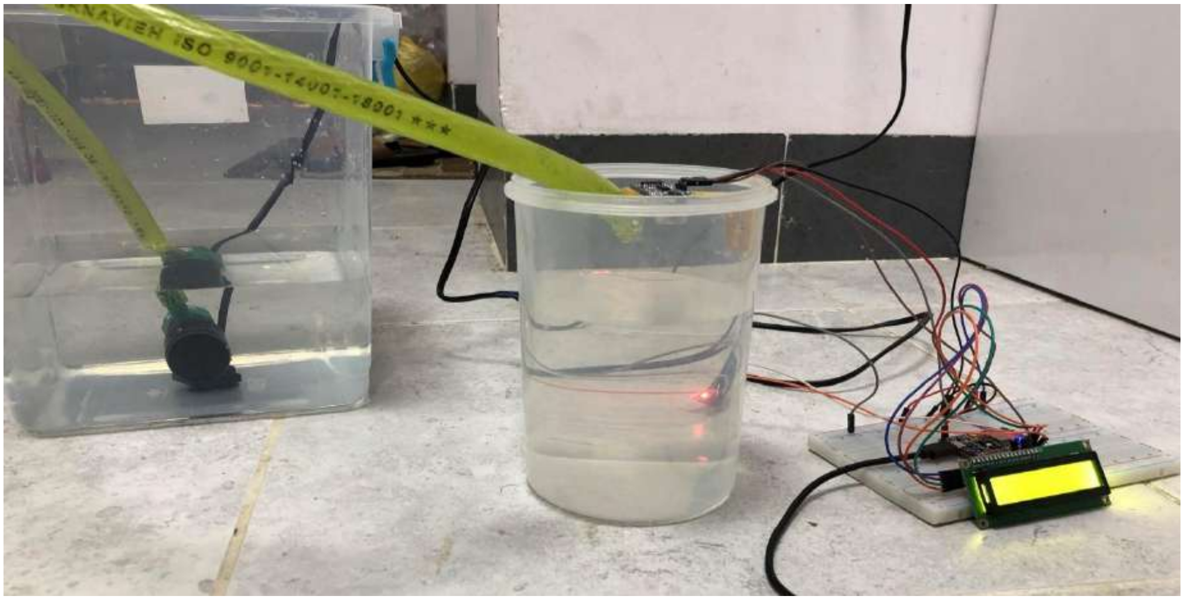


Fig 4.4 (The container is filled)

