

Developing an IoT Based Water Pollution Monitoring System

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Introduction

- Water is a special kind of ecological resource which is a foundation to support the ecosystem on earth.
- It is used in various activities, such as consumption, agriculture and industry, which may affect water quality.
- About 13,700 people die each day from polluted water diseases.
- By making use of the full potential of IoT, It would be possible to prevent individuals from drinking polluted water.



Related Works

↓ The Design of Multi-Parameter Online Monitoring System of Water Quality Based on GPRS.

(Quio Tie-Zhn, 2010)

➤ Work Done:

- Used multi-parameter for water's pollution monitoring system.

i.e. pH, Temperature, COD and TOC.

- Used GPRS for data transmission.

➤ Limitation:

- Used PC instead of microcontroller only for sensors.

- Used 2G technology, i.e. GPRS (56 up to 114 Kbps).



Related Works (Contd.)

➤ **Web Based Water Quality Monitoring with Sensor Network: Employing ZigBee and WiMax Technologies. (Kamal Alameh, 2011)**

➤ Work Done:

- Developed WSN was comprehensively tested in practical area.

➤ Limitation:

- Used ZigBee (maximum speed is just 250kbps) and WiMax both, instead of Wi-Fi.



Related Works (Contd.)

➤ **Real-time environmental sensor data: An application to water quality using web services (Branko Kerkez , 2016)**

➤ Work Done:

- Used 'NeoMote', a programmable system on chip for field deployment.
- Used 'Antelope', an integrated collection of programs for data collection.

➤ Limitation:

- Measures only depth and conductivity of water.



Objectives

- To develop an IoT system and a data server for monitoring water pollution in real time.
- To develop an inexpensive as well as economically affordable device for common people.
- To build an android app for real time data visualization.



Methodology

↓ The overall system is subdivided into three phase. These are:

1. **Physical Phase:** Consist of Sensors, Data Analysis & Communication Module.
2. **Service Phase:** Stores data and Provides tools for analyzing data.
3. **Presentation Phase:** Visualizes the Information to the User and allows user to interact with the system.



Methodology (Contd.)

→ Physical Phase:

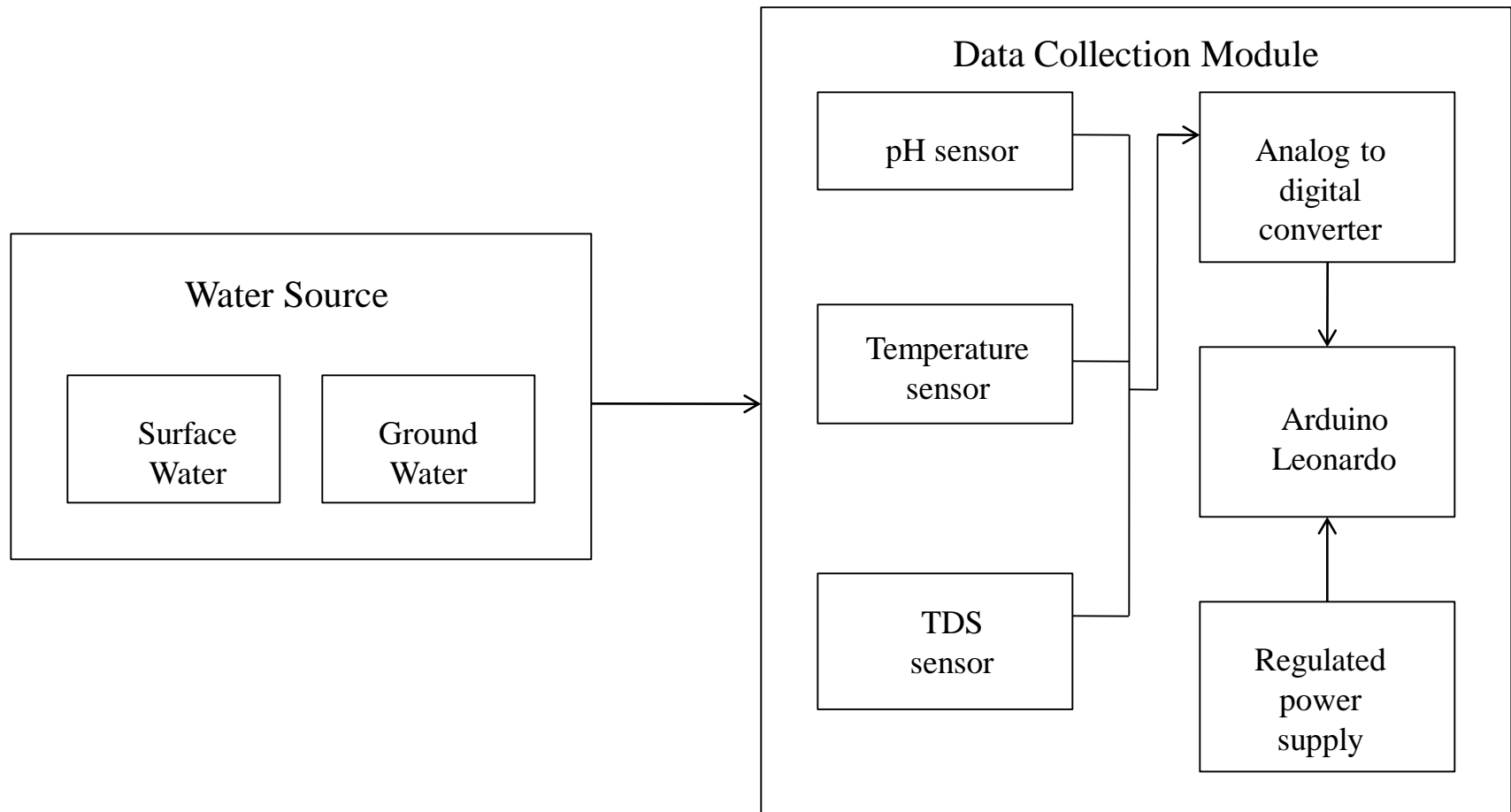


Figure 1: Water Source & Data Collection Module.



Methodology (Contd.)

