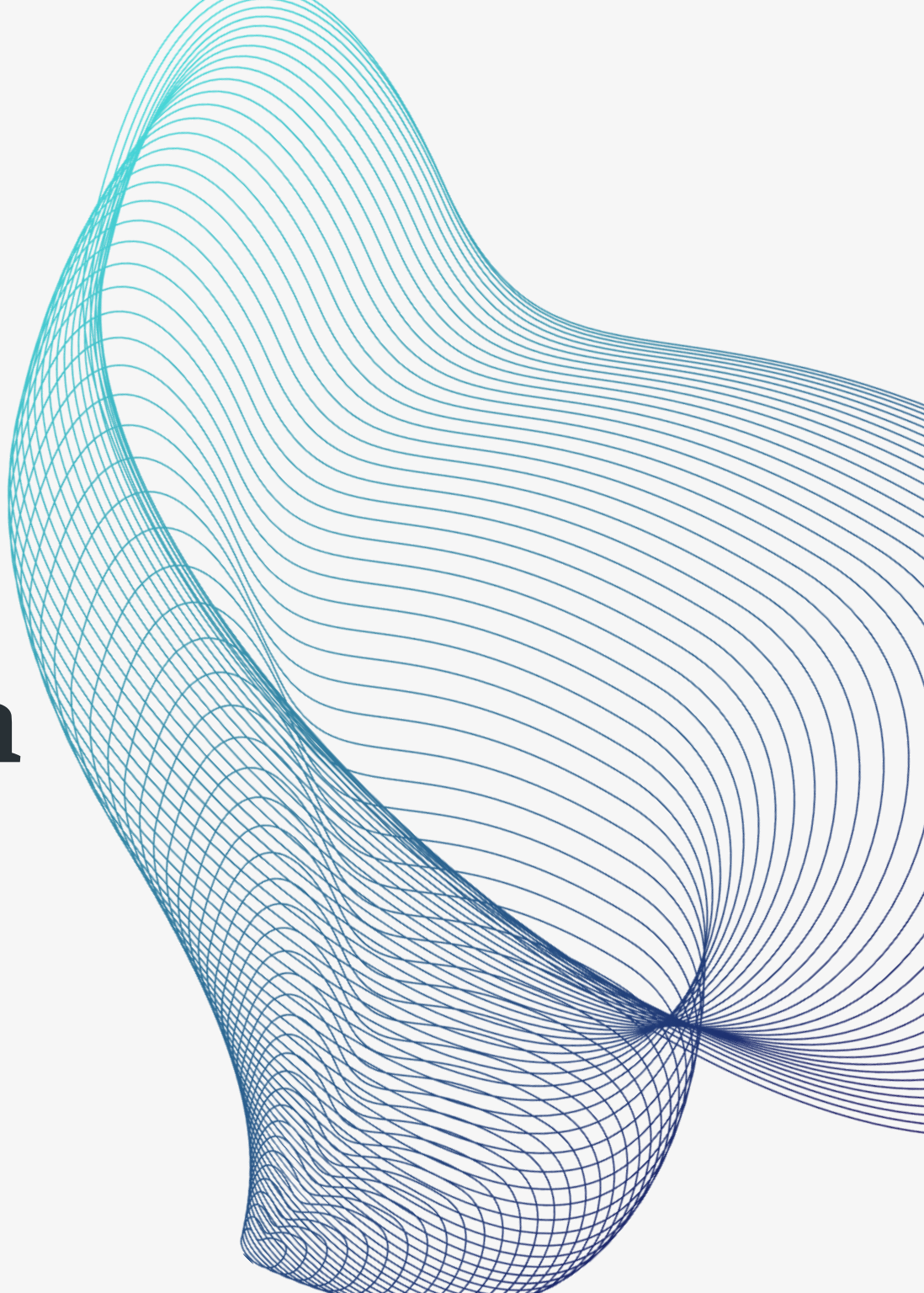
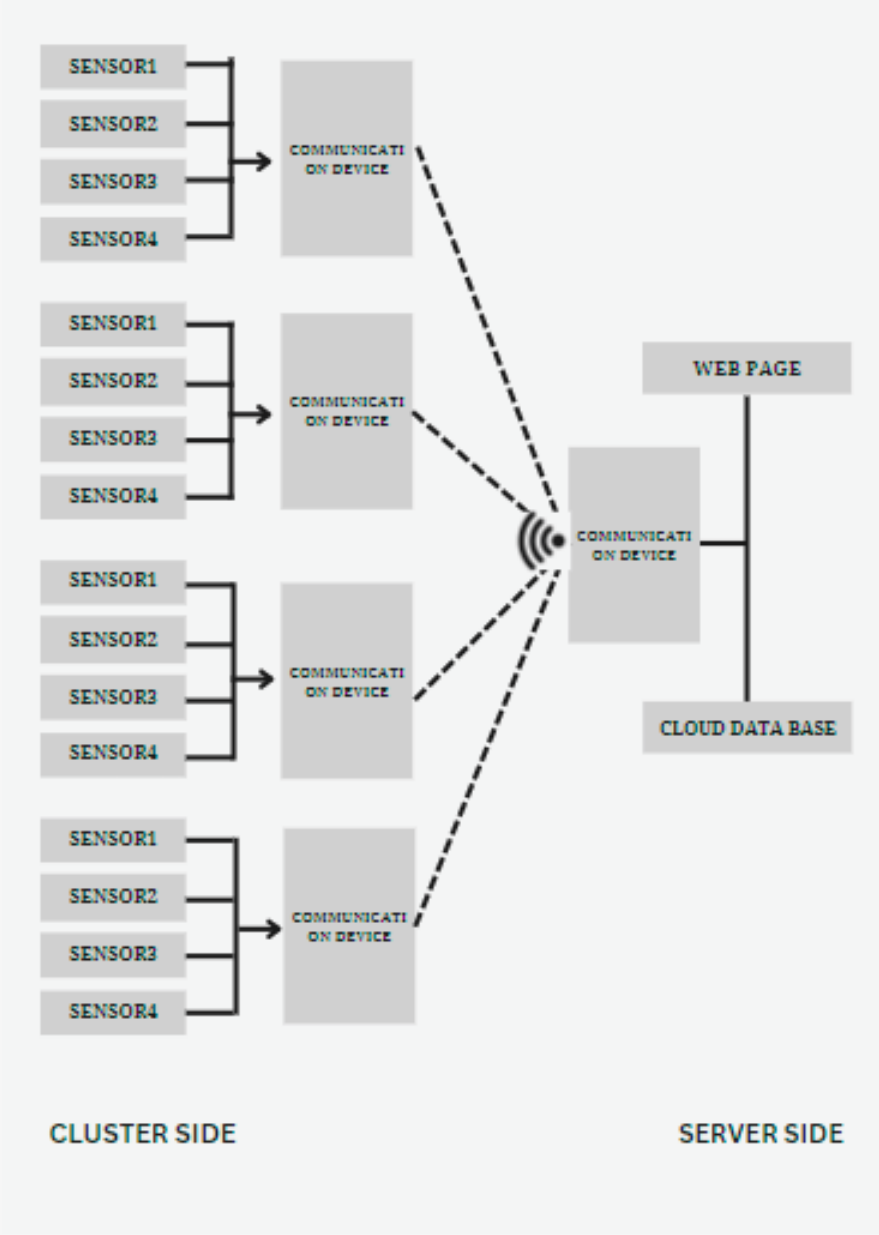
Real-Time Water Health Monitoring System for Smart City



Real-Time Water Health Monitoring System for Smart City

Water is the primary need of all living beings and living without water is impossible. A real-life water health monitoring system in a Smart City is a technology-based solution that checks the quality of water in urban areas. It uses sensors to measure important water parameters like pH level, temperature, and contaminants. The data collected is analyzed using advanced tools to identify any issues or risks to public health.

