AUTOMATED IOT WATERGATE SYSTEM FOR OPTIMAL PADDY FIELD IRRIGATION MANAGEMENT

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ABSTRACT

Paddy rice cultivation necessitates precise water management, particularly during its growth phases. This study presents the development of an automated watergate system for efficient irrigation management in paddy fields. Utilizing an ESP32 microcontroller, ultrasonic sensors for water level detection, and a linear actuator for gate control, the system enables automated monitoring and regulation of water levels. Data collected from the sensors are transmitted to the Blynk IoT platform, allowing real-time monitoring through web or mobile interfaces. Calibration tests were conducted to evaluate the relationship between battery capacity and the operation time of the linear actuator, revealing the impact of reduced battery charge on system performance. Additionally, experiments were conducted to determine the optimal distance between the ultrasonic sensor and the microcontroller for accurate water level readings. Results indicated stable performance within 10 meters, emphasizing the importance of sensor placement for reliable measurements. The IoT-based watergate system provides farmers with a user-friendly solution to manage water levels effectively, reducing labor-intensive tasks and ensuring optimal irrigation throughout the paddy rice growth stages. This technology contributes to modernizing agricultural practices, promoting sustainability, and conserving resources in line with industry demands. Further advancements in sensor technology and decision support systems could enhance the system's capabilities for even more efficient irrigation management.

Keywords: Automated irrigation, iot, esp32, paddy cultivation, watergate system

INTRODUCTION

Water demand for industrial, residential, and other uses has recently increased as less water becomes accessible for agriculture. The yearly water requirement for agricultural usage is high, particularly for paddy (Mohamed Zawawi et al., 2010). There are three types of water management methods for paddy fields, which are continuous submergence, intermittent submergence, and continuous flowing irrigation (E. Vadivel et al., n.d.). Continuous land submergence for rice is typically used because the water layer also aids in controlling weed growth. Paddy is cultivated in level basins submerged underwater for most of the growing season. Paddy required a constant water needs which it was remain submerge in the certain level of water for the paddy growth especially in early and mid-season. Its growth depends on the state of soil development, quantity, type of fertilizer given, quality of water used, and climatic conditions (Mohamed Zawawi et al., 2010). Hence, it was important to make sure that the water was always at the optimum level. In rice cultivation, the water requirements for crop growth are different between phases.

There are three stages of the rice plant’s growth: vegetative, reproductive, and ripening (Mohamed Zawawi et al., 2010). The critical phase of water necessity denotes the point where significant yield reduction occurs due to water stress. Thus, the farmer needs to monitor the water level in the paddy fields. The water inflow into paddy fields will be controlled by the water gate installed at the edge of the fields. Traditionally, the farmers manually open or close the gate to fill the paddy fields at the required level. Internet of Things (IoT) is often used in the agriculture sector recently, where all the data or information can be viewed at the fingertip. IoT refers to a “worldwide network of interconnected objects uniquely addressable, based on standard communication protocols” (S. S. Sabry et al., 2019). Although technology is increasingly being applied to agriculture, many tasks, particularly irrigation, are still performed manually (Rau et al., 2017).

The implementation of the IoT in smart irrigation is to construct paddy field observation equipment with a smartphone-based real-time field data collection for the study system and to lower the threshold for farmers to use irrigation techniques that conserve water (Liu et al., 2021). Implementing the innovative irrigation system is to improve the traditional agricultural system, which can increase water conservation in paddy fields. This smart irrigation monitoring system consists of a sensor, actuator, and microcontroller. Hence, this study will give an overview of the application of IoT for irrigation in paddy fieldsGoods and Services Tax (GST) is a consumption tax imposed on the sale of goods and services. In some countries it is also called Value Added Tax (VAT). It is a new tax instrument introduced by the Malaysian government soon, estimated in 2012 would be the soonest year of implementation (Customs Department, 2010). The introduction of GST in Malaysia has called many arguments from various parties including academics, professionals and the nation (would become the taxpayers) on how GST affect goods prices-increase or decrease. The onus of GST is to replace the current Sales Tax and Service Tax in line with the government policy of conforming policies of AFTA.

