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Water Level Monitoring System for Paddy Field Irrigation

Gunalan P Balan[1], **Faiz Asraf Saparudin**[1]

[1]Department of Electronic Engineering Technology,
Universiti Tun Hussein Onn Malaysia, Pagoh 84600, MALAYSIA`

*Corresponding Author Designation

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Abstract: Paddy fields in Sawah Sungai Balang are owned by different individuals, but they face a common problem of uneven ground and increasing instances of flooding. Manual monitoring of water levels in these large acreages has become a challenging task for farmers and plot owners. To address this issue, accessing and utilizing real-time information for water level monitoring proves to be a potential solution. The irrigation process requires optimal water levels to ensure the growth and development of paddy crops. Therefore, the implementation of a user-friendly Water Level Monitoring System that provides accurate and real time data from the soil can greatly benefit farmers and plot owners. This research aims to develop a water level monitoring system for irrigation systems using the NodeMCU module to transmit data from water level sensors to the cloud. By leveraging this communication technology, data from the field can be efficiently sent to the cloud, enabling farmers and plot owners to access and analyze the data for informed decision-making [6]. The proposed system offers a practical approach for enhancing agricultural activities by facilitating proactive management of water resources.

Keywords: Paddy Fields, Water Level Monitoring, Irrigation Management, Real-Time Data, Nodemcu Module, Cloud Communication, Agricultural Activities

1. Introduction

Water, one of the prime elements for the existence of life needs our immediate attention [1]. When climate changes, so do farming conditions also change [2]. Paddy Fields can survive a short time under water but when big, heavy rains come and paddy fields are flooded for more than a week, the plants die easily [3],[4]. For agriculture, water level monitoring is the most important part to be highlighted [5].

In Sawah Sungai Balang, acres of paddy field are owned by different owners. Each sector of the paddy field has been divided into many plots. Each section has 6 plots which are owned by different owners. However, the irrigation process in the paddy field is undergoing in manual way, there is a chance of water wastage happening by human error. Many plots in the paddy field suffer yield loss and die because of the overflood and uneven ground.

*Corresponding author: faizs@uthm.edu.my

This project aims to develop a system that will let users view plots of information about the water level in paddy fields. The NodeMCU will then be used as a gateway to deliver data to the cloud and to communicate with the other two nodes. The paddy field owners can easily use their smartphones to monitor the water level of paddy field plots by using ThingView apps.

1.1 Problem Statement

The issue found on the paddy field Sungai Balang is the uneven ground, which is getting worse to overflood the plot of paddy fields. The water flowing for the paddy fields is way better, but the issue found for overflood is the condition of the ground of each plot. When the ground is uneven, consequently some of the parts will have less water (the area will dry) and some of the parts will flood. This condition will affect the production of the grain yield in that location and affect the quality of the grain yield. Highly chances of happens overflood which makes the paddy field simply to die. It is important to know the parameter for the paddy field and each plot condition at the area will be affected because of the excess water volume [7]. Conflicts happen between the different plot owners because of overflood happen because of uneven ground. A suitable technology system to monitor water level is needed for the plot owners to monitor water levels.

1.2 Objective

i. To study the limitation of real-life scenario and propose sensor nodes specifications including type of sensors, communication module and power supply.
ii. To develop IoT based monitoring system to collected sensors data (water level) and sent to the users.
iii. To evaluate the performance of the proposed monitoring system in terms of accuracy, reliability, and effectiveness.

1.3 Scope

i. Two nodes of transfer water level data and one node as receive the data and uses as gateway send the data to cloud which will be useful in irrigation process.
ii. Uses ultrasonic sensor AJ-SR04M waterproof to measure water level readings and ESP8266 NodeMCU together with ESP 32 as communication module send the data to cloud.
iii. Test on two plots of paddy field by monitoring water level system and evaluate with the manual calculations.

2. Materials and Methods

Describe the method used to create the Water Level Monitoring System for Paddy Field Irrigation in greater detail. The description will include all hardware details, a system flowchart with an explanation, and a system block diagram with explanation.

