MALAYSIAN JOURNAL OF BIOENGINEERING AND TECHNOLOGY

# Comparison between NodeMCU ESP8266 and Uno R3 for Software Development using Ubidots

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**ARTICLE INFO**

*Received: 12 April 2024*
*Accepted: 15 May 2024*
*Online: 20 June 2024*
*eISSN: 3036-017X*

**ABSTRACT**

The Internet of Things (IoT) refers to devices with the capability to collect, analyze, and communicate sensed data to users. This technology streamlines user observation and control of water quality, aiming to enhance measurement precision and overall water conditions through the integration of Ubidots. The motivation behind this project is to monitor water quality, comparing the effectiveness of the NodeMCU ESP8266 and Uno R3 systems. This project was into hardware and software development. In the hardware development, first part the sensor such as Total Dissolved Oxygen (TDS) value attached with Uno R3 and second part TDS sensor attached with NodeMCU ESP8266 was integrated. For software development, Arduino IDE programming is used to program the operation of water quality monitoring system. Furthermore, Ubidots software to ensure the real-time update of data collection from water quality monitoring system (WQMS). Finally, the recorded data will be uploaded simultaneously to be an analyzed and compared on the IoT platform. The result shows that the WQMS can fully function in different conditions of water and software development using Ubidots.

*Keywords: Ubidots; NodeMCU; Uno R3; WQMS; IoT*

## 1. Introduction

Aquaculture involves the cultivation of aquatic organisms like fish and aquatic flora. Aquaculture operations rely significantly on water quality, influenced by various factors like temperature, pH levels, dissolved oxygen, and nutrient concentrations. Within aquaculture systems, inadequate water quality can lead to substantial economic losses, hindered fish growth, and heightened vulnerability to diseases [1]. In recent years, water pollution has emerged as a foremost challenge confronting governments worldwide. The proliferation of technologies and industries has sparked a corresponding increase in the discharge of polluted water and chemical substances into various aquatic environments, including rivers, oceans, and ponds [2]. As manufacturing processes expand and urbanization accelerates, the volume of contaminants released into these ecosystems rises, posing significant threats to aquatic life, human health, and the overall ecological balance.

Consequently, there has been a notable surge in endeavours aimed at advancing water quality monitoring technologies. Recognizing the critical importance of preserving and safeguarding water resources, governments, research institutions, and private enterprises worldwide have intensified their efforts to develop innovative methods and tools for continuously monitoring and assessing the quality of water bodies [3]. These initiatives encompass a wide range of approaches, including the deployment of remote sensing technologies, the development of sophisticated sensors and probes, and the implementation of data analytics and modelling techniques. By enhancing our ability to detect and respond to changes in water quality parameters promptly, these advancements play a crucial role in supporting effective environmental management strategies and promoting the sustainable utilization of water resources for future generations [4]. Therefore, the integration of smart multisensory research with microcontrollers and wireless sensor networks has enabled the provision of precise, real-time data concerning water quality. Through the implementation of such technology, monitoring water quality becomes feasible, facilitating timely intervention to prevent adverse consequences [5].

# 2. Materials and Methods

## 2.1 Conceptual Framework

Figure 1a) depicts the procedural steps for configuring and utilizing the TDS sensor alongside the Arduino Uno and NodeMCU ESP8266. Initially, the TDS sensor needed to link with Arduino Uno. The sensor comprises three wires: black (GND), red (VCC), and green (SIG). Following the sensor connection, the subsequent action involved initializing both the Arduino and the TDS sensor. Meanwhile, for Fig. 1b), the GND pin of the sensor connects to the GND pin of the ESP8266, the VCC pin links to the 3.3V pin of the ESP8266, and the SIG pin attaches to an analog pin like A0 on the ESP8266. Subsequently, launch Ubidots on the computer and configure the serial port settings to align with the baud rate specified in the ESP8266 code, typically set at 9600 bps. Upon successful configuration, monitor the Ubidots window for real-time TDS measurements. The system can be configured to include a backup data mechanism when sending strings through Ubidots. This backup functionality ensured redundancy and data integrity by saving the transmitted strings to a secondary storage or log file, serving as a precautionary measure in the event of data loss or system interruptions.