Block Diagram of the System



Comparative study

Embedded Board

ESP32

Arduino Uno

Raspberry Pi

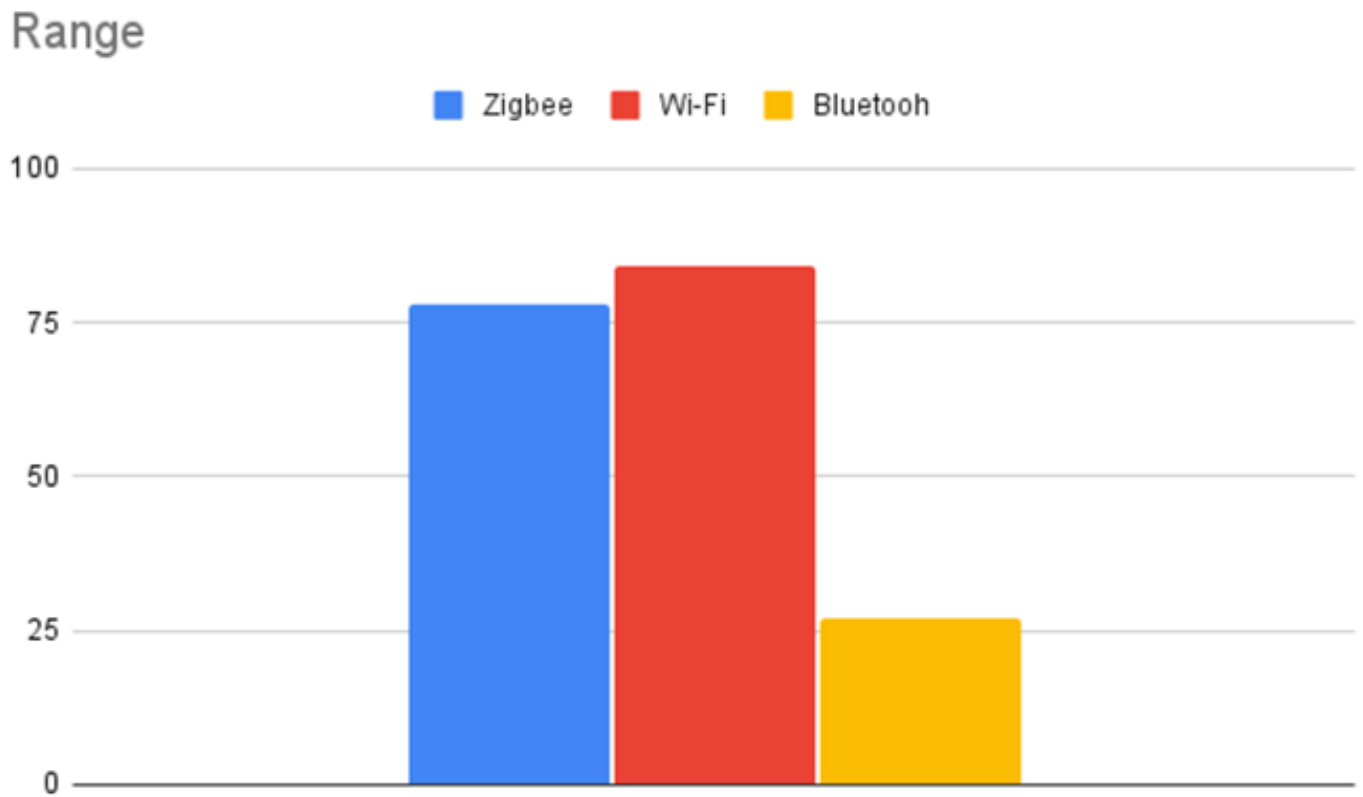
Communication Protocol

Zigbee

Wi-Fi

Bluetooth

Comparison between communication protocol



Sensors

Sensors are primary hardware component of the system. A sensor is a device that detects and responds to some type of input from the physical environment.

We are using four type of sensors :

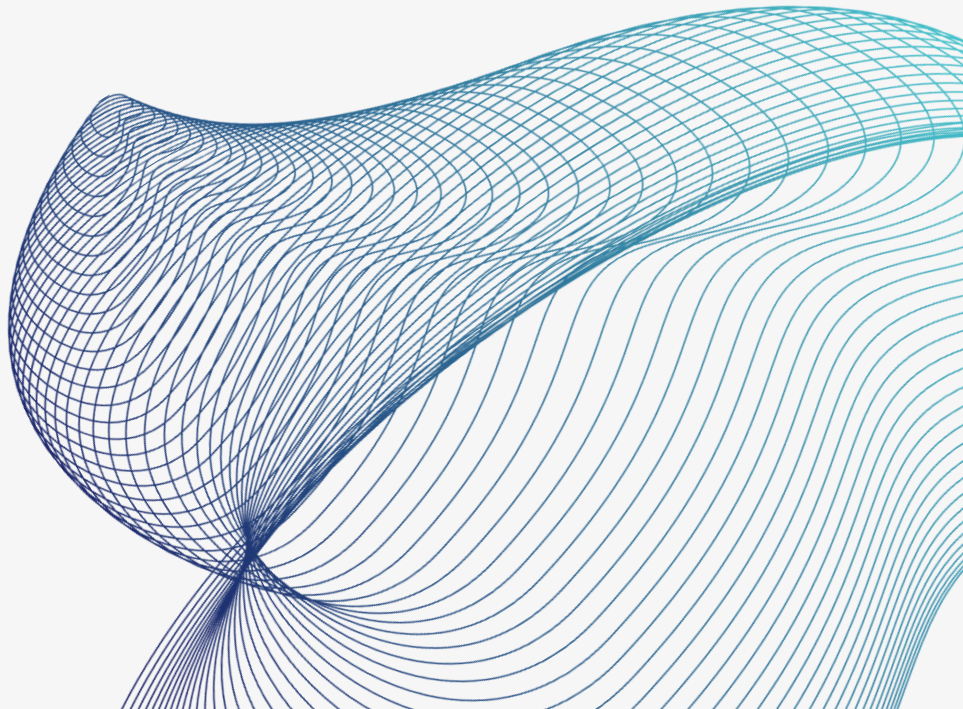
- pH Sensor
- TDS Sensor
- Water proof temperature Sensor
- Water Level Sensor(Ultrasonic Sensor)

pH Sensor

The pH of a solution is the measure of the acidity of that solution. The pH scale is a logarithmic scale whose range is from 0-14 with a neutral point being 7.

Specification of pH sensor

- Module Power : 5.00
- Measuring Range:0-14PH
- Measuring Temperature :0-60 ℃
- Accuracy : ± 0.1pH (25 ℃)
- pH Sensor with BNC Connector



Pin Diagram of pH sensor

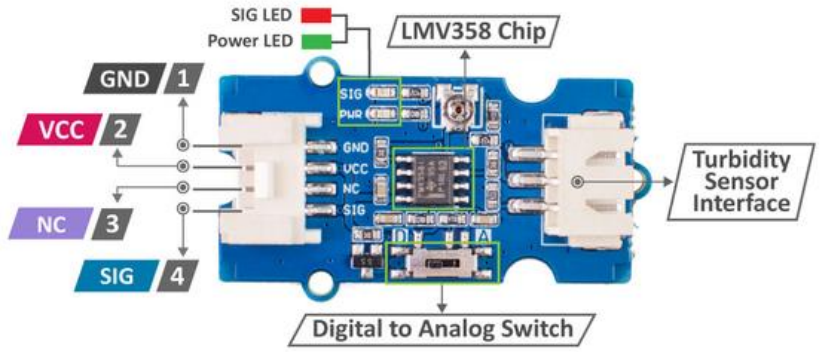
TDS Sensor

A TDS sensor, also known as a Total Dissolved Solids sensor, is a device used to measure the concentration of dissolved solids in a liquid. It typically measures the conductivity of the solution, which is directly related to the amount of dissolved ions and particles present.

TDS sensors are commonly used in applications such as water quality monitoring, hydroponics, aquariums, and industrial processes to ensure the purity or cleanliness of the liquid.

Specifications and Pin Diagram

- Analog Signal, easy to implement
- Support 3.3 / 5V Input Voltage
- Waterproof TDS Probe



1 : Connected to the system GND
2 : Power supply from Grove 5V/3.3V
3 : Not connected in this module
4 : Output signal from this module

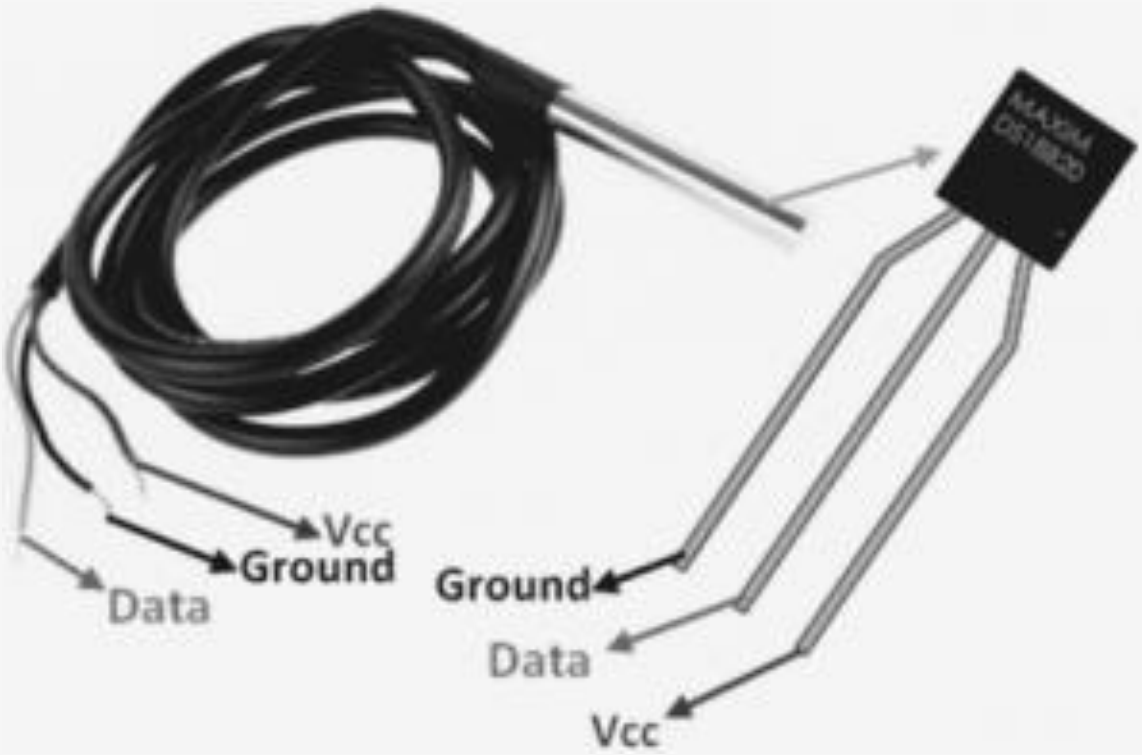
Waterproof temperature sensor(DS18B20)

DS18B20 Waterproof Digital Temperature Sensor Probe-1 Meter (100cm)-

Specification of Waterproof temperature sensor

- Communicates using 1-Wire method
- Operating voltage: 3V to 5V
- Temperature Range: -55°C to +125°C
- Accuracy: ±0.5°C