2.1 Materials

Table 1: Hardware Details

No	Part Name	Qty	Function	Cost (RM)
1	NodeMCU ESP8266	3	Used as microcontroller board for communicate between three nodes	75.00
2	ESP32	1	Used as microcontroller board for send data to ThingSpeak	35.00
3	Battery 1x 3.7V	3	Power source for the circuit	18.00
4	Battery Holder	3	Holds and provides connection for the battery	7.50

5	Battery Charger	3	Charges the battery when connected to Solar PV	12.00
6	AJ-SR04M Waterproof Ultrasonic Sensor	2	Measures distance using sound waves	80.00
7	Solar PV	2	Converts sunlight into electrical energy and charge the battery	30.00
8	Rocker Switch	1	Controls the circuit's power supply	2.00
9	LED	2	Emits light when gateway system powered on	0.60
10	Resistor	2	Regulates current flow in the circuit	0.40
11	1N5819 Diode	2	Allows current flow in one direction from solar PV	3.60
12	Protoshield	2	Board with complete pin arrangement to fit for the microcontroller	30.00
13	Stripboard	1	Perforated board for soldering electronic components	1.60
14	Jumper Wire	1	Connects components on a circuit board	5.00
15	PVC Pipe 6 inch	2	Encloses and protects components or wires	53.84
16	PVC End Cap 6 inch	2	Closes the end of a PVC pipe	37.80
17	Weatherproof Box IP56 (6x4x3)	3	Protective enclosure for electronics in outdoor environments	19.50
18	Hole Drill Set 6s KZ-6	1	Used for drilling holes in PVC	10.50
19	X-Bond Construction Silicone	1	Adhesive for securing components and sealing gaps	5.90
20	Bracket 60x60 4s	1	Support structure for mounting components	2.00
21	Screw Set YLT-2020-12	1	Fasteners for securing components and brackets	2.70