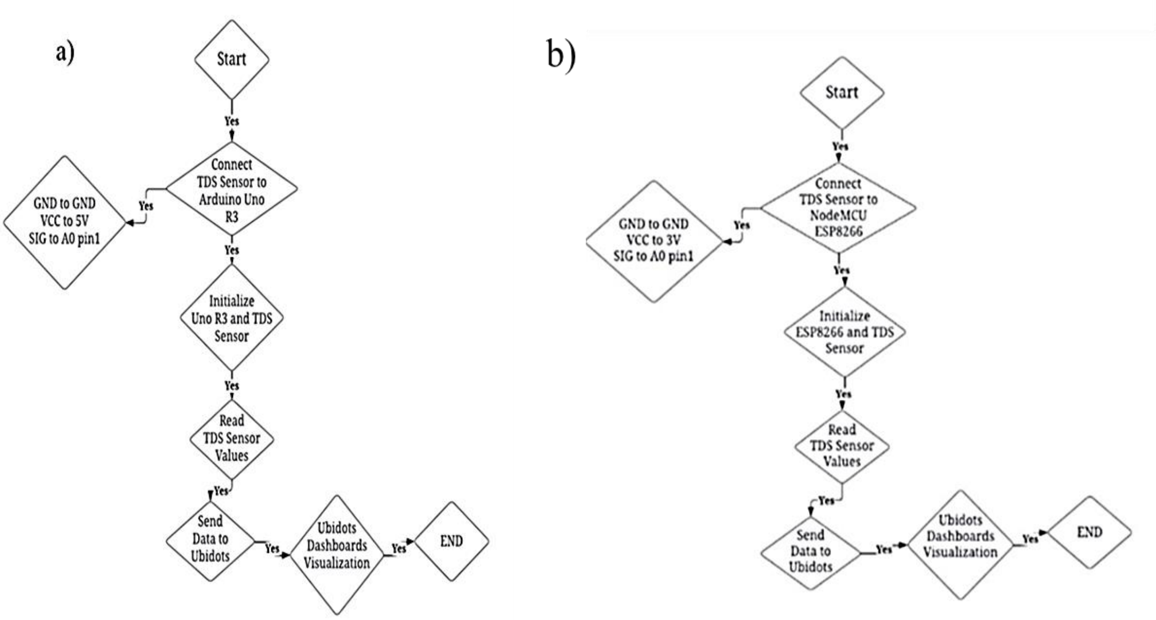


**Fig.1**: Flow chart TDS Sensor with Ubidots databased using a) Uno R3; b) NodeMCU ESP8266

# 3. Results and Discussion

TDS sensor works effectively in two different types of water using Uno R3 and NodeMCU ESP8266 and sends through Ubidots. Based on Fig. 2, the TDS sensor works effectively in two different types of water. The average distilled and typical water values are 0 and 22 ppm, respectively. It can be concluded that distilled water is highly pure and contains minimal impurities or dissolved substances [6]. Distilled water is typically expected to have a very low concentration of ions, minerals and contaminants [7]. In contrast, normal water is within an acceptable and typical range for certain agriculture and aquaculture. Based on Fig. 3, data from Ubidots captured real-time monitoring from distilled and normal water from the TDS sensor. The receiver subsystem is configured to seamlessly transmit data from the



eISSN Number: 3036-017X 

sensor subsystem to the Ubidots cloud whenever an internet connection is detected, as shown in Fig. 4. The data is stored in the Ubidots database and presented through either the graphical user interface (GUI) or dashboard, accessible via the Ubidots website or its mobile application. The number of variables created for this project in the cloud is 2, in which two variables (grey coloured) are real-time sensor data. In Fig. 3 also, the variables are created in the cloud, where each variable is issued a unique API key so that the sensor data will be stored to the correct variable. The time and date at the time of upload will be captured.