Pin Diagram of Waterproof Sensor



Ultrasonic Sensor

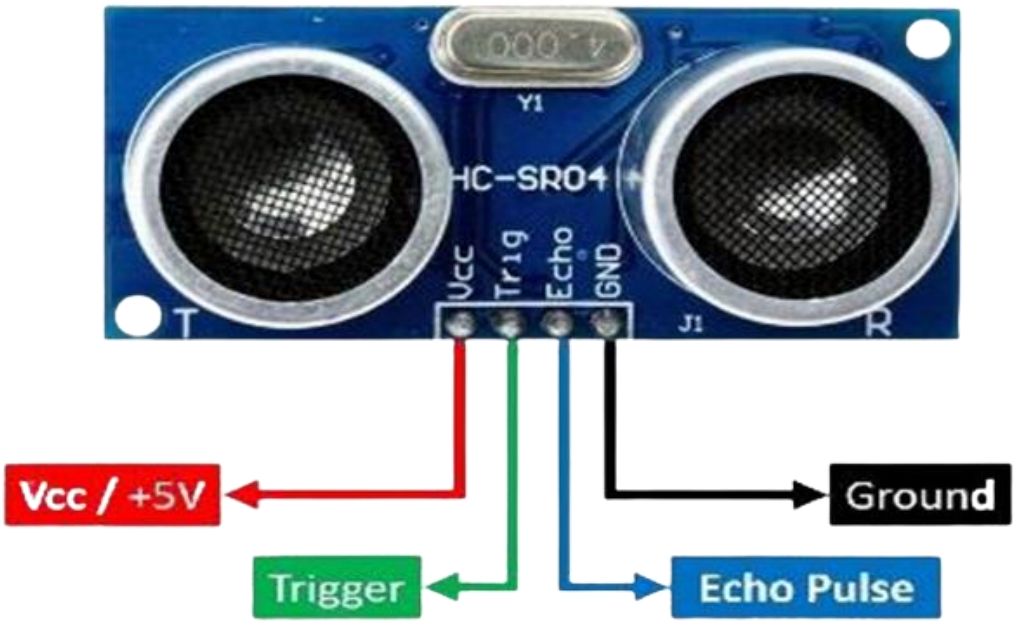
Ultrasonic sensors can be helpful in a real-time water health monitoring system in several ways. Ultrasonic sensors use sound waves to detect the distance between the sensor and an object, and they can also measure the speed of sound through a medium such as water.

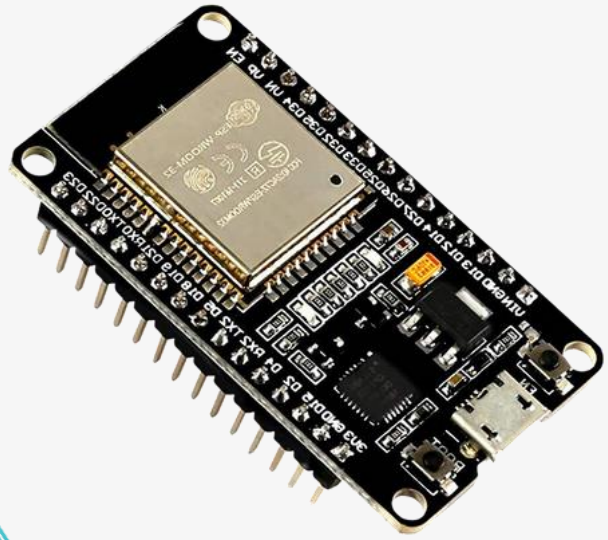
Ultrasonic sensors are used to measure the depth of water in a tank, reservoir, or other body of water.

Specifications of Ultrasonic Sensor

- Power Supply :+5V DC
- Quiescent Current : <2mA
- Working Current: 15mA
- Effectual Angle: <15°
  - Ranging Distance : 2cm – 400 cm

Pin Diagram of Ultrasonic Sensor





ESP32

ESP32 is a low-cost System on Chip (SoC) Microcontroller from Espressif Systems, the developers of the famous ESP8266 SoC. It is a successor to ESP8266 SoC and comes in both single-core and dual-core variations of the Tensilica's 32-bit Xtensa LX6 Microprocessor with integrated Wi-Fi and Bluetooth.

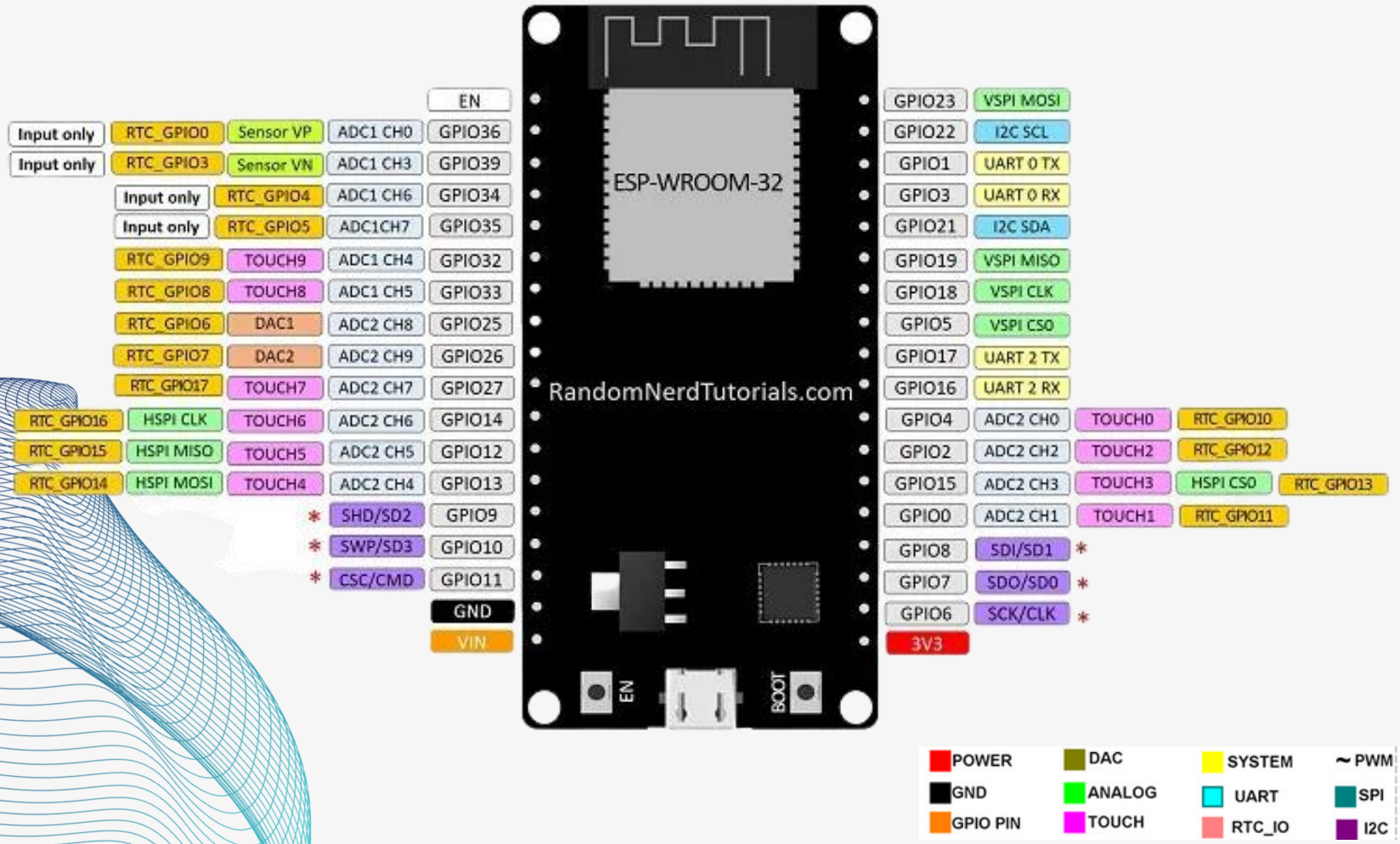
The important thing in this brief intro is whether it is a small DIY project by a hobbyist or a complex industrial project, any IoT project must have connectivity to Internet. This is where the likes of ESP8266 and ESP32 come into picture.

Specifications of ESP32

- Single or Dual-Core 32-bit LX6 Microprocessor with clock frequency up to 240 MHz .
- 520 KB of SRAM, 448 KB of ROM and 16 KB of RTC SRAM.
- Supports 802.11 b/g/n Wi-Fi connectivity with speeds up to 150 Mbps.
- Support for both Classic Bluetooth v4.2 and BLE specifications.
- 34 Programmable GPIOs.
- Up to 18 channels of 12-bit SAR ADC and 2 channels of 8-bit DAC
- Serial Connectivity include 4 x SPI, 2 x I^2C, 2 x I^2S, 3 x UART.
- Ethernet MAC for physical LAN Communication (requires external PHY).
- 1 Host controller for SD/SDIO/MMC and 1 Slave controller for SDIO/SPI.
- Motor PWM and up to 16-channels of LED PWM.