→ Physical Phase:

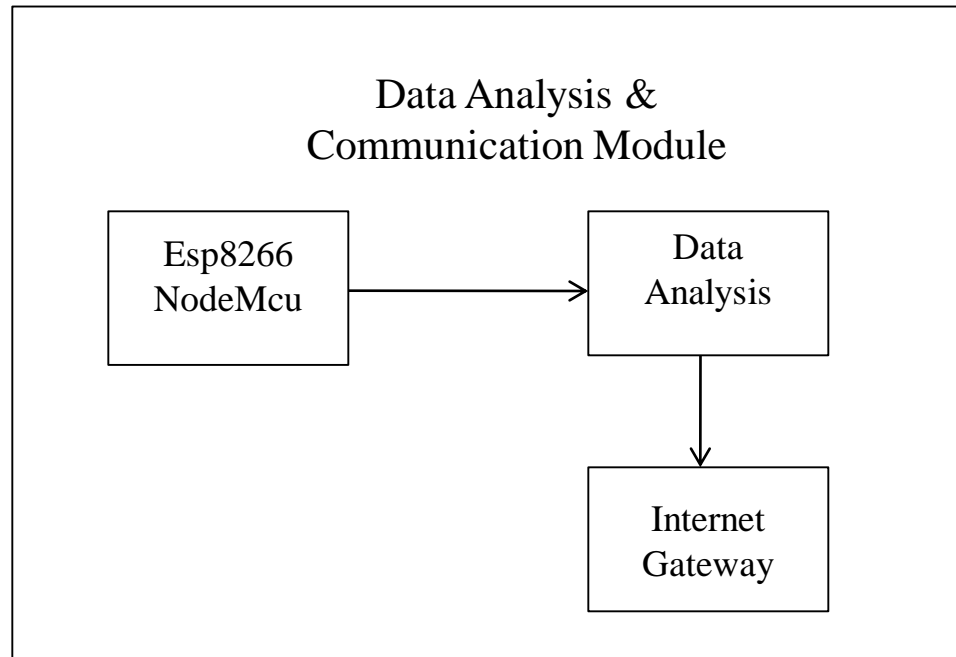


Figure 2: Data Analysis & Communication module.



Methodology (Contd.)

→ Service Phase:

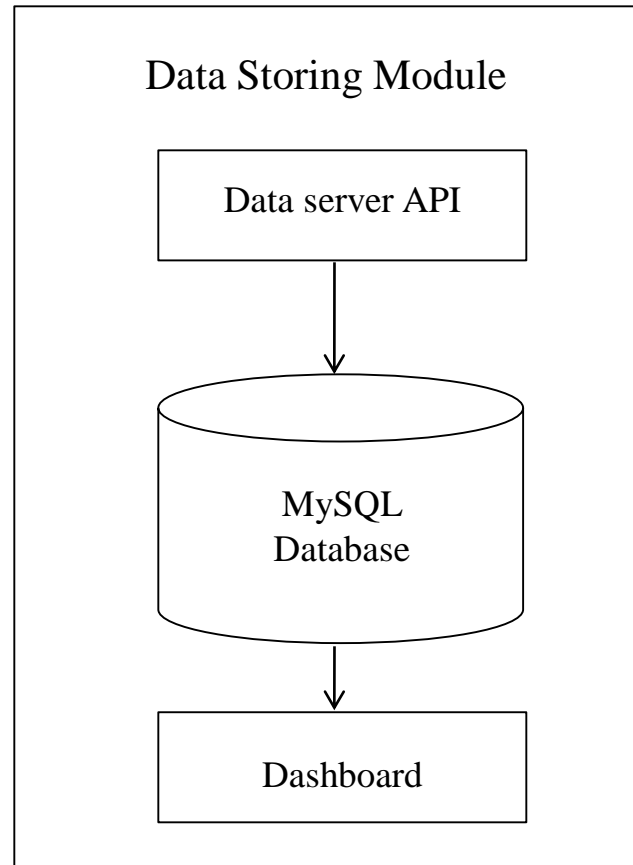


Figure 3: Data Storing Module.



Methodology (Contd.)

➤ Presentation Phase:

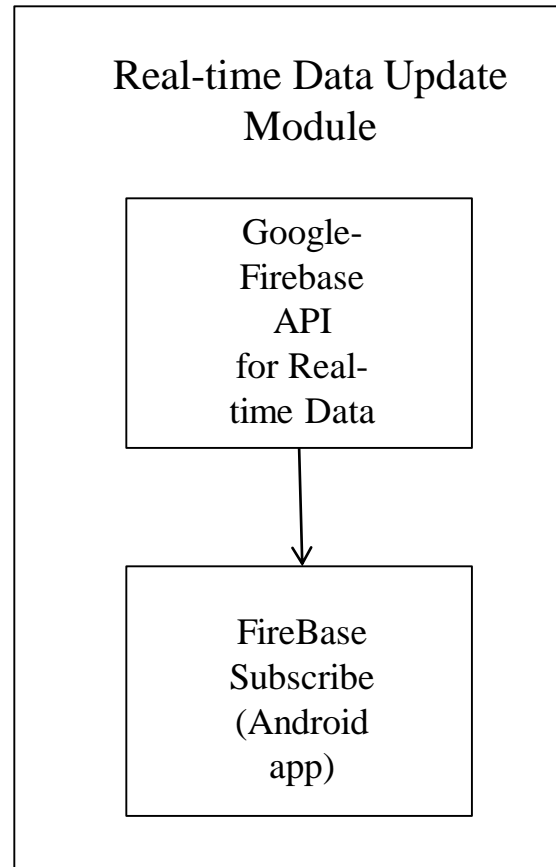


Figure 4: Data visualization module.



Methodology (Contd.)