2.2 System Block Diagram

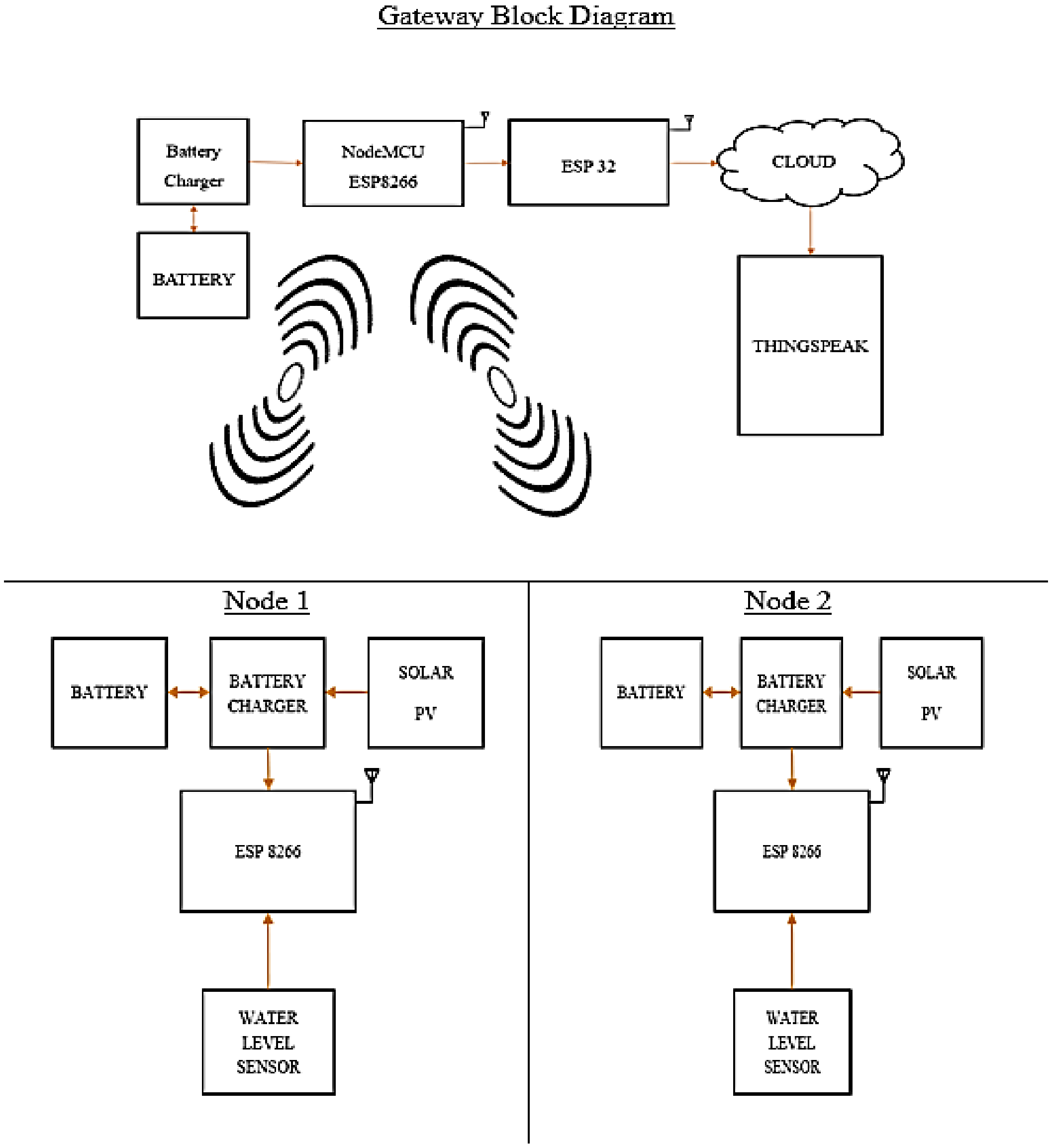

Figure 1: Full System Block Diagram

Solar energy will be used in the project to charge the battery and supply power to the microcontroller NodeMCU ESP8266 and ESP32 to process the other component. There will be 3 NodeMCU ESP8266 in node 1, 2, and in the gateway. These three microcontrollers transfer and receive data in one Wi-Fi connection. Node 1 and node 2 will be transfer data to gateway ESP 8266. Node 1 and node 2 will transfer data to gateway ESP8266 [8]. The transferred data will be received to ESP 32 by connecting to receiver RX pin. The received data will be sent to ThingSpeak in graph form. An ultrasonic sensor is an instrument that measures the distance to an object using ultrasonic sound wave or movement waves. The AJ-SR04M sensor connectivity sequence is the same as in HC SR04, but the high signal on the Trigger pin must be at least 10ms wide [9]. Only after increasing the trigger width to 20m will get a reading.