Pinout of ESP32 Board

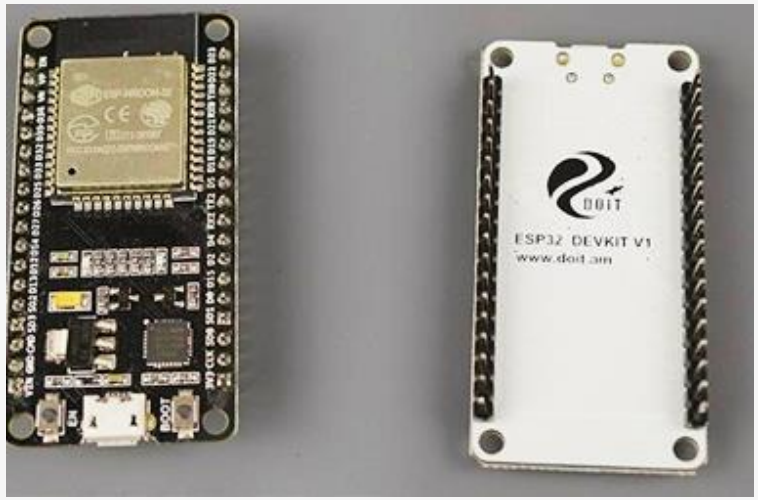
The ESP32 chip comes with 48 pins with multiple functions. Not all pins are exposed in all ESP32 development boards, and some pins should not be used. The ESP32 DEVKIT V1 DOIT board usually comes with 36 exposed GPIOs that you can use to connect peripherals.



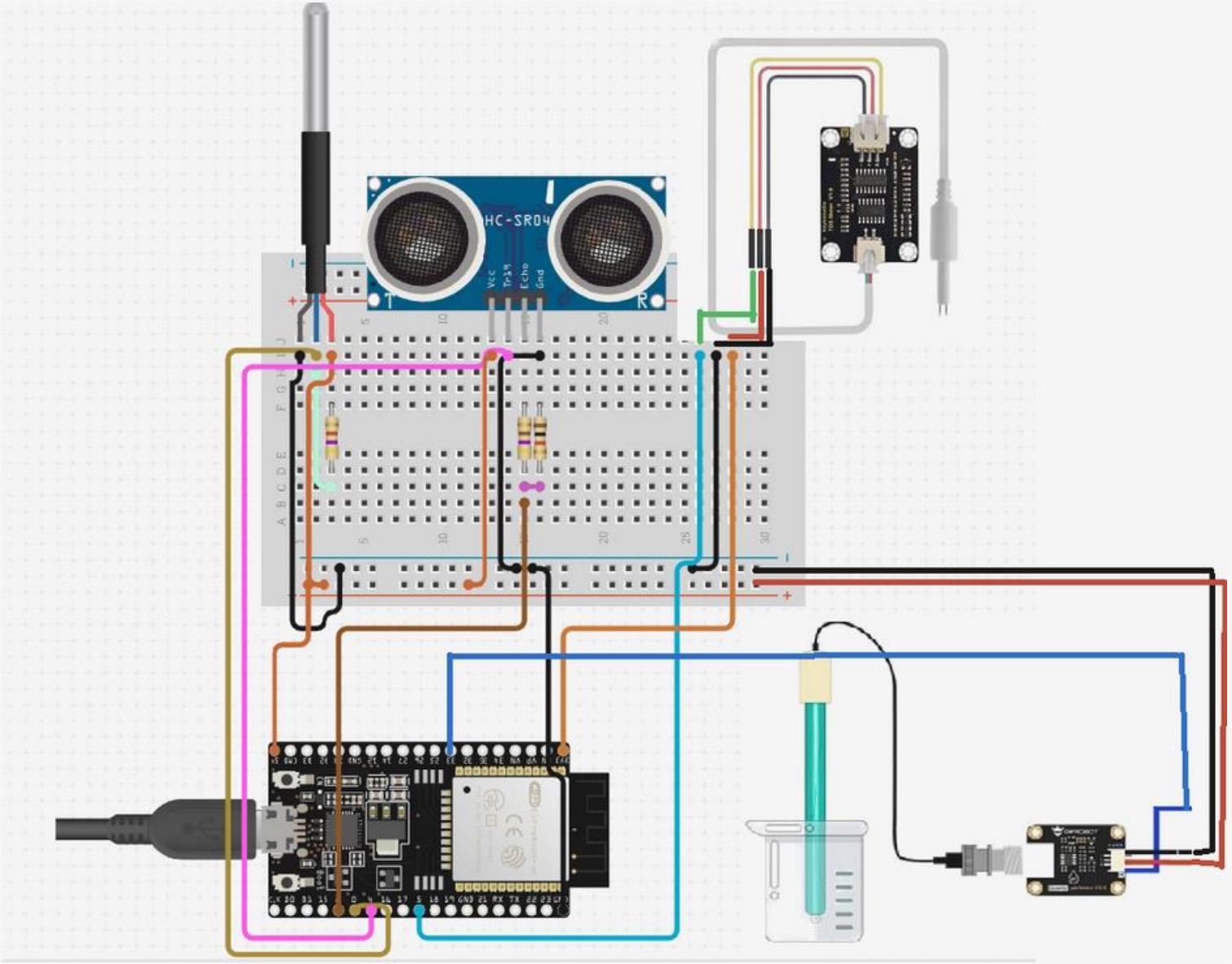
ESPNOW

ESP-NOW is a communication protocol developed by Espressif Systems, the company behind the ESP8266 and ESP32 microcontroller chips. It is designed specifically for low-power, peer-to-peer communication between ESP8266 and ESP32 devices. ESP-NOW allows for efficient and direct communication between these devices without the need for a traditional Wi-Fi network or an access point.

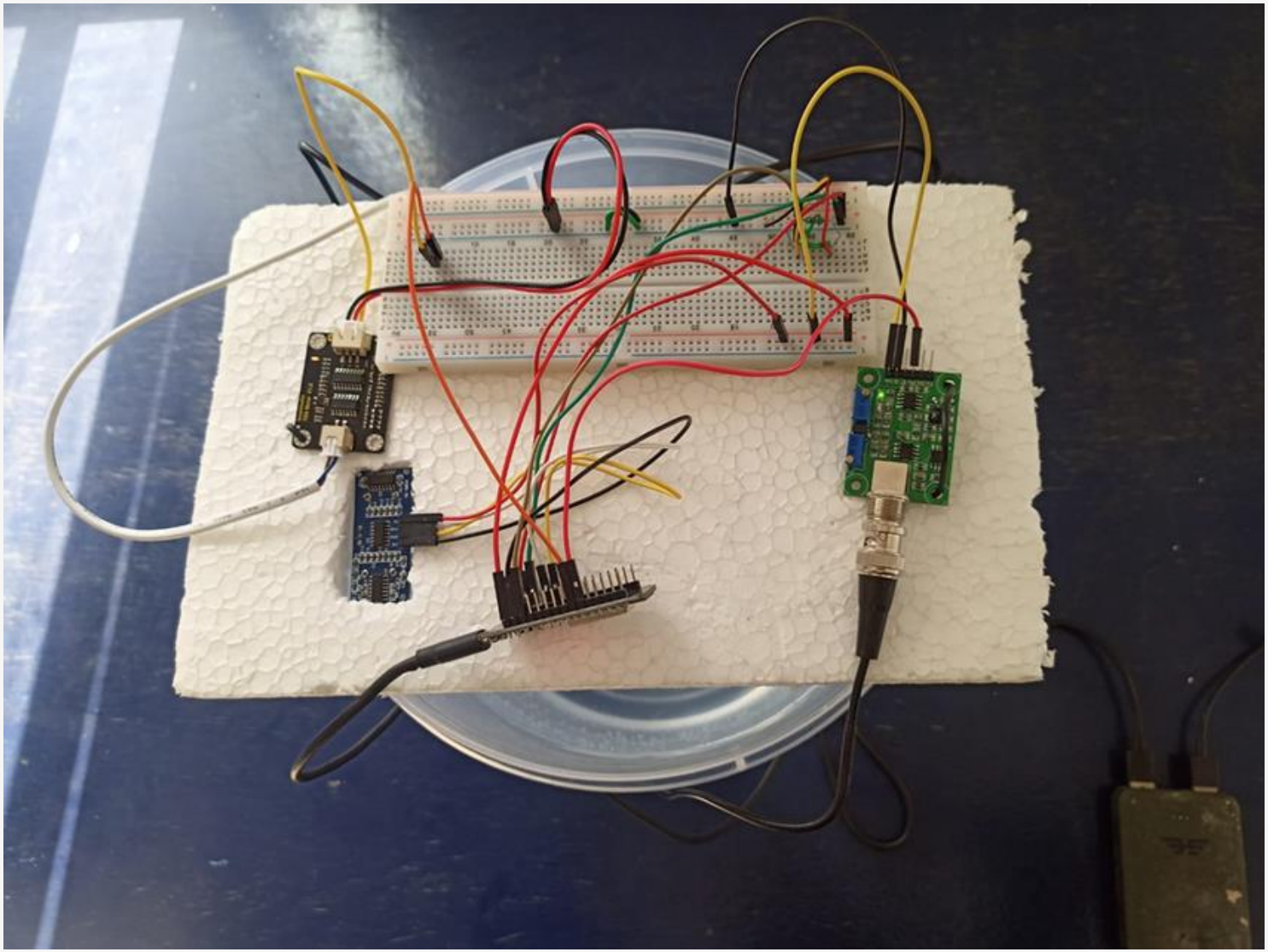
The ESP-NOW protocol operates in the data link layer of the OSI model, providing a simple and lightweight way to exchange data between ESP devices.