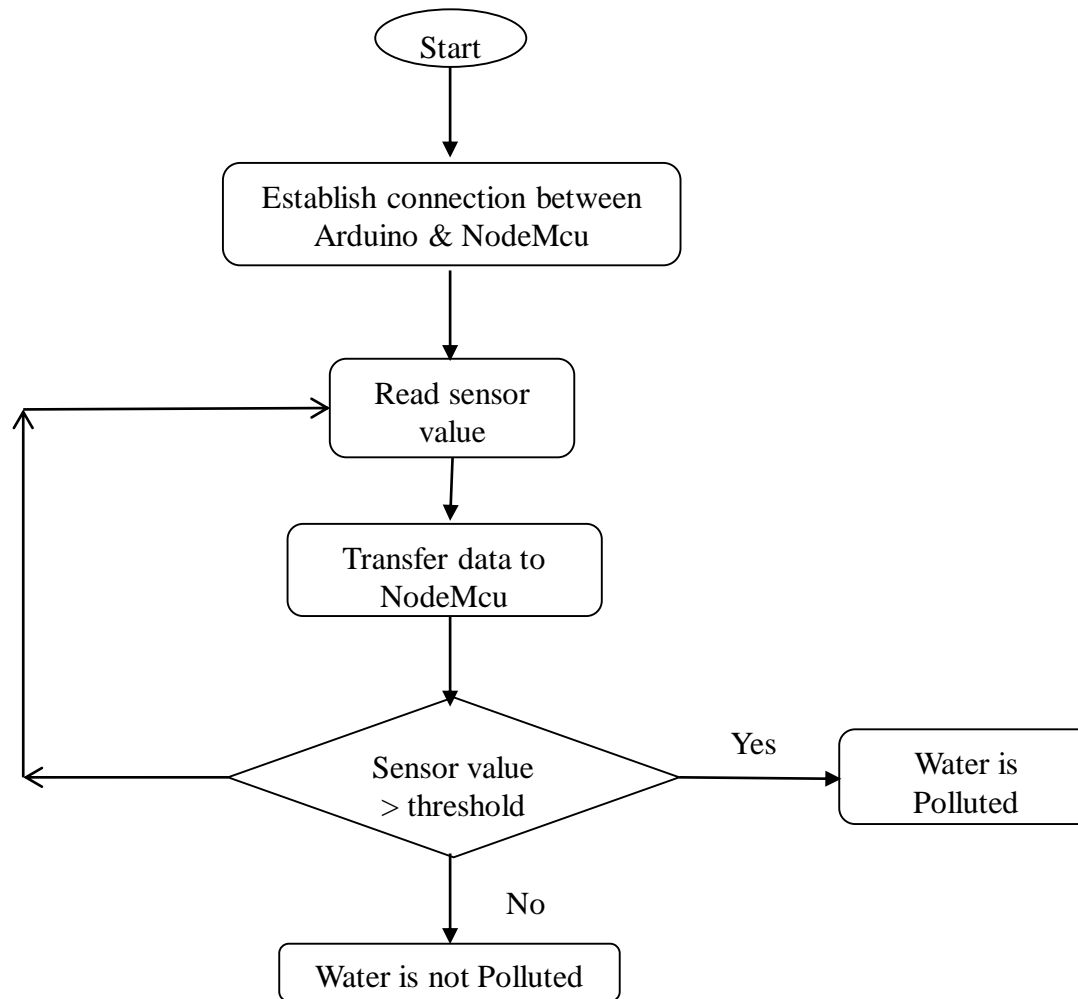
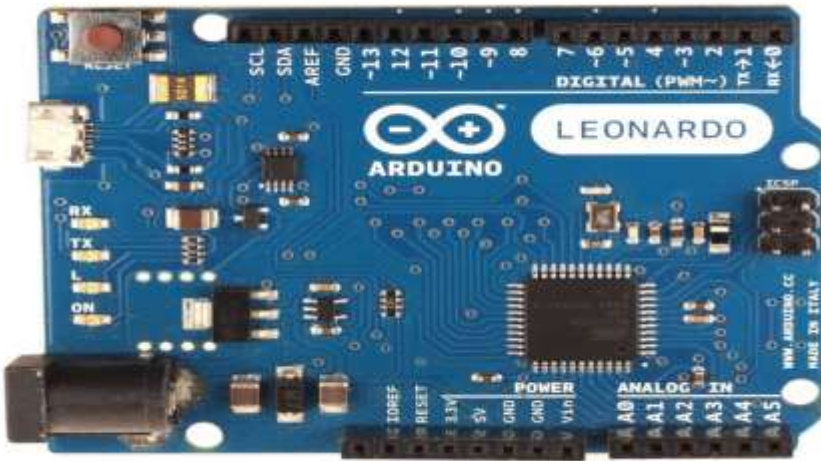


Figure 5: Flowchart representation of data analysis & communication module.



Implementation

→ Hardware:



a) Arduino Leonardo

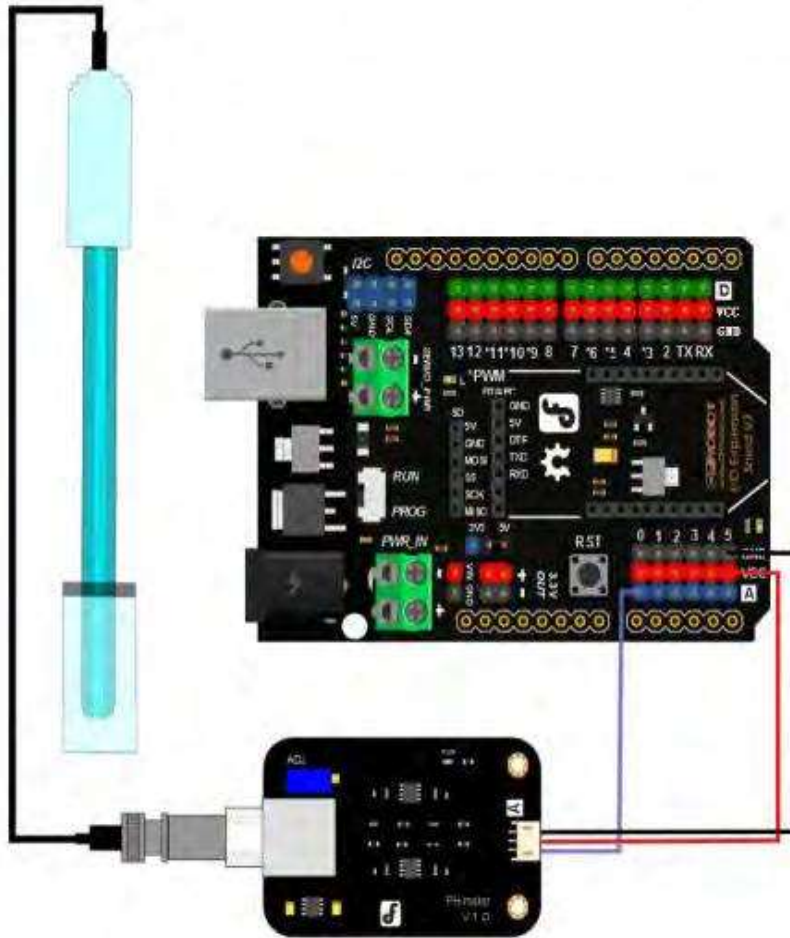


b) Esp8266 NodeMcu

Figure 6: Arduino Leonardo & NodeMcu.



Implementation (Contd.)



SL	Max	Min	Comment
1.	9.0	6.5	Natural Water
2.	6.5	4.5	Slightly Acid
3.	4.5	<4.5	Very Acid
4.	11.5	9.0	Slightly Alkaline
5.	>11.5	11.5	Very Alkaline

