ENHANCING PADDY WATER MANAGEMENT WITH WATER MONITORING SYSTEM

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ABSTRACT

Efficient water management is critical in rice cultivation, and it plays a pivotal role in ensuring high crop yields while conserving this precious resource. This abstract introduces a comprehensive approach to enhance paddy water management through the integration of a state-of-the-art water monitoring system. The proposed system leverages advanced sensor technology, data analytics, and real-time feedback mechanisms to optimize water usage in paddy fields. The water monitoring system collects crucial data points such as water level. Through the application of machine learning algorithms, this data is processed to provide actionable insights for farmers. These insights empower them to make informed decisions regarding irrigation schedules, ensuring that water is applied precisely when and where it is needed most. By adopting this innovative water monitoring system, farmers can significantly reduce water wastage, lower operational costs, and enhance overall crop productivity. Additionally, the system contributes to sustainable agriculture practices by conserving water resources and minimizing the environmental impact associated with excessive irrigation.

Keywords: Water monitoring system, irrigation, paddy

INTRODUCTION

Management of water resources is a major challenge, especially in the context of agriculture such as rice production which requires sufficient water supply. Efficiency in the use of water resources is becoming increasingly important for growth and climate change that impacts the stability of water supplies(Arouna et al., 2023). Water monitoring system (WMS) emerged as an innovation that utilizes the latest technology to improve the efficiency of water management in paddy fields. WMS utilizes smart sensors, high-tech data analysis, and real-time monitoring to optimize water use, and reduce the wastage of water resources. By aligning water needs with factors such as dynamically adjusted watering schedules, WMS aims to meet the challenge of deepening water scarcity. The introduction of this technology in agricultural water management leads to potential efficiency in the use of water resources. The effectiveness of WMS also provides an opportunity to reduce production costs and provide a positive impact on environmental sustainability. To support the above statement, research shows that water monitoring system in agriculture provide positive results (Khairuman et al., 2021). By understanding and caring about the importance of this smart system, we can develop and implement more effective strategies in managing water supply to increase agricultural productivity sustainably. Inefficient water management practices pose a major challenge to sustainable development. Traditional water monitoring methods are often manual, time-consuming, and lack real-time capabilities(Sethy et al., 2021), leading to delays in identifying and addressing issues. In addition, increasing demand on water resources, coupled with the effects of climate change, exacerbates this challenge. Internet of thing(IoT) application through water monitoring system can be identify the water needs and the irrigation will supply to the exact location more efficient(Zulkifli et al., 2022).

MATERIALS AND METHODS

The methodology for a smart water management system in paddy fields involves systematic steps to ensure the effective use of technology and data. System Design Several components are used in this project to produce a complete system that can function well.

i. Water level sensor (Ultrasonic Water sensor)
ii. sluice gate (electric motorized sluice)
iii. Global System for Mobile Communication (GSM) module
iv. GSM control system
v. Data logger
vi. Batteries and solar panels

Water monitoring system components

Ultrasonic water level sensors operate based on the principle of ultrasonic technology to measure the distance between the sensor and the water surface. These sensors use ultrasonic waves to determine the time it takes for a signal to travel from the sensor to the surface of the water and back. Here is a general method of how an ultrasonic water level sensor works:

1. Transmitter and Receiver Configuration:
The sensor consists of an ultrasonic transmitter and receiver. The transmitter sends out ultrasonic pulses, which then bounce off the surface of the water.
2. Pulse transmission:

The transmitter emits ultrasonic pulses in the form of sound waves. These pulses travel through the air until they encounter an obstacle, in this case, the water surface.
3. Reflection from the Water Surface: When reaching the water surface, the ultrasonic pulse is reflected towards the sensor due to the difference in acoustic impedance between air and water.

4.Time of Flight Measurement: The sensor measures the time it takes for the ultrasonic pulse to travel from the transmitter to the water surface and back to the receiver. This time-of-flight measurement is used to calculate the distance between the sensor and the water surface.
5. Distance Calculation: The sensor uses the speed of sound in air and the measured time of flight to calculate the distance to the water surface. The formula for distance (D) is given by:

$$D = \frac{1}{2} \times \text{Speed of Sound} \times \text{Time-of-Flight}$$

6. Conversion to Water Level: The calculated distance is then converted to a water level measurement based on the known sensor mounting height above the water surface.

7. Output Signal: The sensor provides an output signal, usually in the form of an analog or digital signal, which represents the water level. This signal can be read by a microcontroller or data logger for further processing.

8. Integration with the Control System: The water level data obtained from the ultrasonic sensor can be integrated into the control system.