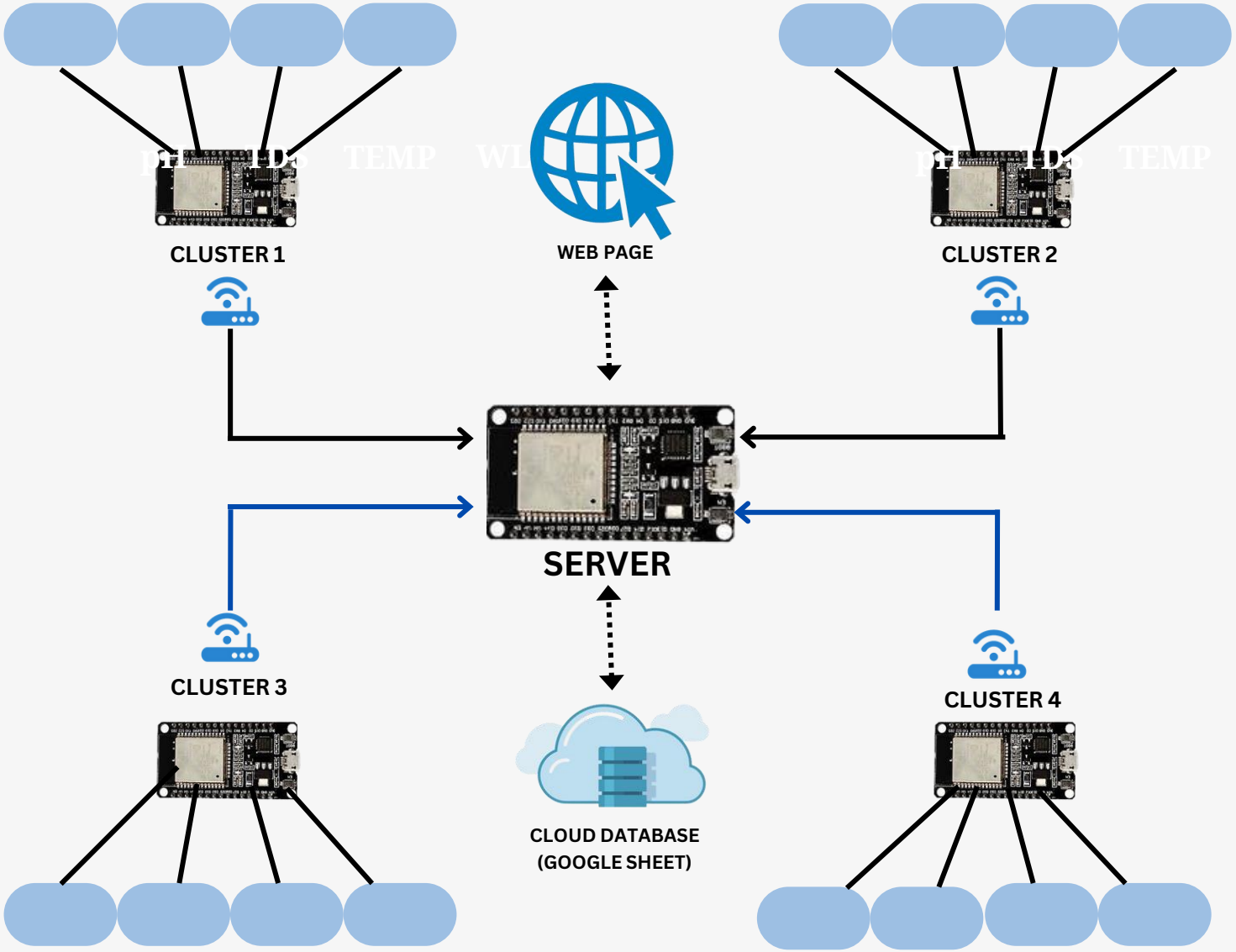
Circuit Diagram



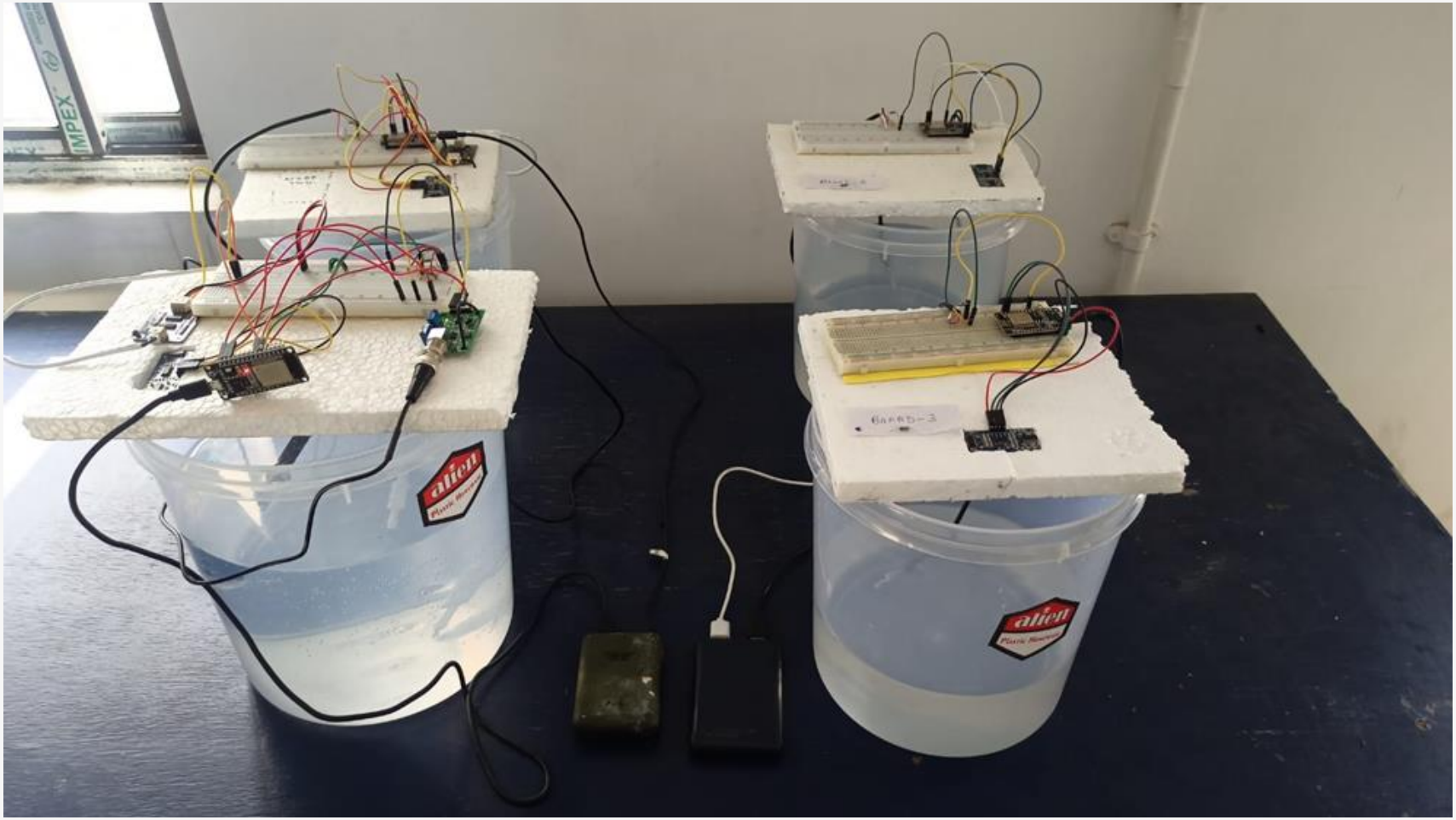
System Overview



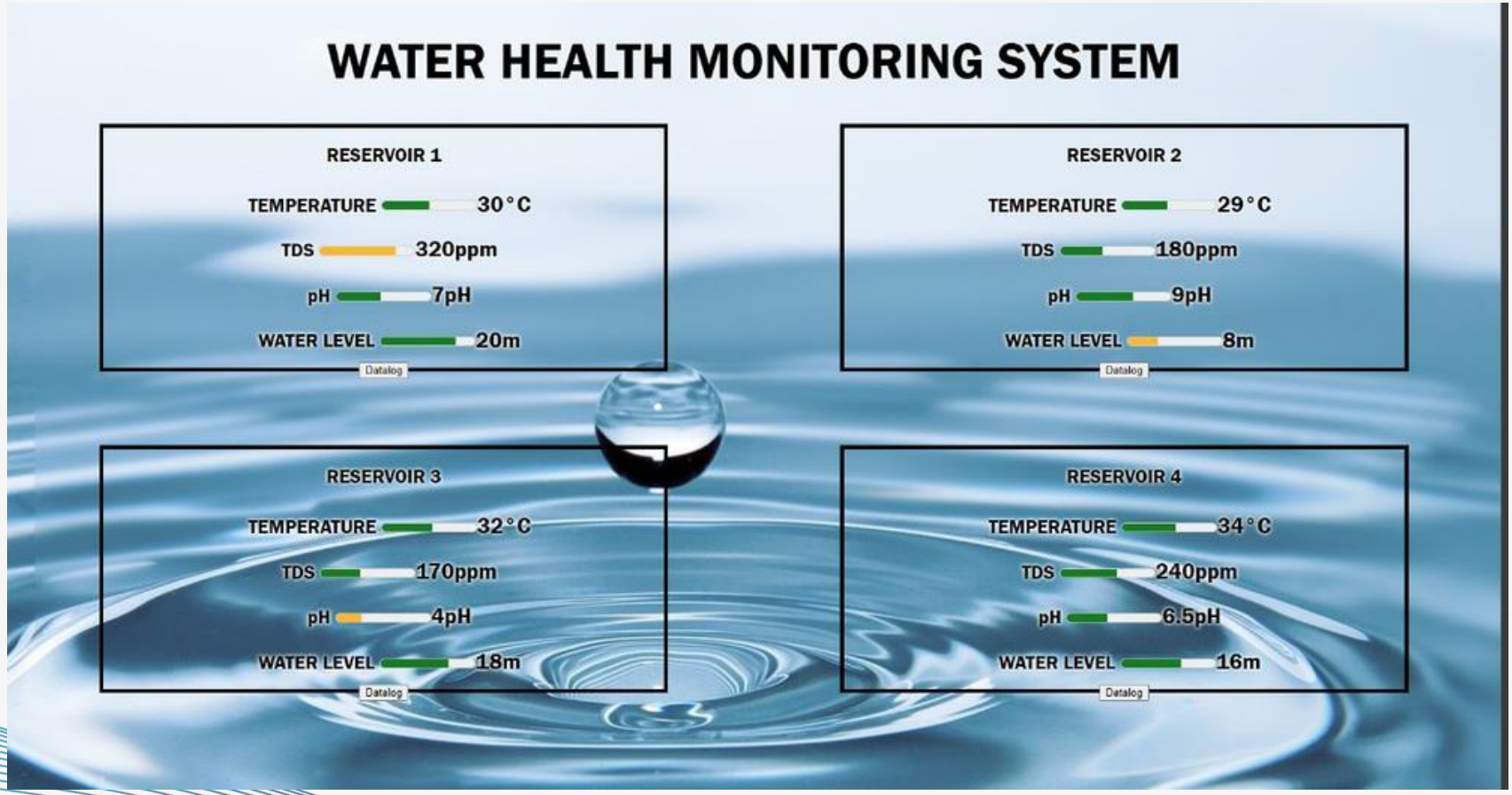
System Overview



System Overview



System Overview



System Overview

Search the menus (Alt+/) 100% View only

A1 Date

	A	B	C	D	E	F
1	Date	Time	Temperature	TDS	pH	Water_Level
2	2023/05/19	16:59:12	33.5	14.03	4.86	16.81
3	2023/05/19	16:57:11	33.5	14.9	4.84	16.81
4	2023/05/19	16:55:11	33.5	15.48	4.87	16.83
5	2023/05/19	16:53:23	33.5	15.77	5.21	16.81
6	2023/05/19	16:51:39	33.5	15.48	5.16	16.81
7	2023/05/19	16:49:09	33.5	14.03	4.82	16.83
8	2023/05/19	16:47:09	33.5	13.74	5	16.83
9	2023/05/19	16:45:08	33.5	14.9	4.91	16.81
10	2023/05/19	16:43:09	33.5	14.03	5.16	16.81
11	2023/05/19	16:41:08	33.5	13.16	4.75	16.83
12	2023/05/19	16:39:07	33.5	14.03	5.01	16.83
13	2023/05/19	16:37:06	33.5	14.32	4.97	16.81
14	2023/05/19	16:35:06	33.5	14.03	5.13	16.83
15	2023/05/19	16:33:08	33.5	13.45	4.94	16.83
16	2023/05/19	16:31:06	33.5	13.45	4.81	16.81
17	2023/05/19	16:29:05	33.5	14.03	4.79	16.83
18	2023/05/19	16:27:04	33.5	14.61	5.14	16.83
19	2023/05/19	16:25:04	33.5	15.77	5.11	16.81
20	2023/05/19	16:23:03	33.5	14.03	4.8	16.83
21	2023/05/19	16:21:03	33.5	14.03	5	16.81
22	2023/05/19	16:19:03	33.5	14.03	4.86	16.83
23	2023/05/19	16:17:02	33.5	14.03	5.11	16.81
24	2023/05/19	16:15:39	33.5	15.19	5.12	16.83
25	2023/05/19	16:12:53	33.5	15.19	5.23	16.81
26	2023/05/19	16:01:11	33	14.15	5.09	16.83
27	2023/05/19	15:57:22	33	12.69	5.03	16.81

Reservoir1 Reservoir2 Reservoir3 Reservoir4

Search the menus (Alt+/) 100% View only

A1 Date

	A	B	C	D	E	F
1	Date	Time	Temperature	TDS	pH	Water_Level
2	2023/05/19	16:59:16	34.63	48.19	6	14.09
3	2023/05/19	16:57:15	34.63	48.19	6	14.09
4	2023/05/19	16:55:17	34.63	48.19	6	14.09
5	2023/05/19	16:53:28	34.63	48.19	6	14.09
6	2023/05/19	16:49:14	34.63	47.11	6	14.09
7	2023/05/19	16:47:14	34.63	47.11	6	14.09
8	2023/05/19	16:45:12	34.63	47.11	6	14.09
9	2023/05/19	16:43:13	34.56	47.11	6	14.07