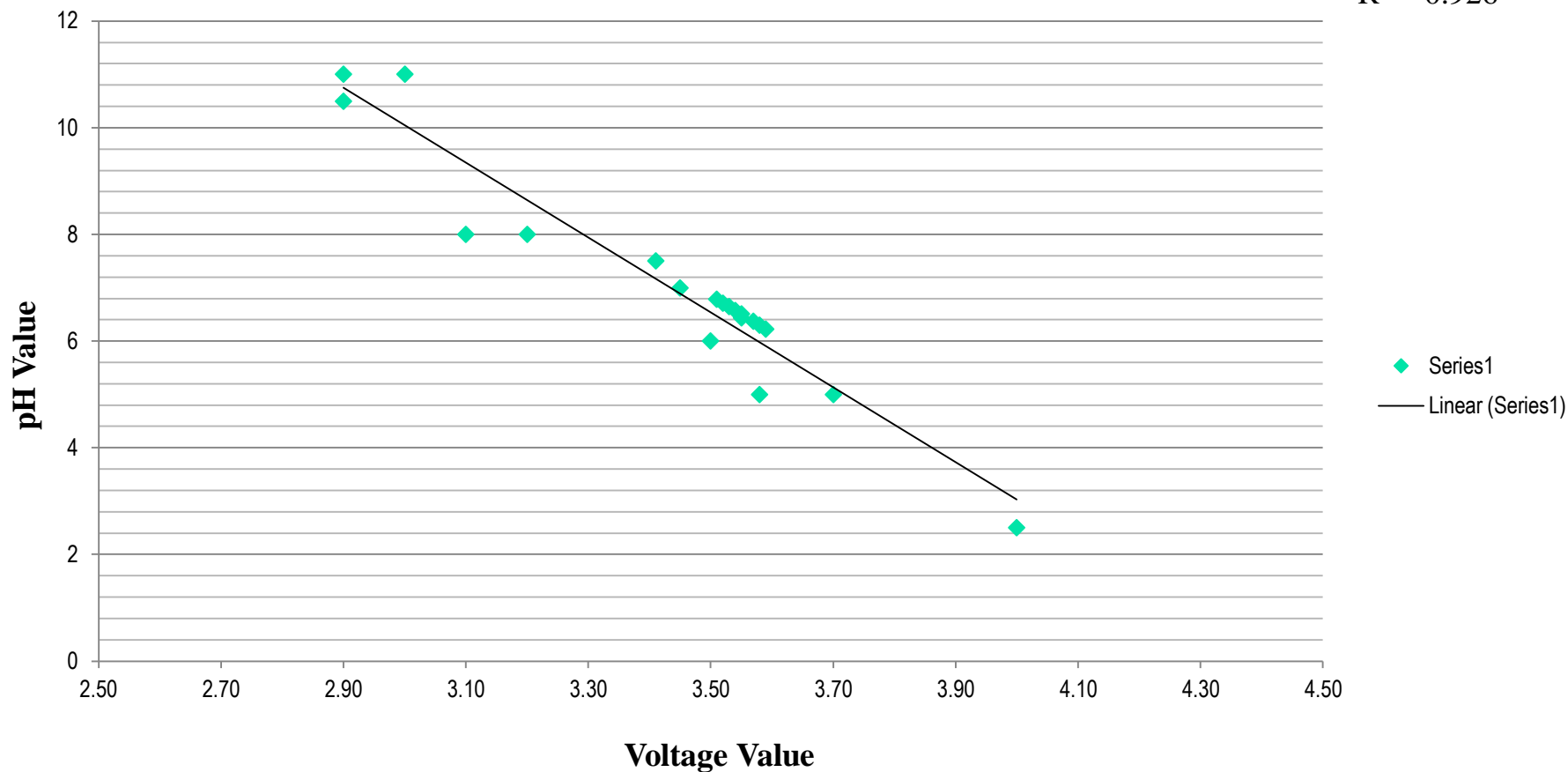
Figure 7: pH Sensor



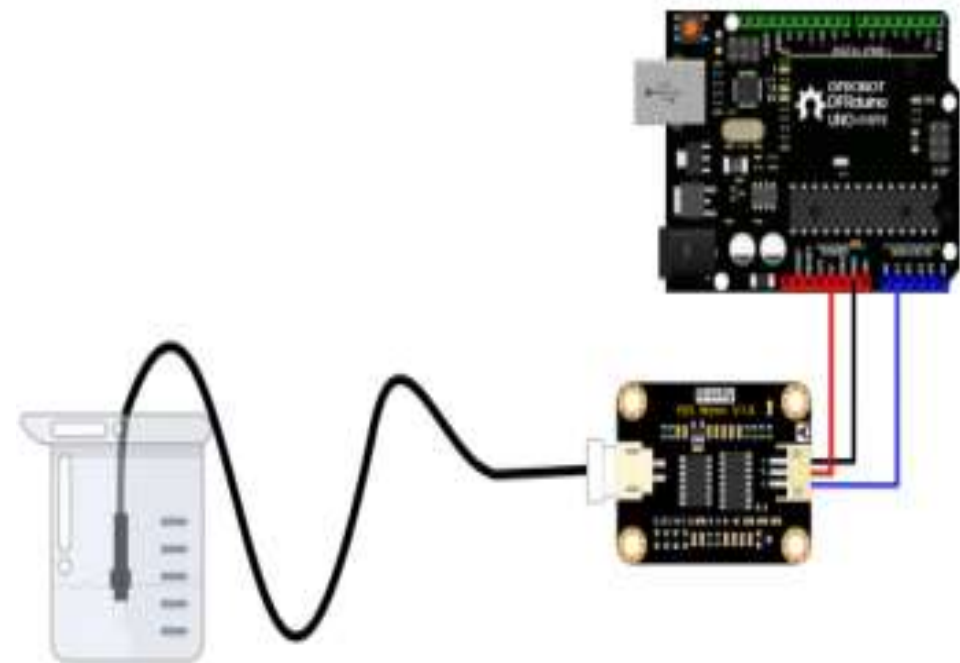
Implementation (Contd.)

pH Calibration

$$y = -7.027x + 31.133$$
$$R^2 = 0.926$$



Implementation (Contd.)



SL	Max	Min	Comment
1.	400	<400	Excellent
2.	600	400	Good
3.	900	600	Fair
4.	1200	900	Poor
5.	>1200	1200	Unacceptable

Figure 9: TDS Sensor

Implementation (Contd.)