2.3 System Flowchart

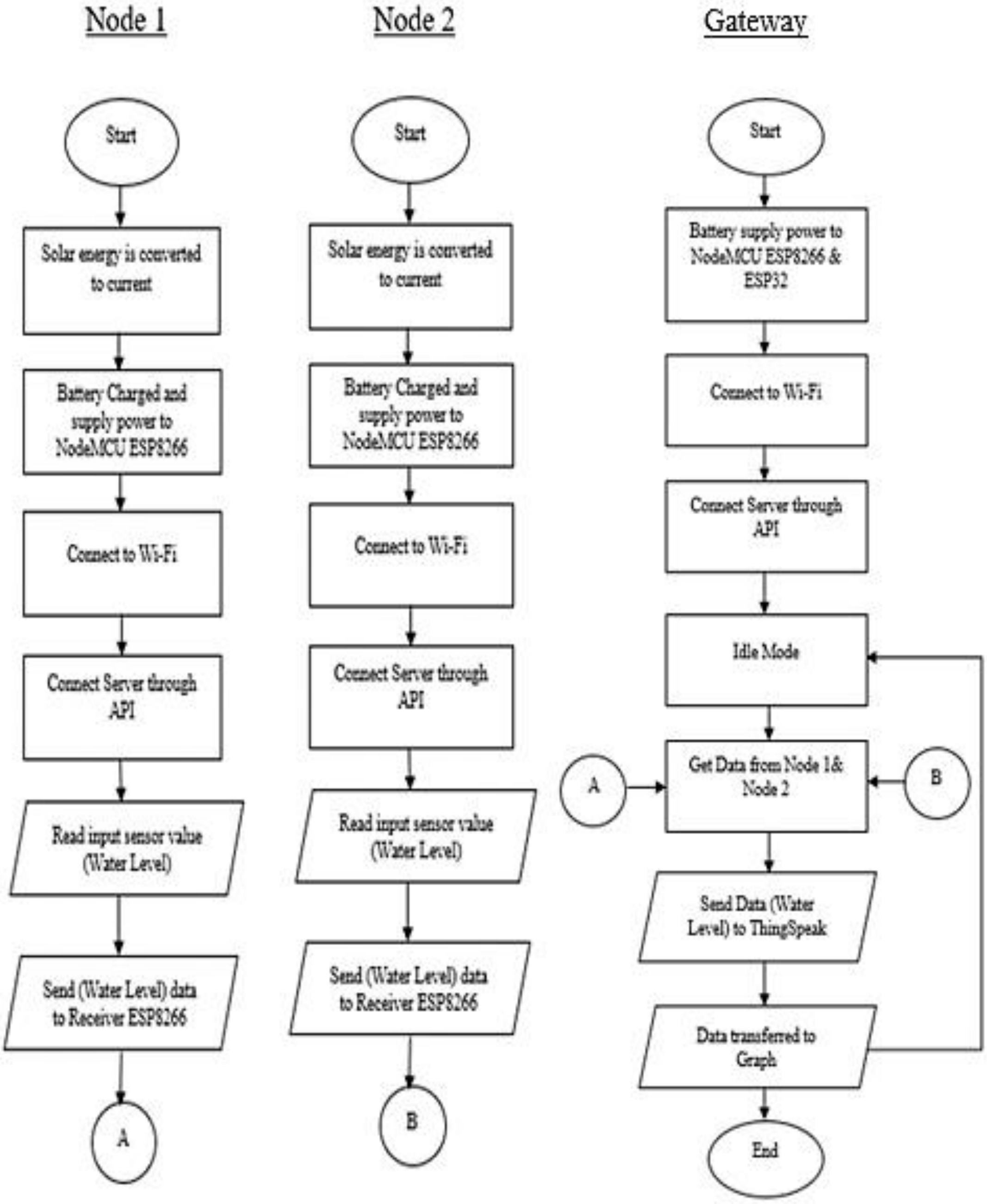

Figure 2: System Flowchart

The system is only functional after the battery is charged using the system solar panel. There are three flowcharts drawn above. There are two nodes with the sender data functional NodeMCU. Another ESP8266 will collect the data and send the data to ThingSpeak to transform into a Graph. Both nodes 1 and 2 function same as read the water level of the paddy field data send to another NodeMCU ESP8266 as gateway.

3. Results and Discussion

3.1 Results

Hardware testing is performed to ensure that the hardware is fully operational. There are three 4 tests have been conducted which are first node, second node third node and gateway test. Both nodes measurement was placed accurate, reliable and had an error of ±1cm. The error might be happening of the wind or other factors that interrupt the signal of the ultrasonic sensor. Figure 3 shows the working overall system prototype.

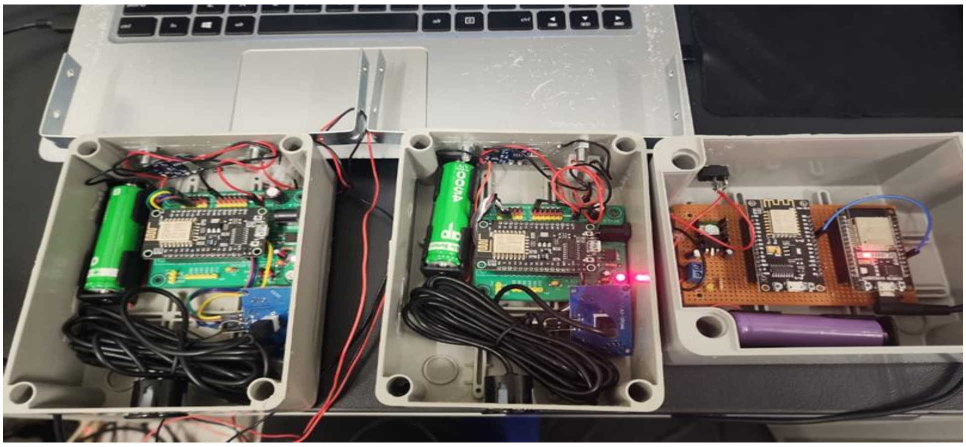

Figure 3: Overall System Working

Both nodes sent water level data continuously in ThingSpeak in graph. For example, figure 4 shows the serial monitor value of both nodes which easy to get know the measurements and check whether it send to correct field graph or not. Then the same after the measurement value appears the data will send to ThingSpeak to generate graph. When the graph goes to high value the owner of the paddy field can act immediately.