10	2023/05/19	16:41:11	34.63	47.11	6	14.09
11	2023/05/19	16:39:11	34.56	47.16	6	14.07
12	2023/05/19	16:37:11	34.56	47.16	6	14.07
13	2023/05/19	16:35:11	34.56	47.16	6	14.09
14	2023/05/19	16:33:11	34.56	47.16	6	14.09
15	2023/05/19	16:31:11	34.56	47.16	6	14.09
16	2023/05/19	16:29:09	34.5	47.2	6	14.09
17	2023/05/19	16:27:08	34.5	47.2	6	14.09
18	2023/05/19	16:25:07	34.5	47.2	6	14.09
19	2023/05/19	16:23:07	34.5	47.2	6	14.09
20	2023/05/19	16:21:07	34.5	47.2	6	14.09
21	2023/05/19	16:19:07	34.44	47.25	6	14.09
22	2023/05/19	16:17:06	34.5	47.2	6	14.09
23	2023/05/19	16:12:57	34.44	47.25	6	13.66
24	2023/05/19	16:01:27	34.38	47.3	6	14.07
25	2023/05/19	15:55:09	34.31	47.35	6	14.09
26	2023/05/19	15:53:33	34.31	47.35	6	14.07
27	2023/05/19	15:51:10	34.25	47.35	6	14.09

Reservoir1 Reservoir2 Reservoir3 Reservoir4

System Overview

Search the menus (Alt+/) 100% View only

A1 Date

	A	B	C	D	E	F
1	Date	Time	Temperature	TDS	pH	Water_Level
2	2023/05/19	16:59:20	34.5	165	6	13.09
3	2023/05/19	16:57:19	34.56	102	7	13.09
4	2023/05/19	16:55:22	34.56	157	6	13.07
5	2023/05/19	16:49:18	34.56	115	6	13.07
6	2023/05/19	16:47:18	34.56	131	6	13.07
7	2023/05/19	16:45:17	34.56	123	6	13.07
8	2023/05/19	16:43:17	34.56	174	6	13.09
9	2023/05/19	16:41:15	34.56	116	7	13.09
10	2023/05/19	16:39:15	34.5	102	6	13.09
11	2023/05/19	16:37:15	34.56	106	7	13.09
12	2023/05/19	16:35:15	34.56	145	7	13.09
13	2023/05/19	16:33:15	34.5	137	6	13.07
14	2023/05/19	16:31:15	34.5	111	6	13.07
15	2023/05/19	16:29:13	34.5	169	7	13.09
16	2023/05/19	16:27:12	34.5	156	6	13.07
17	2023/05/19	16:25:11	34.5	124	7	13.09
18	2023/05/19	16:23:12	34.44	150	6	13.09
19	2023/05/19	16:21:11	34.5	126	6	13.07
20	2023/05/19	16:19:11	34.5	130	7	13.09
21	2023/05/19	16:17:10	34.5	162	6	13.09
22	2023/05/19	16:13:01	34.44	111	7	13.09
23	2023/05/19	16:01:32	34.38	100	7	13.09
24	2023/05/19	15:55:24	34.31	133	7	13.09
25	2023/05/19	15:53:39	34.38	150	6	13.09
26	2023/05/19	15:51:20	34.31	141	6	13.09
27	2023/05/19	15:49:44	34.31	136	6	13.07