10. Power Supply. Batteries and solar panels are used as power supplies.

Water monitoring system flow chart

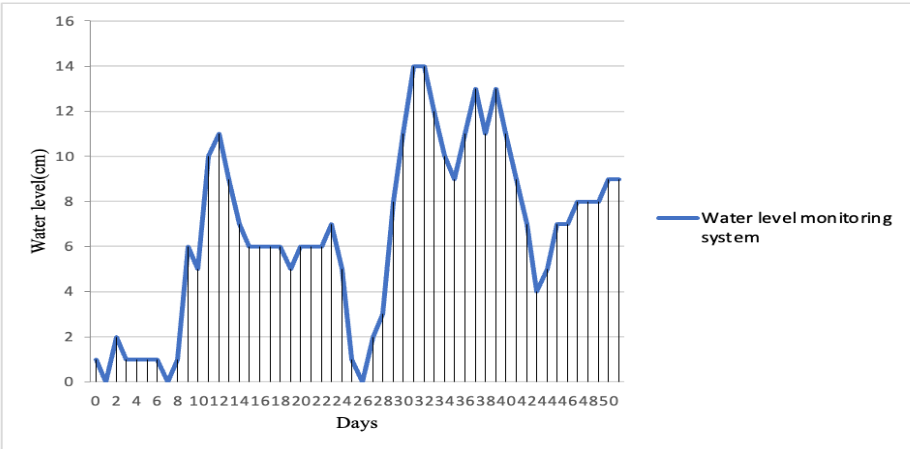
Figure 1 flowchart of water monitoring system

Figure 1 shows a block diagram of a remote water monitoring system. This block diagram is divided into three parts namely input, control system and output. The components in the inlet section consist of a water level sensor and a water flow sensor. and the RV50X GSM modem module acts as the main control; LCD, LED and phone/laptop function as output.

RESULTS AND DISCUSSION

Analysis data for water monitoring systems and rice field water control systems

Figure 2. Water level of paddy field



From the records of the water monitoring system, the average total volume of rice paddy water is 626 m3/day/ha. The average water height is 6.5 cm per season. The activity of increasing the water level is to control weeds and avoid water stress on plants. In addition, water level release activity is to encourage root development and poison weeds. Average Volume of water release 110 m3/ha/day. Average water level 1 cm/ha/day.

Table 1. Evaluation of water monitoring system

Data	*Time*	*Sensor Water level reading (cm)*	*Manual water level reading (cm)*
Water level before irrigation	8.00 AM	4	4.4±2.15
Water level after irrigation	6.00 PM	6	6.5±2.5
Percentage of accuracy	-	93%	-

Table 1 shows the difference between water level sensor readings and manual water level readings in paddy fields. A change of 2 cm during 10 hours of irrigation. The sensor shows an accuracy of 93% compared to the readings taken manually in the rice field average 2.13 cm. The data of 2.15 to 2.5 cm represents the slope of the rice field which can be considered as significant. Water monitoring system components such as water level sensors, automatic pump systems and automatic control gates are ready to be installed on the block B seed production plot in MARDI Parit. IoT water level monitoring and control of water entry in the plot with IoT water gate control. The water monitoring system records continuous flooded irrigation activities in the paddy seed production plot in block B2. On average, 196 m3/ha of water for 10 hours is required to raise the water level by 2 cm. Water is supplied through tube wells on a fully Iot operation. IoT-based control of water gates is tested during the opening and closing of the irrigation system. This system can save water as much as 5 m3/ha every hour if the gate is closed late.

CONCLUSION

This research aims to fill this gap by evaluating the impact of a water monitoring system on paddy water management through field trials and data analysis. The findings are expected to provide valuable insights into the potential benefits, challenges, and best practices for implementing such systems in paddy cultivation.

REFERENCES

Arouna, A., Dzomeku, I. K., Shaibu, A. G., & Nurudeen, A. R. (2023). Water Management for Sustainable Irrigation in Rice (Oryza sativa L.) Production: A Review. In *Agronomy* (Vol. 13, Issue 6). MDPI. https://doi.org/10.3390/agronomy13061522

Khairuman, Satria, E., Anugreni, F., Asmaidi, Rusnanda, R., Barus, E. S., Yuna, A., & Arifa, M. (2021). Irrigation control system design for paddy field by means of internet of things. *IOP Conference Series: Earth and Environmental Science*, *644*(1). https://doi.org/10.1088/1755-1315/644/1/012065

Sethy, P. K., Behera, S. K., Kannan, N., Narayanan, S., & Pandey, C. (2021). Smart paddy field monitoring system using deep learning and IoT. *Concurrent Engineering Research and Applications*, *29*(1), 16–24. https://doi.org/10.1177/1063293X21988944

Zulkifli, C. Z., Garfan, S., Talal, M., Alamoodi, A. H., Alamleh, A., Ahmaro, I. Y. Y., Sulaiman, S., Ibrahim, A. B., Zaidan, B. B., Ismail, A. R., Albahri, O. S., Albahri, A. S., Soon, C. F., Harun, N. H., & Chiang, H. H. (2022). IoT-Based Water Monitoring Systems: A Systematic Review. In *Water (Switzerland)* (Vol. 14, Issue 22). MDPI. https://doi.org/10.3390/w14223621
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