MATERIALS AND METHODS

System Components

The automated watergate system were set up which comprise of ultrasonic sensor, microcontroller and linear actuator. The ESP32 board was utilized as a microcontroller in an automated water gate system. This highly capable microcontroller, equipped with built-in Wi-Fi and Bluetooth functionalities, was designed to be a perfect solution for Internet of Things (IoT) applications. This setup employs three ultrasonic sensors to observe water levels at various distances within the paddy field. It automatically delivers water from the canal to the paddy field when the water level in the field falls below 5 cm. The HC-SR04 ultrasonic sensor is utilized for this purpose. Collected water level sensor data are stored in a Blynk channel database, which was then used for monitoring and analysis of water level in the field.

Calibration And Test

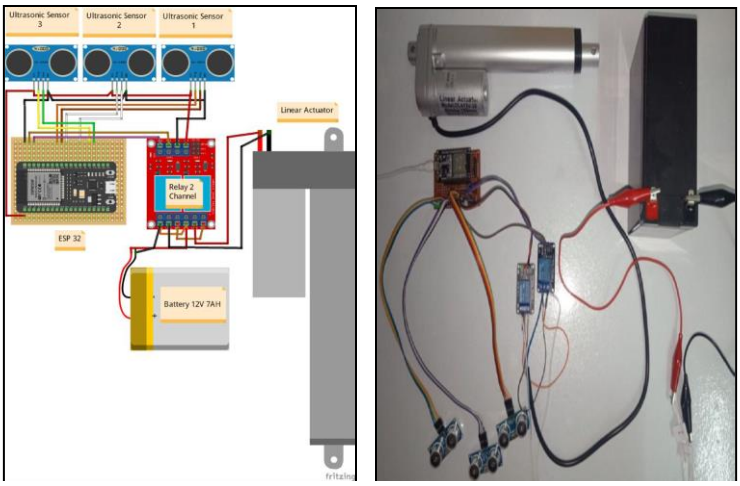
The relationship between battery capacity against extension time of linear actuator were evaluated which examined the time taken for linear actuator to extend or retract at different state of charge of the 12 V battery. Time data for the watergate extension was documented throughout the battery capacity range, spanning from 100% to 0%. The experiment commenced with a voltage check using the multimeter, and simultaneously, the time for the linear actuator's elongation was recorded using a stopwatch. This procedure was repeated throughout the battery capacity range, until the battery's state of charge reached 0%. Apart from that, an experimental investigation focused on evaluating the efficacy of a water level sensor under varying distances. Each of the ultrasonic sensor were placed at the different distance which were 5 m, 10 m, and 15 m from the microcontroller to detect water level with a measured value of 5 centimetres over a 30-second duration. These data were analysed to investigate the effect of ultrasonic sensor distance from microcontroller on the water level reading.

RESULTS AND DISCUSSION

System Component Setup

Figure 1(a) shows the schematic diagram of automatic watergate system drawn using Fritzing software. There were three sensors used to monitoring water level while linear actuator used to control the opening ang closing of the gate. Figure 1(b) shows the developed automatic watergate system that connected to 12 V battery.

Figure 1: (a) Schematic diagram of the automatic watergate system (b) Developed automated watergate system