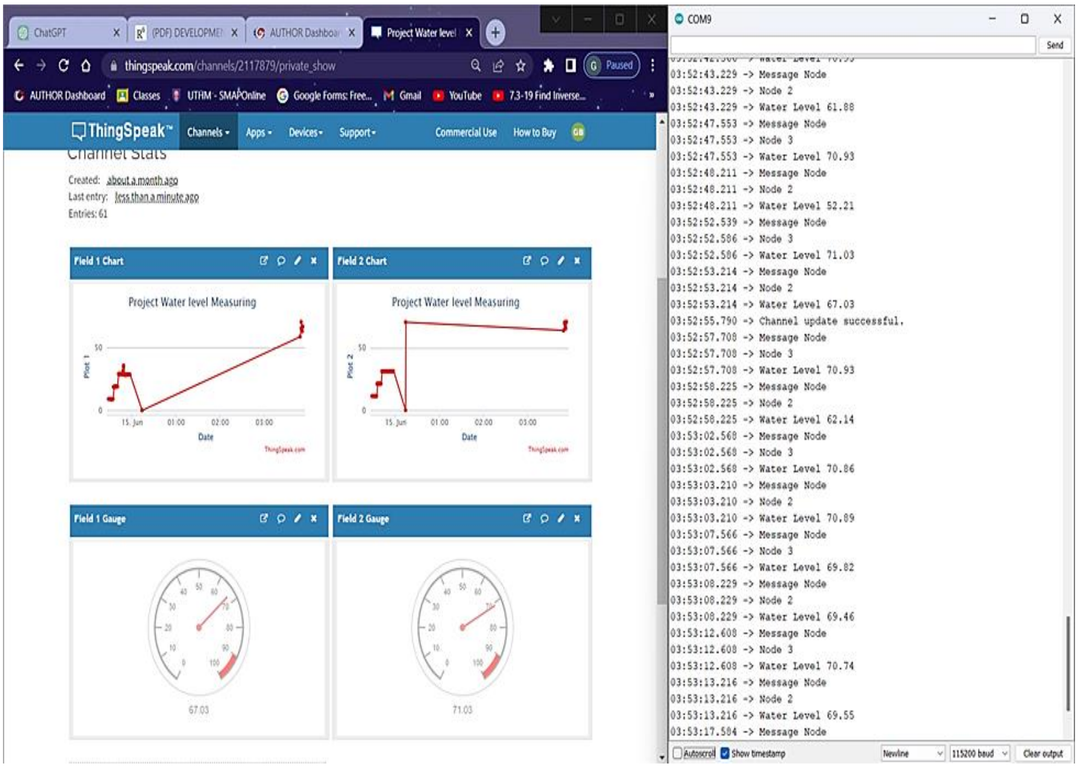

Figure 4: Arduino IDE Serial Monitor with ThingSpeak

3.2 Discussions (Water Level Data Measurement)

The water level data simultaneously taken for both node 1 and node 2. The water level data was taken 6 entries for each specific measurement which 10cm, 20cm, and 30 cm. The test was conducted at a nearby lake. The reading is taken outdoors, so the data will be more different than the data taken indoors. Node 1 and 2 have been fixed in each PVC, and the gateway microcontroller connected to the laptop just to make sure the data sent to ThingSpeak whether correct or not by looking at serial monitor. After adjusting all the readings and hardware, submerged both PVC into the lake to get the readings.

Table 2: Line Graph of the Node 1 & 2

Entries	Node 1 (cm)			Node 2 (cm)		
	10cm	20cm	30cm	10cm	20cm	30cm
1.	11.02	19.95	30.74	10.80	21.99	31.13
2.	10.43	19.64	30.40	11.35	21.92	31.63
3.	10.87	20.47	30.79	11.29	22.07	31.59
4.	10.77	20.34	30.69	12.04	21.83	30.91
5.	10.92	20.24	30.62	11.45	21.21	31.52
6.	9.85	20.13	30.16	11.94	20.63	30.74

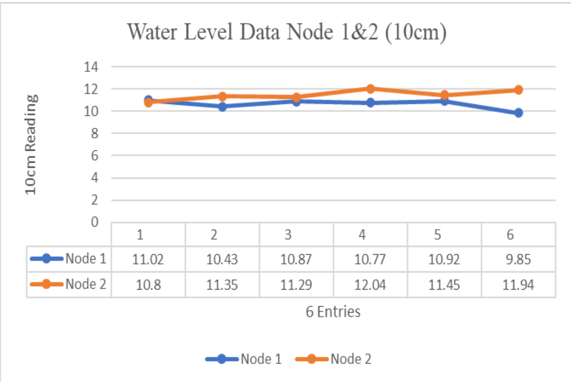

Figure 5: Line Graph of the Node 1 & 2 (10 cm)