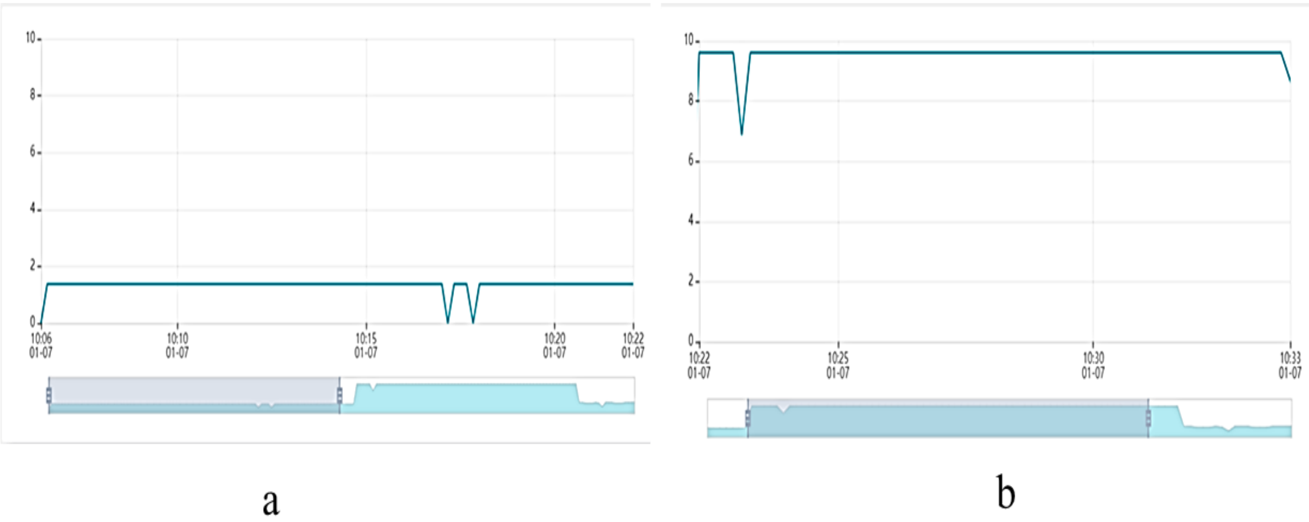


**Fig.2**: TDS reading of a) Distilled water; b) Normal water

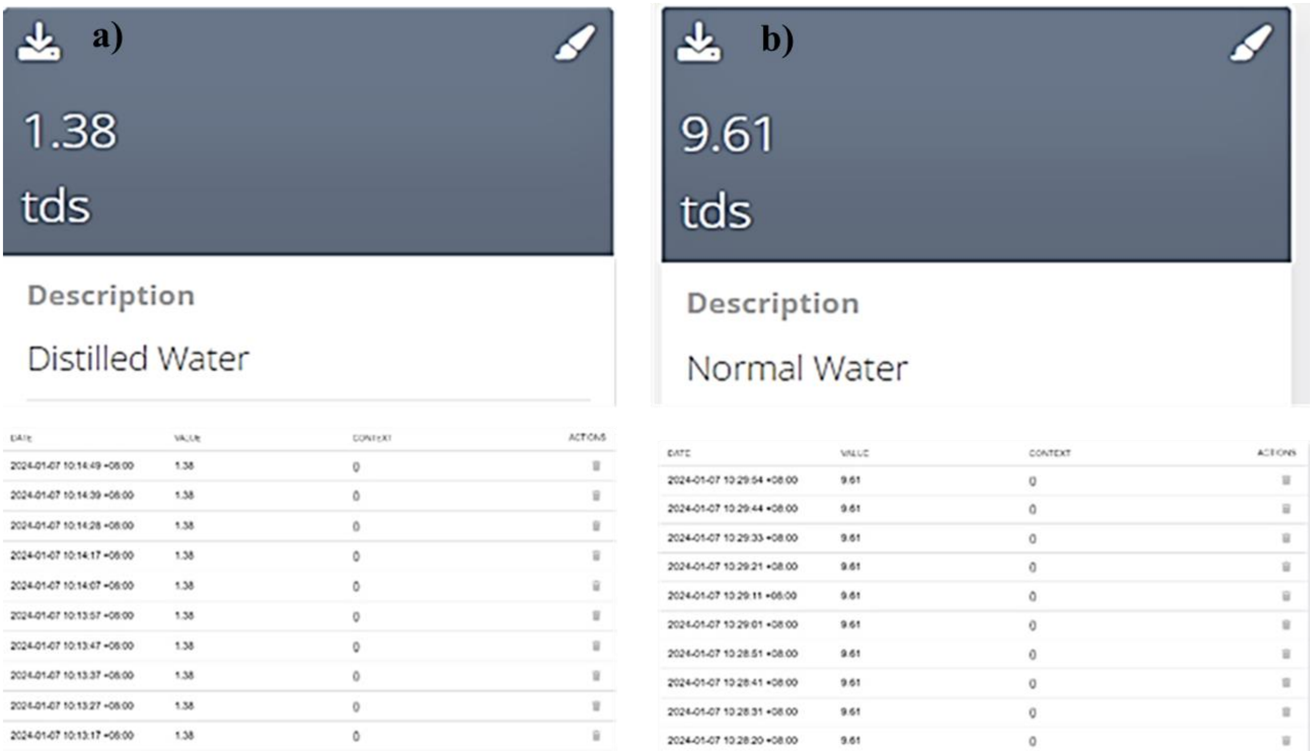


**Fig. 3**: Ubidots cloud database a) Distilled water; b) Normal water

In Fig. 4, users can view the data in graphical format on the dashboard, with the option