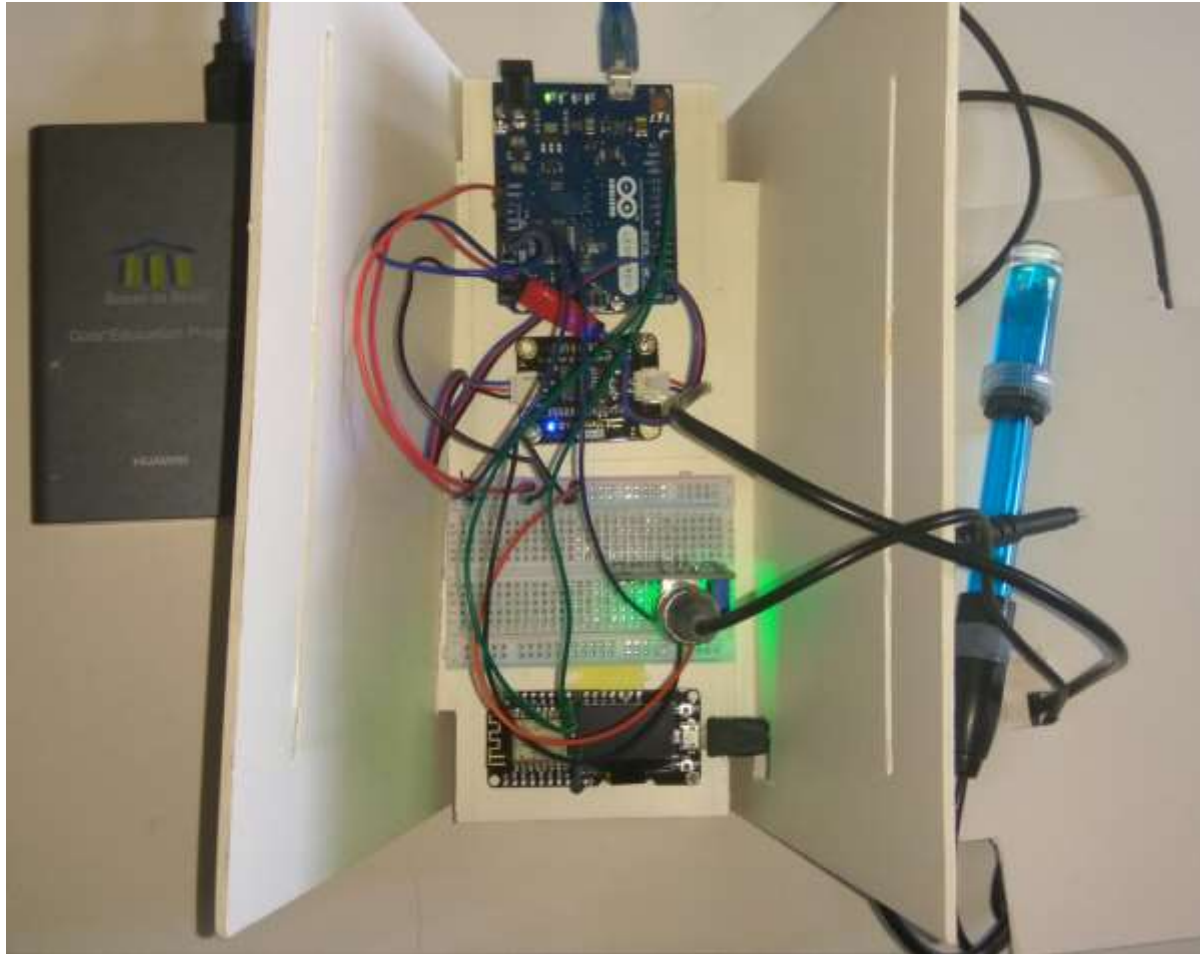
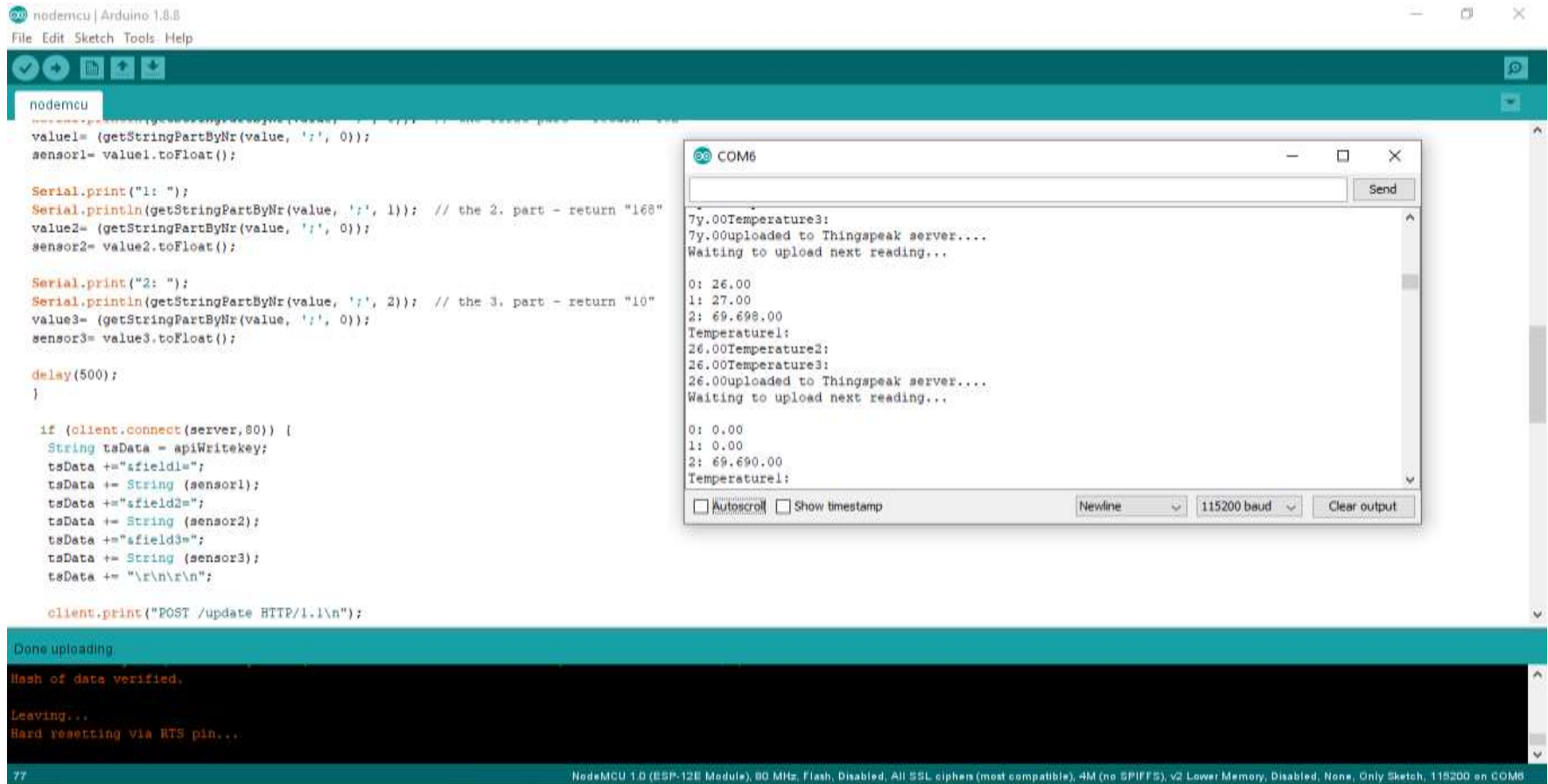


Figure 10: Top View of this Device



Implementation

➤ Software:



The screenshot displays the Arduino IDE interface with the NodeMcu board selected. The code in the editor is for an ESP8266 module, parsing a JSON string and sending data to a Thingspeak server. The serial monitor window, titled 'COM6', shows the output of the code, including sensor readings and server upload status.

```
nodemcu | Arduino 1.8.8
File Edit Sketch Tools Help

nodemcu
// ...
value1= (getStringPartByNr(value, ':', 0));
sensor1= value1.toFloat();

Serial.print("1: ");
Serial.println(getStringPartByNr(value, ':', 1)); // the 2. part - return "168"
value2= (getStringPartByNr(value, ':', 0));
sensor2= value2.toFloat();

Serial.print("2: ");
Serial.println(getStringPartByNr(value, ':', 2)); // the 3. part - return "10"
value3= (getStringPartByNr(value, ':', 0));
sensor3= value3.toFloat();

delay(500);
}

if (client.connect(server,80)) {
  String tsData = apiWritekey;
  tsData += "sfield1=";
  tsData += String (sensor1);
  tsData += "sfield2=";
  tsData += String (sensor2);
  tsData += "sfield3=";
  tsData += String (sensor3);
  tsData += "\r\n\r\n";

  client.print("POST /update HTTP/1.1\r\n");
}

Done uploading.
Hash of data verified.
Leaving...
Hard resetting via RTS pin...

77 NodeMCU 1.0 (ESP-12E Module), 80 MHz, Flash, Disabled, All SSL cipher (most compatible), 4M (no SPIFFS), v2 Lower Memory, Disabled, None, Only Sketch, 115200 on COM6
```

Serial Monitor (COM6) Output:

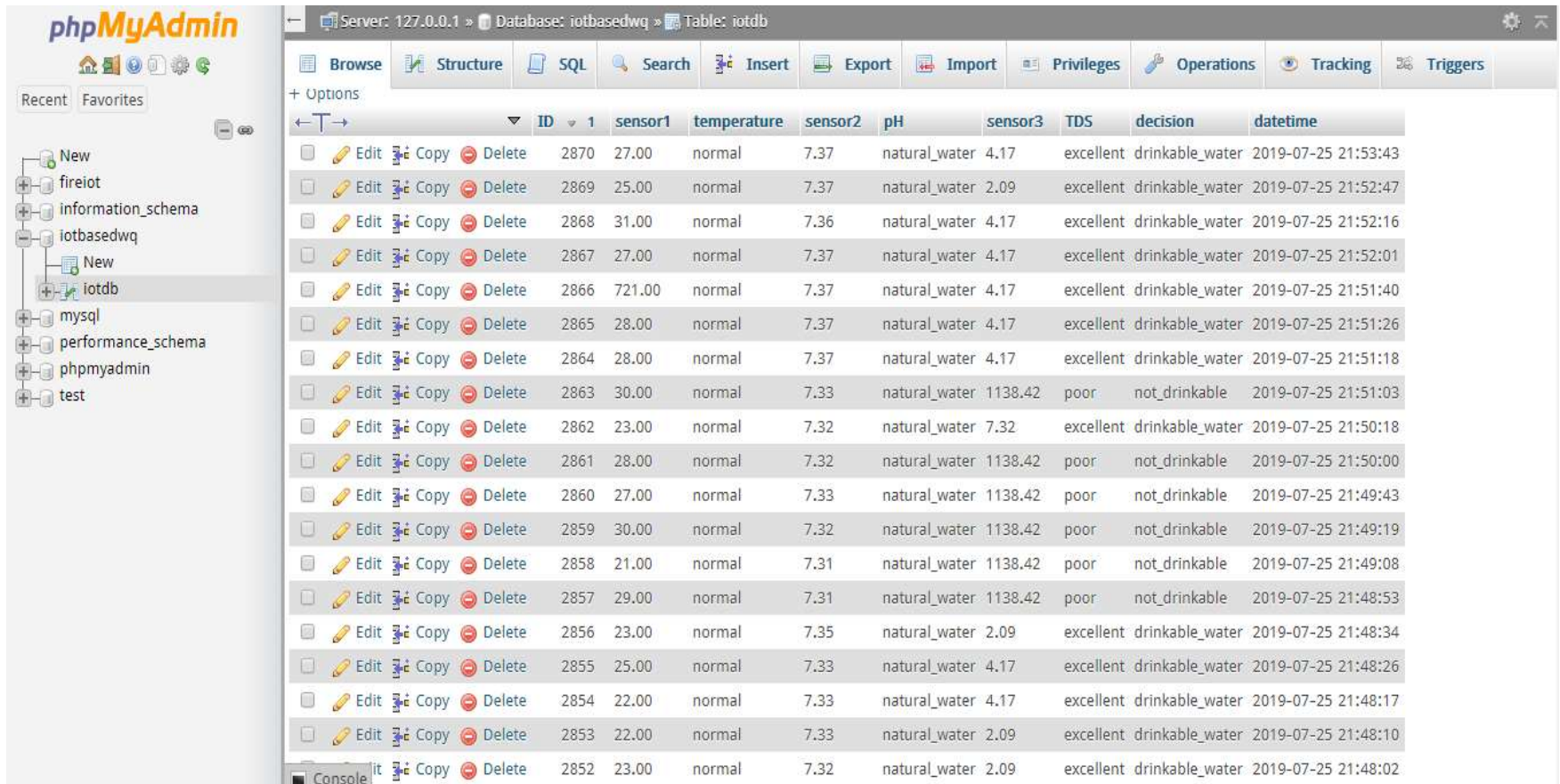
```
7y.00Temperature3:
7y.00Uploaded to Thingspeak server....
Waiting to upload next reading...

0: 26.00
1: 27.00
2: 69.698.00
Temperature1:
26.00Temperature2:
26.00Temperature3:
26.00Uploaded to Thingspeak server....
Waiting to upload next reading...

0: 0.00
1: 0.00
2: 69.690.00
Temperature1:
```

Figure 11: NodeMcu Coding in Arduino.cc IDE.

Implementation (Contd.)



The screenshot shows the phpMyAdmin interface. On the left is the sidebar with a tree view of databases: fireiot, information_schema, iotbasedwq (selected), mysql, performance_schema, phpmyadmin, and test. The main panel displays the 'Table: iotdb' structure. The table has 11 columns: ID, sensor1, temperature, sensor2, pH, sensor3, TDS, decision, and datetime. The data rows show various sensor readings and their corresponding decisions (e.g., 'drinkable_water' or 'not_drinkable').