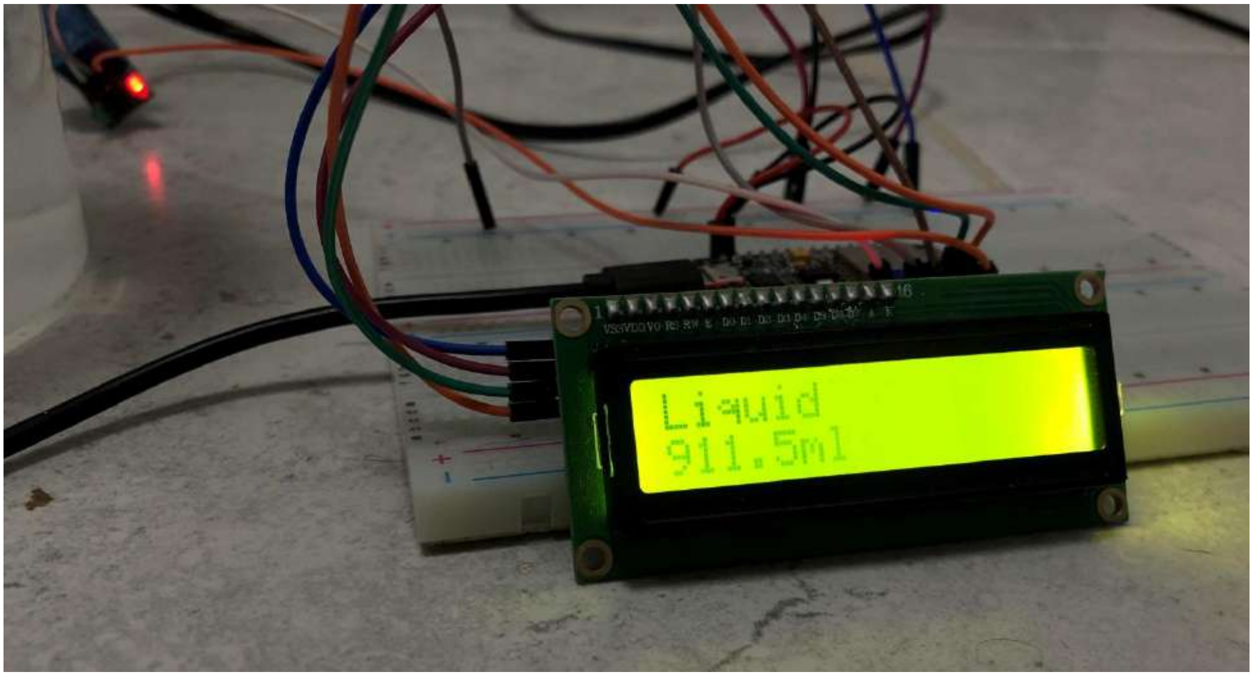
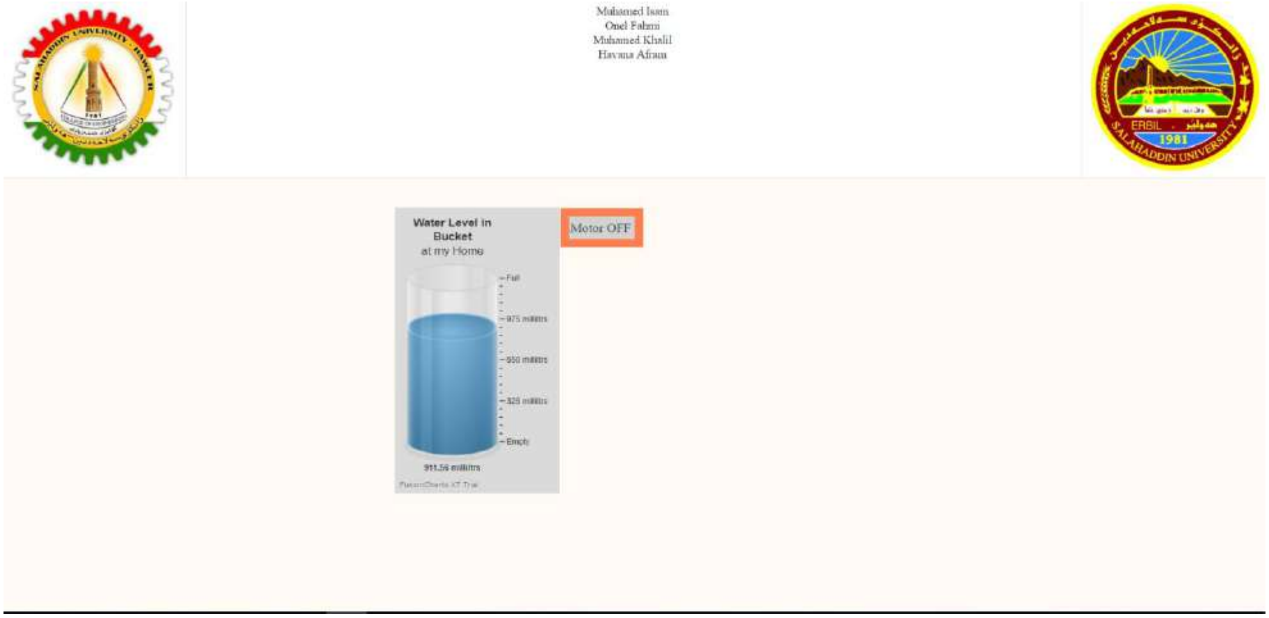


Fig 4.5 (LCD display showing the level of liquid on the container)



Muhamed Isam
Omel Fahmi
Muhamed Khalil
Havana Afram

Fig 4.6 (The website showing the level of liquid on the container)

After several trails the errors where solved which were from the quality of the board and from connecting and uploading the liquid level to the server. The main requirement for this system is a good internet which needs to be provided to avoid the delay in uploading the liquid level to the webpage, because the rate of the data transfer is dependent on the rate of the internet. The delay in uploading the liquid level in our system is very low which does not exceed 5s if good internet was used as mentioned before.

4.2 Conclusion

This system will have a wide use in the society if good and high quality tools were used because it makes monitoring easier. It can be used for any type of liquid and any type of containers as long as the dimensions are measured accurately and the right tools are used.

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