to modify the duration range of the displayed data. Fig. 4 shows the snapshot of the dashboard for displaying a real-time or the latest set of data from a desktop view.



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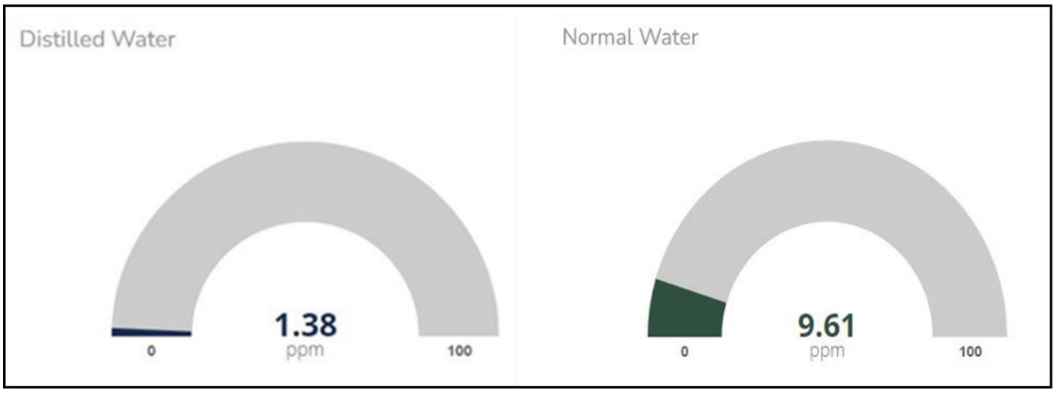
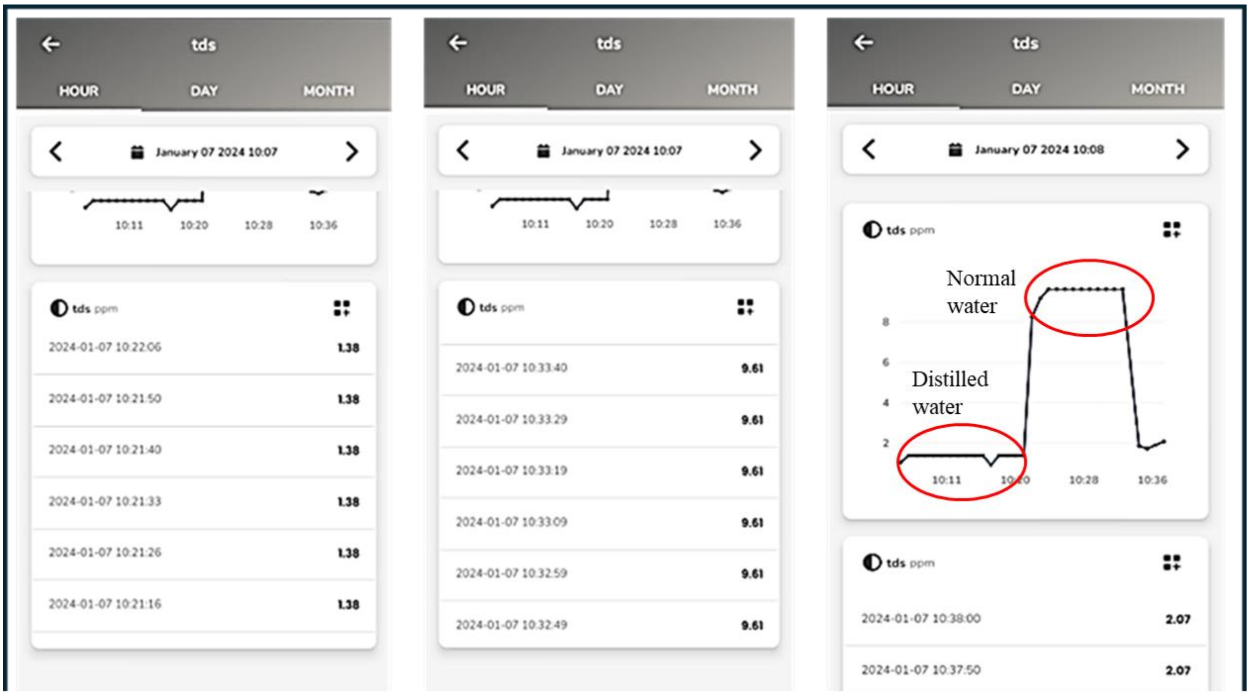