ID	sensor1	temperature	sensor2	pH	sensor3	TDS	decision	datetime
2870	27.00	normal	7.37	natural_water	4.17	excellent	drinkable_water	2019-07-25 21:53:43
2869	25.00	normal	7.37	natural_water	2.09	excellent	drinkable_water	2019-07-25 21:52:47
2868	31.00	normal	7.36	natural_water	4.17	excellent	drinkable_water	2019-07-25 21:52:16
2867	27.00	normal	7.37	natural_water	4.17	excellent	drinkable_water	2019-07-25 21:52:01
2866	721.00	normal	7.37	natural_water	4.17	excellent	drinkable_water	2019-07-25 21:51:40
2865	28.00	normal	7.37	natural_water	4.17	excellent	drinkable_water	2019-07-25 21:51:26
2864	28.00	normal	7.37	natural_water	4.17	excellent	drinkable_water	2019-07-25 21:51:18
2863	30.00	normal	7.33	natural_water	1138.42	poor	not_drinkable	2019-07-25 21:51:03
2862	23.00	normal	7.32	natural_water	7.32	excellent	drinkable_water	2019-07-25 21:50:18
2861	28.00	normal	7.32	natural_water	1138.42	poor	not_drinkable	2019-07-25 21:50:00
2860	27.00	normal	7.33	natural_water	1138.42	poor	not_drinkable	2019-07-25 21:49:43
2859	30.00	normal	7.32	natural_water	1138.42	poor	not_drinkable	2019-07-25 21:49:19
2858	21.00	normal	7.31	natural_water	1138.42	poor	not_drinkable	2019-07-25 21:49:08
2857	29.00	normal	7.31	natural_water	1138.42	poor	not_drinkable	2019-07-25 21:48:53
2856	23.00	normal	7.35	natural_water	2.09	excellent	drinkable_water	2019-07-25 21:48:34
2855	25.00	normal	7.33	natural_water	4.17	excellent	drinkable_water	2019-07-25 21:48:26
2854	22.00	normal	7.33	natural_water	4.17	excellent	drinkable_water	2019-07-25 21:48:17
2853	22.00	normal	7.33	natural_water	2.09	excellent	drinkable_water	2019-07-25 21:48:10
2852	23.00	normal	7.32	natural_water	2.09	excellent	drinkable_water	2019-07-25 21:48:02

Figure 12: MySql database for the proposed system.

Implementation (Contd.)

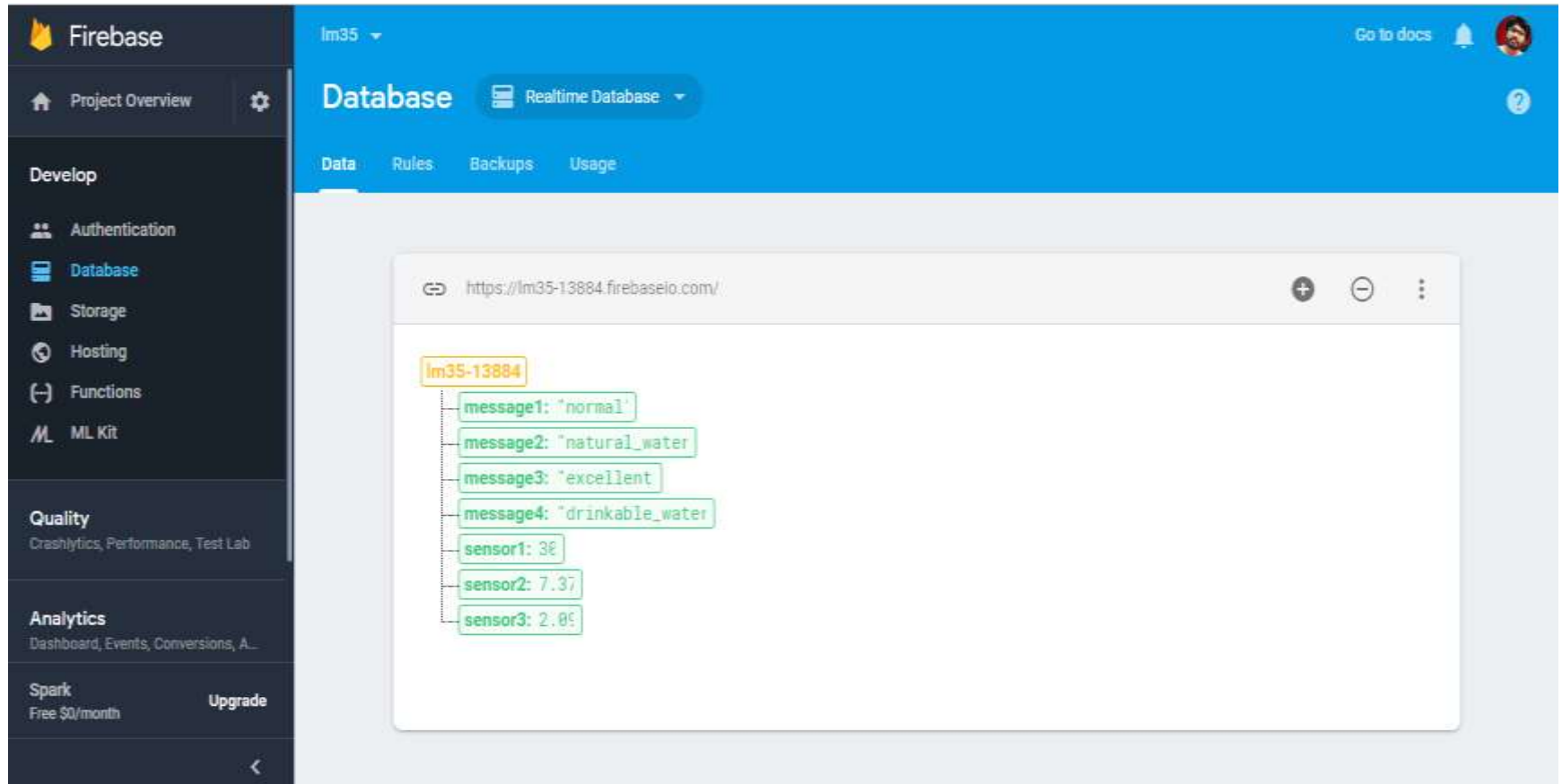
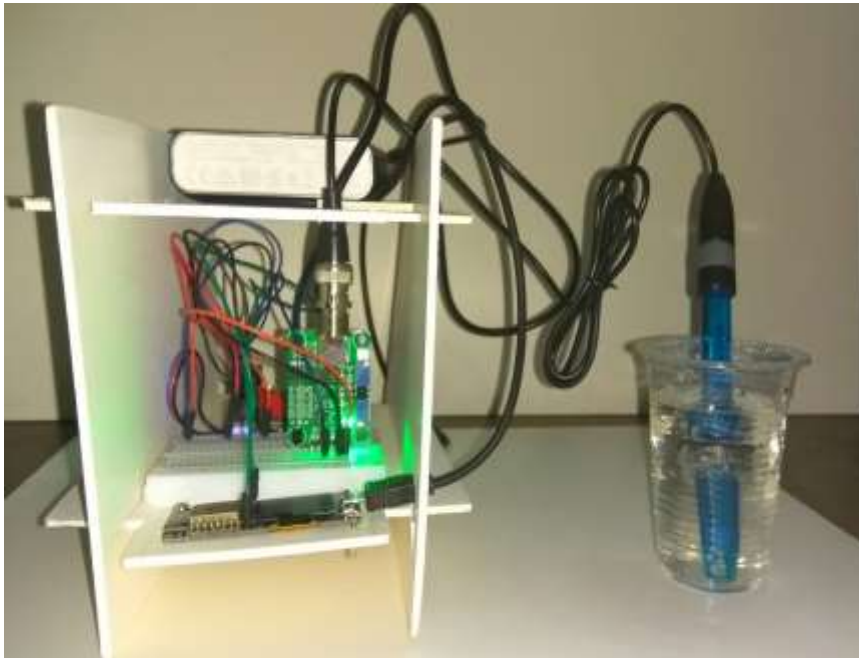


Figure 13: Google-Firebase for real-time data update.