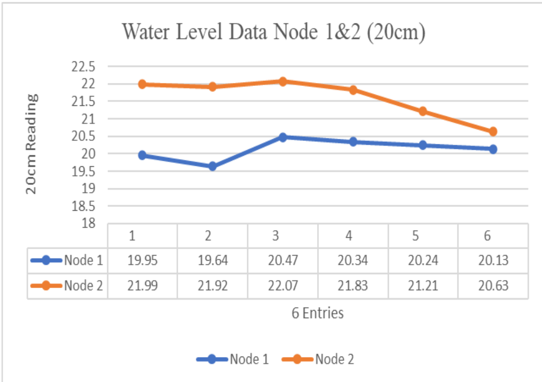

Figure 6: Line Graph of the Node 1 & 2 (20 cm)

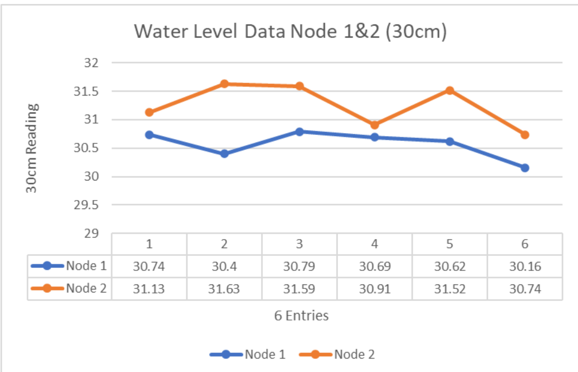

Figure 7: Line Graph of the Node 1 & 2 (30 cm)

Figures 5, 6 and 7 show the line graph chart of the Node 1 and 2 of the water level measurement 10 cm, 20 cm, and 30 cm.. Both nodes measurement was placed accurate and had an error of ±1 cm. The error might be happening of the wind, wave of the lake water and other factors that interrupt the signal of the ultrasonic sensor.

3.3 Discussions (Connectivity Test of The Prototype)

Table 3: Connectivity Test Data Table

Distance (feet)	Connectivity
5	Stable
15	Stable
25	Stable
35	Stable
45	Unstable

This connectivity test was conducted to ensure stable wireless connection between the node 1 and 2 with the gateway by moving far distance. The distance recorded in this test was 5 feet , 15 feet, 25 feet, 35 feet and lastly 45 feet. In the last 45 feet the connection was unstable the data transferring has been stopped receiving.

3.4 Discussions (The Battery Durability of the Prototype)

Table 4: Node 1 and 2 Battery Durability Test Data

Time (Min)	**Voltage (V)**
10	4.0884
20	4.0769
30	4.0653
40	4.0538
50	4.0422
60	4.0307
70	4.0191
80	4.0076
90	3.9960
100	3.9845
110	3.9729
120	3.9614
130	3.9498
140	3.9383
150	3.9267
160	3.9152
170	3.9036
180	3.8921

Table 5: Node 1 and 2 Battery Durability Test Data

Time (Min)	**Voltage (V)**
10	3.9945
20	3.9891
30	3.9836
40	3.9782
50	3.9728
60	3.9673
70	3.9619
80	3.9564
90	3.9510
100	3.9456
110	3.9401
120	3.9347
130	3.929
140	3.9238
150	3.9184
160	3.9129
170	3.9075
180	3.9020

The battery durability test for the prototype aimed to ensure continuous power for monitoring water levels in paddy fields. The Node 1 and Node 2 batteries showed a voltage drop of 0.208 V over 3 hours, indicating a consumption rate of 0.01155 V per 10 minutes, allowing the prototype to last approximately 12 hours. The Gateway battery exhibited a voltage drop of 0.098 V over the same duration, consuming 0.00544 V per 10 minutes and enabling the prototype to last approximately 21 hours. These results demonstrate the prototype's ability to provide sustained power for the intended monitoring system.

4. Conclusion

The water level monitoring system developed for paddy field irrigation successfully achieved its objectives and scope. Through extensive studies and analysis, suitable specifications were determined, including the use of waterproof ultrasonic sensors for measuring water levels, ESP8266 as client and server for communication, and ESP32 for Wi-Fi connectivity to send data to ThingSpeak. The system also employed an environmentally friendly power source with solar power supply. The IoT-based monitoring system effectively collected water level data from three nodes and transmitted it to users through ThingSpeak, allowing easy monitoring via smartphones. The system's performance was evaluated in terms of accuracy, reliability, and effectiveness, with comparisons made between manual measurements and data obtained from the automated system, as well as tests conducted on battery durability and connectivity. Overall, the project successfully created a reliable and efficient water level monitoring system for paddy field plot owners, empowering them to take appropriate actions to safeguard their paddy field conditions and ensure optimal irrigation processes.

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