**Fig. 4:** Snapshot of the dashboard for displaying real-time (latest) data

Fig. 5(a) and Fig. 5(b) indicated the reading from distilled and regular water, while Fig. 5(c) was a plotted graph for distilled and normal water from TDS reading through the Ubidots mobile app. Besides using the website to monitor the data, users can use Ubidots through mobile apps to monitor the data. It can be easier to monitor data through a mobile phone than through a website. This is because mobile applications can utilize push notifications, alerting users promptly about significant events or alterations in monitored data. This functionality is typically more seamlessly incorporated into mobile apps than websites, offering a more immediate and attention-grabbing method to notify users about crucial updates.




a) Distilled water b) Normal water c) Graph for Distilled and Normal water

**Fig.5**: TDS reading through Ubidots App using mobile phone for a) Distilled water, b) Normal water, c) Graph for Normal and Distilled water

An email alert notification will be activated whenever the value of a water quality parameter deviates from the predefined safe range, whether for distilled or normal water. Fig. 6 below depicts snapshots of emails received when the sensor is put into distilled and normal water, affecting a specific parameter. In each case, the parameter fell outside the defined range, triggering an email alert to prompt the user to inspect the water in real-time notifications.

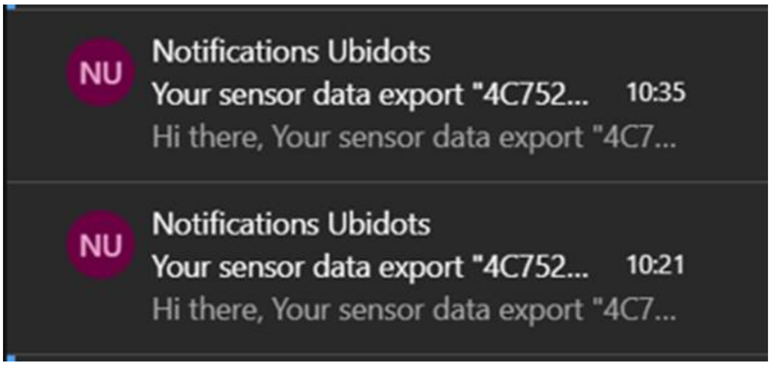



**Fig. 6**: Notification email to alert user for TDS values

# 4. Conclusion

This project has successfully developed an Internet of Things water quality monitoring parameter, such as a TDS sensor. This system was able to capture the data of this parameter in real time and allow users to monitor at any time while being remotely away when monitoring the samples. The ESP8266 microcontroller, with its integrated Wi-Fi capabilities, provides a seamless and efficient means of establishing a connection to the Ubidots cloud platform. This wireless connectivity not only streamlines the data transmission process but also allows for real-time monitoring and analysis, aligning with the contemporary demands for IoT-enabled applications. Moreover, the decision to prioritize the ESP8266 over the Arduino Uno R3 stems from the ESP8266's inherent advantages in compactness, cost-effectiveness, and energy efficiency. The ESP8266's compact form makes it particularly suitable for applications with space constraints, while its cost-effectiveness aligns with the resource considerations of research projects. Additionally, the lower power consumption of the ESP8266 is crucial for projects aiming to optimize energy usage.

# Acknowledgement

This research was supported by fundamental research grant scheme (UMK-FUND) under grant number of R/FUND/A1300/00895A/002/2022/01027.

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