Results



a) testing tap water pH, TDS and temperature value



b) data logger for the system.

Figure 14: Testing the tap water quality.

Results (Contd.)

Search by

ID ID Temperature Temperature pH pH TDS TDS Type of Water Water Type Date & Time Date & Time

IoT Based Water Quality Monitoring System								
ID	Temperature	Type of Temperature	pH	Type of pH	TDS	Type of TDS	Type of Water	Date & Time
2421	27.00	normal	8.45	natural_water	12.45	excellent	drinkable_water	2019-07-09 16:02:13
2420	29.00	normal	8.45	natural_water	12.45	excellent	drinkable_water	2019-07-09 16:02:08
2419	21.00	normal	8.47	natural_water	12.45	excellent	drinkable_water	2019-07-09 16:02:03
2418	29.00	normal	8.47	natural_water	12.45	excellent	drinkable_water	2019-07-09 16:01:57
2417	24.00	normal	8.46	natural_water	12.45	excellent	drinkable_water	2019-07-09 16:01:52
2067	23.00	normal	12.45	very_alkaline	22.00	excellent	not_drinkable	2019-07-09 15:19:48
1956	30.00	normal	8.32	natural_water	1160.88	poor	not_drinkable	2019-07-08 14:27:27
1955	23.00	normal	8.31	natural_water	1165.42	poor	not_drinkable	2019-07-08 14:27:21
1954	21.00	normal	8.29	natural_water	1165.42	poor	not_drinkable	2019-07-08 14:27:15
1953	24.00	normal	8.30	natural_water	1165.42	poor	not_drinkable	2019-07-08 14:27:10



Figure 15: Real-time datasheet for Sensor Value and Decision Parameter.



Results (Contd.)

➤ Accuracy:

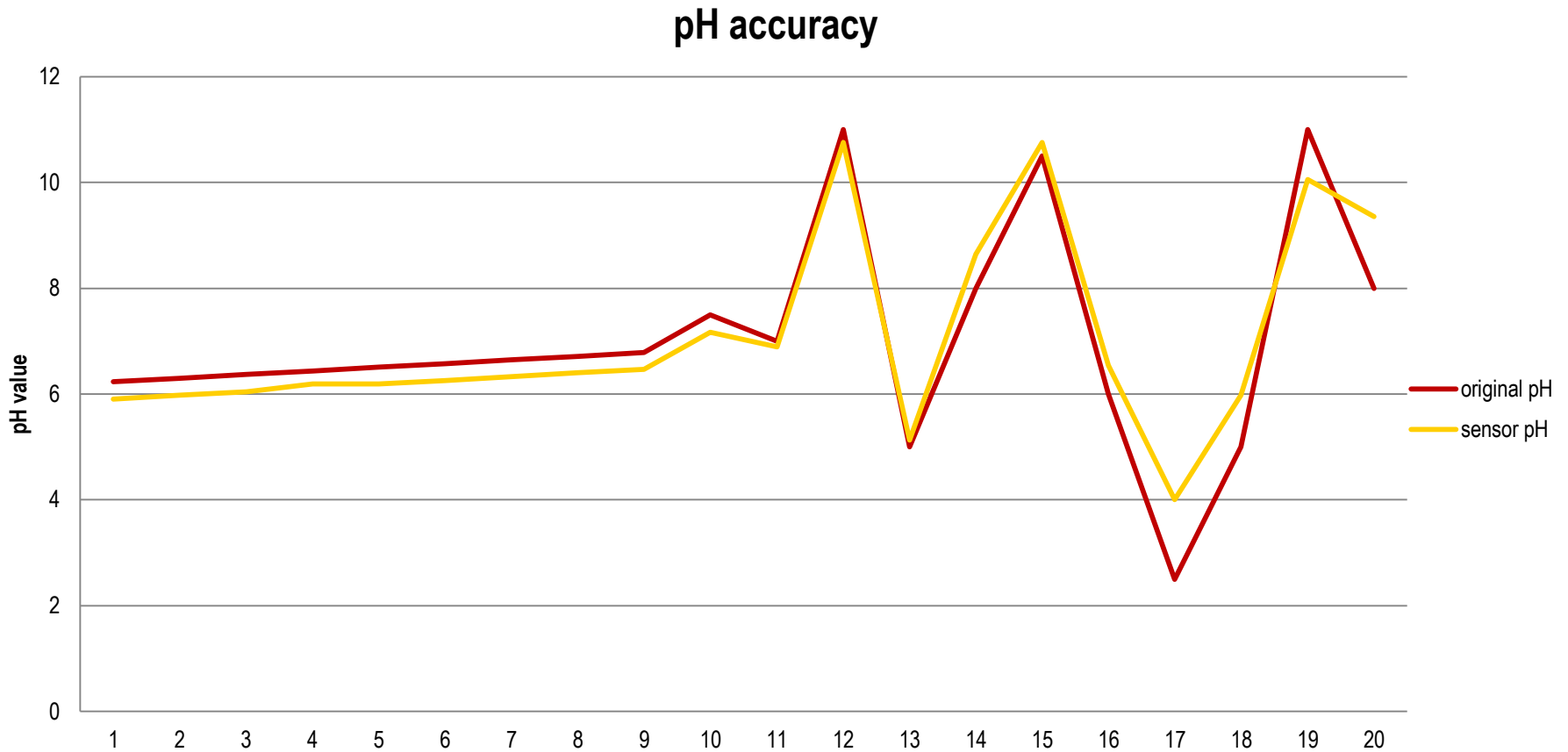


Figure 16: pH accuracy curve.



Advantages

➤ Advantages

- ✓ Due to automation it will reduce the time to measure the parameters.
- ✓ This is economically affordable for common people.
- ✓ Low maintenance.
- ✓ Prevention of water diseases.



Limitation

↘ Limitations

- Based on only three parameters: Temperature, pH, TDS.
- Type of water pollution could not be determined,
i.e. Chemical water pollution, suspended matter,
microbiological water pollution etc.
- Works over high-speed WiFi only.



Future Work

- Turbidity, electronic conductivity and Oxidation-Reduction Potential (ORP) can be quantified for more accuracy.
- Arsenic contamination can be identified using Machine learning.



Conclusion

- IoT based water pollution monitoring system has significant application scenarios in the context of smart cities.
- It ensures the reduced amount of time and energy required to provide analytical services.
- As developing countries have deficiency for socio-economic environment, So, In this project I have concentrated my thought on developing a low cost IoT device, that will ensure proper analysis of polluted water with the minimum amount of resources being available.



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The End

Thank You