Reservoir1 Reservoir2 Reservoir3 Reservoir4

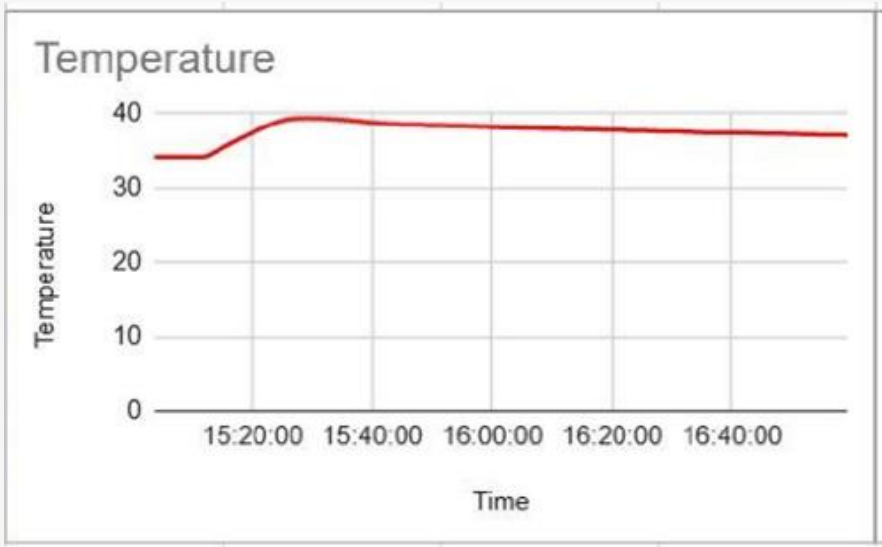
Search the menus (Alt+/) 100% View only

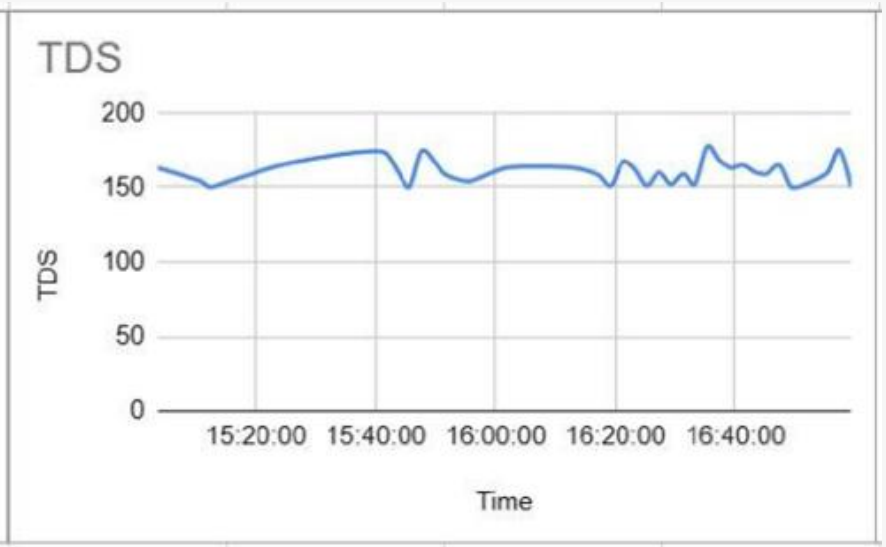
B28 15:45:37

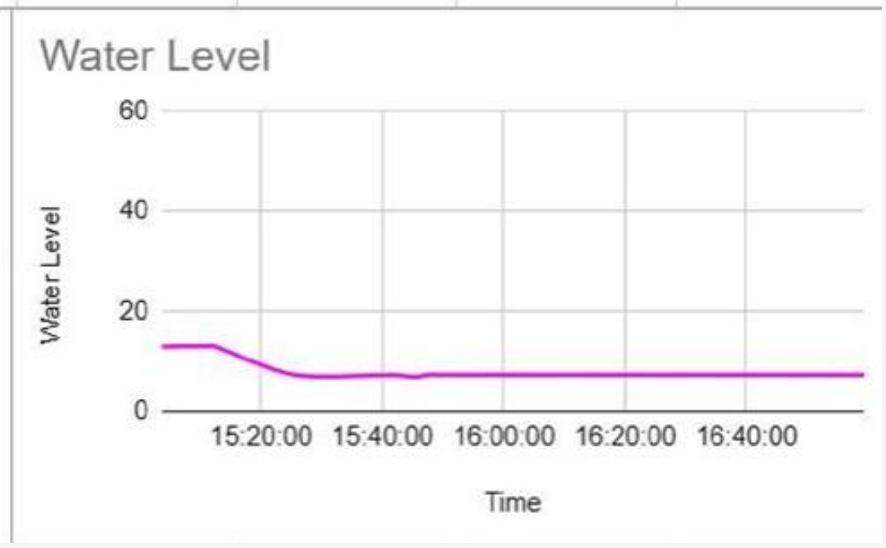
	A	B	C	D	E	F
1	Date	Time	Temperature	TDS	pH	Water_Level
2	2023/05/19	16:59:24	36.94	150	7	7.32
3	2023/05/19	16:57:23	37	175	8	7.31
4	2023/05/19	16:55:25	37	160	7	7.31
5	2023/05/19	16:49:23	37.13	150	7	7.31
6	2023/05/19	16:47:22	37.19	165	7	7.32
7	2023/05/19	16:45:21	37.19	159	7	7.31
8	2023/05/19	16:43:21	37.25	160	7	7.31
9	2023/05/19	16:41:19	37.31	165	7	7.31
10	2023/05/19	16:39:19	37.31	163	8	7.32
11	2023/05/19	16:37:19	37.31	168	8	7.31
12	2023/05/19	16:35:20	37.31	177	8	7.31
13	2023/05/19	16:33:19	37.38	152	8	7.32
14	2023/05/19	16:31:19	37.44	159	8	7.31
15	2023/05/19	16:29:17	37.44	152	8	7.32
16	2023/05/19	16:27:17	37.5	160	8	7.31
17	2023/05/19	16:25:14	37.56	151	7	7.31
18	2023/05/19	16:23:16	37.56	162	8	7.31
19	2023/05/19	16:21:15	37.69	167	7	7.31
20	2023/05/19	16:19:15	37.69	151	8	7.31
21	2023/05/19	16:17:14	37.75	158	7	7.31
22	2023/05/19	16:13:04	37.81	163	7	7.32
23	2023/05/19	16:01:45	38	163	7	7.31
24	2023/05/19	15:55:31	38.19	154	7	7.37
25	2023/05/19	15:51:26	38.25	159	7	7.37
26	2023/05/19	15:49:48	38.25	167	8	7.37
27	2023/05/19	15:47:39	38.38	174	7	7.37

Reservoir1 Reservoir2 Reservoir3 Reservoir4

Result and Analysis

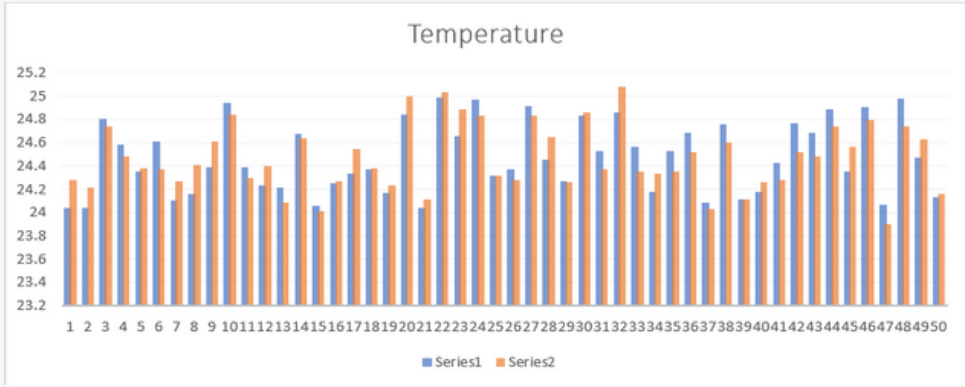






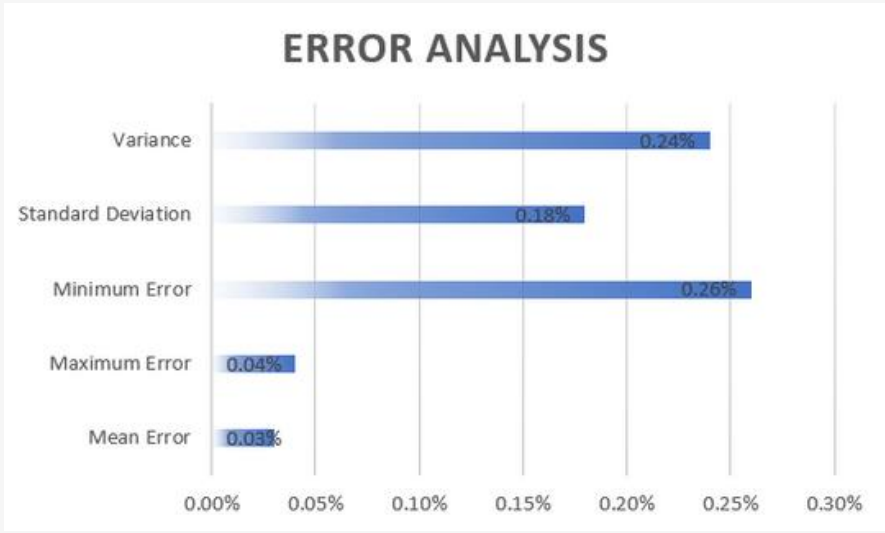
System Efficiency and Error Analysis of Temp Sensor

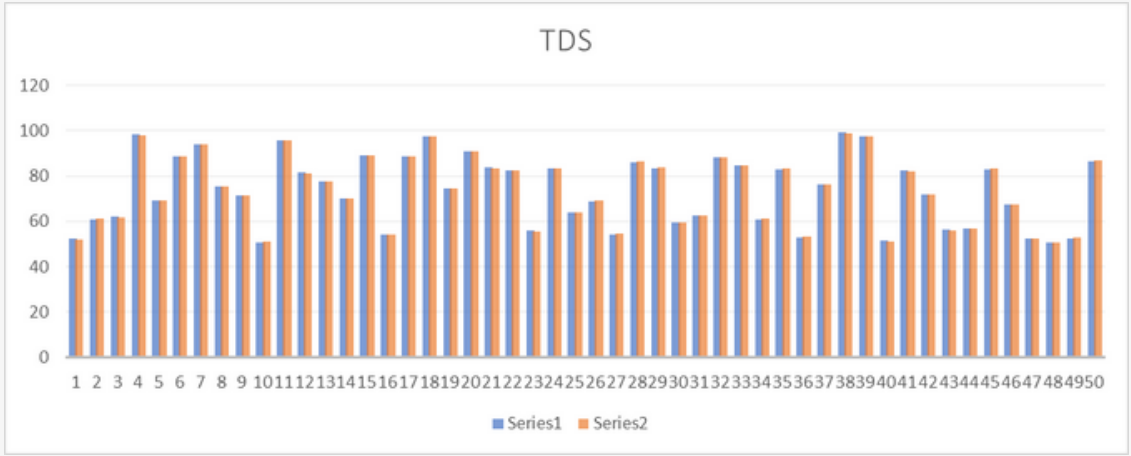
Temperature 1			
SN	Mesured by proposed syste	Mesured by Standard Mesuring Insrument	Error
1	24.04	24.28	0.99%
2	24.04	24.21	0.70%
3	24.8	24.74	0.24%
4	24.58	24.48	0.41%
5	24.35	24.38	0.12%
6	24.61	24.37	0.98%
7	24.1	24.27	0.70%
8	24.16	24.41	1.02%
9	24.39	24.61	0.89%
10	24.94	24.84	0.40%
11	24.39	24.3	0.37%
12	24.23	24.4	0.70%
13	24.21	24.09	0.50%
14	24.67	24.64	0.12%
15	24.06	24.01	0.21%
16	24.25	24.27	0.08%
17	24.33	24.55	0.90%
18	24.37	24.38	0.04%