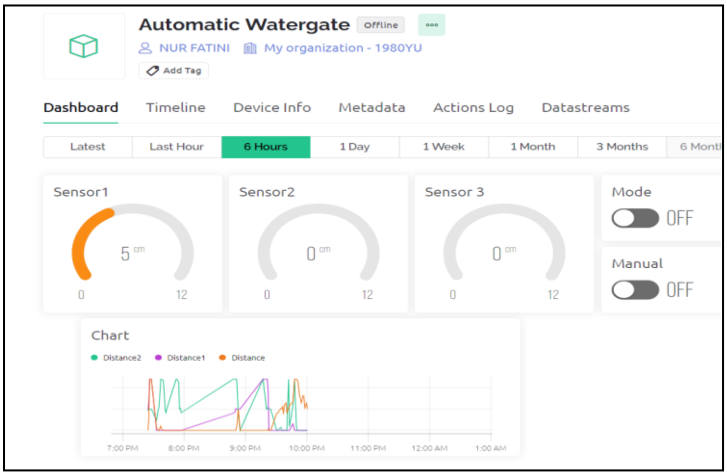


(a) **(b)**

IoT Based Web Platform Interface

The IoT system was designed to obtain value from the sensors and uploaded to the IoT platform through and ESP 32 microcontroller. The IoT platform used was Blynk which was capable of previewing the data obtained in mobile or web interface. Figure 2 displays the interface of the Blynk web dashboard, showcasing the automatic watergate system. The figure illustrates three gauges that indicate the readings from three ultrasonic sensors. The maximum value for the sensor gauge is set at 12 cm, which represents the maximum distance between the water base and the ultrasonic sensor. Activation of the automatic and manual system operation is achieved by clicking on the designated push button. The automated monitoring system successfully reads and uploads water level data from the sensors to the Blynk IoT platform. In the graph, the orange, purple, and green lines correspond to sensor 1, 2, and 3, respectively. The system allows users to access and review the historical data of water levels, enabling them to monitor and track fluctuations in water levels over a selected time period

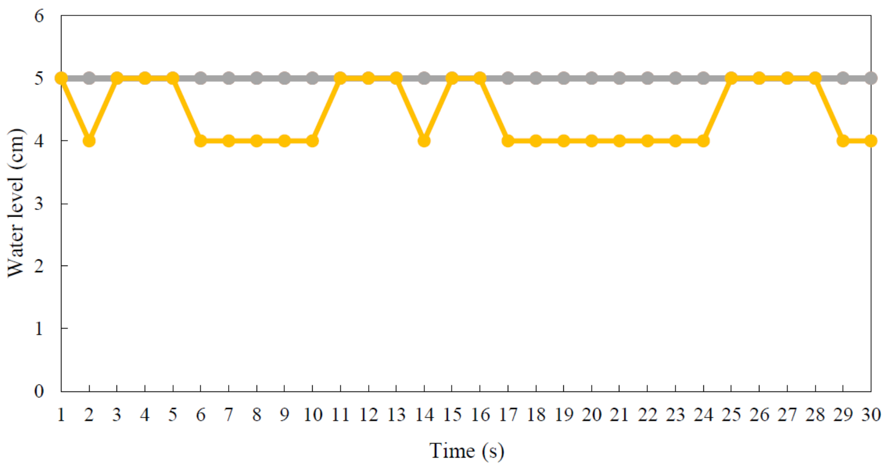
Figure 2: IoT platform dashboard.



The effect of water level sensor distance from microcontroller on the reading of water level

Figure 3 illustrates the operational characteristics of a water level sensor and the microcontroller across various distances on recorded water level values over a 30-second timeframe Determining this optimal distance is crucial when deciding the placement of the sensor in a paddy field, especially avoiding uneven soil areas that can impact measurement accuracy. The experimental results indicated that at distances of 5 and 10 meters, the sensor consistently displayed stable water level readings. The sustained stability of these readings implies that the transmission of signals between the sensor and the microcontroller was reliable and resistant to potential influences from environmental factors or signal degradation. Contrarily, at a distance of 15 meters, the water level readings exhibited fluctuations and instability. This deviation suggests compromised sensor performance at the extended distance, with the observed fluctuations likely arising from signal attenuation or interference, leading to unreliable measurements. It is advisable for optimal accuracy that the distance between the ultrasonic sensor and the microcontroller not exceed 15 meters, ideally in the centre of the field will ensures reliable and accurate water level monitoring.

Figure 3: Water level reading at different water sensor distance



CONCLUSION

In conclusion, this study successfully implemented an automated watergate system for paddy fields using an ESP32 microcontroller and an IoT platform. The research highlighted stable sensor placement within 10 meters, emphasizing the correlation between battery capacity and watergate opening time for consistent system performance. Future improvements could involve advanced sensors and decision support systems. The system's commercial potential lies in cost savings, precise irrigation, and sustainability benefits, making it adaptable to diverse farming scenarios. Overall, this research contributes to modernizing water management practices and promoting efficient, sustainable agriculture in line with industry demands.

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