System Efficiency and Error Analysis of TDS Sensor

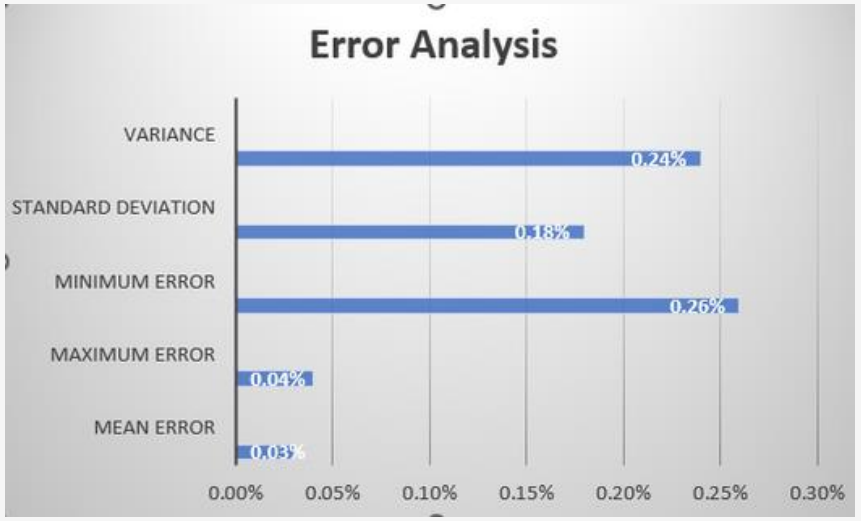
TDS1			
SN	Mesured by proposed syste	Mesured by Standard Mesuring Insrument	Error
1	80.67	80.63	0.05%
2	74.62	74.77	0.20%
3	79.52	79.49	0.04%
4	56.88	57.06	0.32%
5	98.21	98.22	0.01%
6	99.53	99.58	0.05%
7	88.36	88.4	0.05%
8	88.21	88.2	0.01%
9	92.49	92.5	0.01%
10	91.56	91.52	0.04%
11	74.98	74.76	0.29%
12	80.78	81.01	0.28%
13	86.47	86.62	0.17%
14	80.64	80.67	0.04%
15	92.62	92.86	0.26%
16	58.88	58.96	0.14%
17	58.42	58.5	0.14%
18	61.68	61.64	0.06%
19	76.41	76.44	0.04%
20	69.8	69.67	0.19%

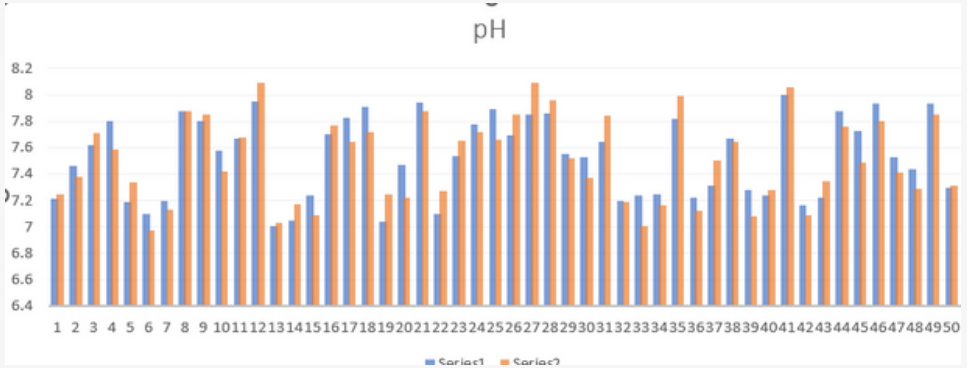




System Efficiency and Error Analysis of pH Sensor

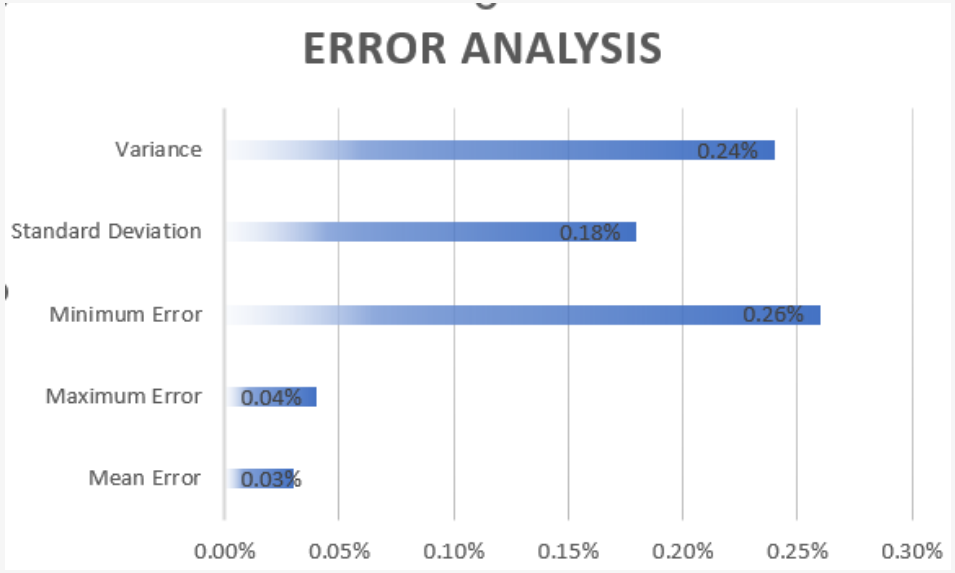
pH1			
SN	Mesured by proposed syste	Mesured by Standard Mesuring Insrument	Error
1	7.21	7.25	0.55%
2	7.46	7.38	1.08%
3	7.62	7.71	1.17%
4	7.8	7.59	2.77%
5	7.19	7.34	2.04%
6	7.1	6.97	1.87%
7	7.2	7.13	0.98%
8	7.88	7.88	0.00%
9	7.8	7.85	0.64%
10	7.58	7.42	2.16%
11	7.67	7.68	0.13%
12	7.95	8.09	1.73%
13	7.01	7.03	0.28%
14	7.05	7.17	1.67%
15	7.24	7.09	2.12%
16	7.7	7.77	0.90%
17	7.83	7.64	2.49%
18	7.91	7.72	2.46%

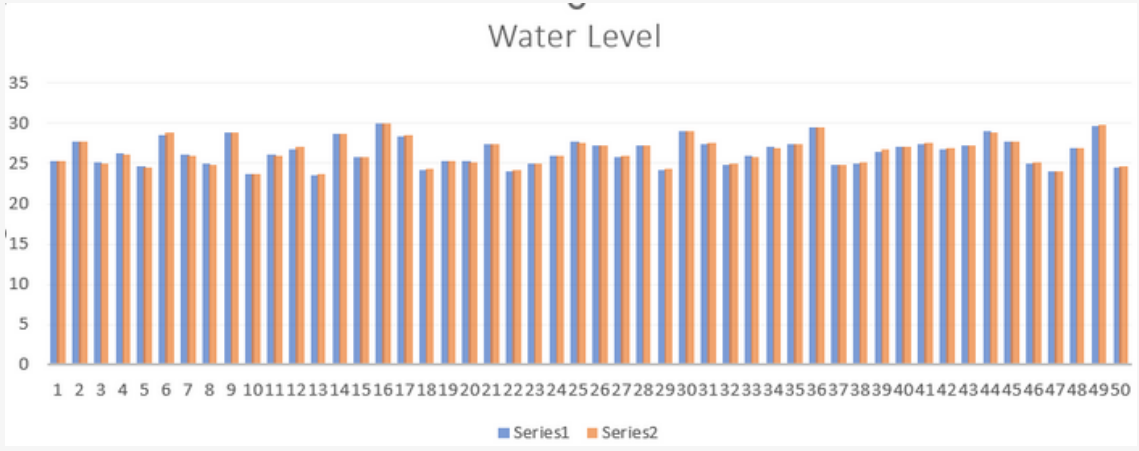




System Efficiency and Error Analysis of Water level Sensor

Water Level1			
SN	Mesured by proposed syste	Mesured by Standard Mesuring Insrument	Error
1	25.39	25.38	0.04%
2	27.78	27.67	0.40%
3	25.18	24.96	0.88%
4	26.29	26.2	0.34%
5	24.66	24.55	0.45%
6	28.61	28.81	0.69%
7	26.05	25.93	0.46%
8	25.02	24.85	0.68%
9	28.92	28.94	0.07%
10	23.67	23.66	0.04%
11	26.12	25.94	0.69%
12	26.76	27.01	0.93%
13	23.55	23.69	0.59%
14	28.78	28.62	0.56%
15	25.74	25.78	0.16%
16	29.98	29.97	0.03%
17	28.32	28.49	0.60%
18	24.27	24.42	0.61%
19	25.33	25.3	0.12%
20	25.29	25.23	0.24%





Applications

- Real-time Monitoring
- Remote Accessibility
- Comprehensive Data Collection
- Scalability and Flexibility
- Early Warning System
- Data Analysis and Visualization

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Thank You