International Journal of Artificial Intelligence & Robotics (IJAIR)
Vol.6, No.2, 2024, pp.65-74
E - ISSN : 2686-6269

The Implementation of a Smart Energy System with IoT Concept for River Water Distribution Pumps in Rainfed Agricultural Areas

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ABSTRACT

Water pumps for irrigating rainfed rice fields are typically located near or at the edge of rivers, for example, in several locations in Bulakelor and Luwunggede, Brebes Regency villages. Similar situations are found in some rice fields in Sendangadi, Mlati, Sleman, and Piyungan, Bantul, where irrigation pumps are near or at the edge of rivers. According to residents, this reduces the suction power needed. Unfortunately, this also affects the terrain, making it damp and the roads muddy and even slippery, which makes the journey to the pump location difficult and risky, like slipping into a river when the ground is wet and slippery. There is a need to solve this problem by creating an automated pump system that implements IoT concepts using microcontrollers and other control components. The manual water pump is replaced with an electric pump to simplify operation. Control is carried out remotely using a mobile application accessible via websites or smartphones, allowing users to monitor pump operations such as usage duration, automatic on/off scheduling, pump status, and more. This reduces the risk of work accidents with the conventional system. A Renewable Energy System (RES) using a solar power plant (PLTS) is also applied to anticipate power outages, ensuring the IoT system continues to operate and irrigation remains manageable. The operation of such pumps still uses conventional methods that require direct human labor, and only specific individuals can operate the pumps. One example is using diesel pumps that are started by cranking, which requires significant physical strength. These pumps are typically managed collectively by the residents, who take turns operating the pump. Another factor is the age of the pump engine itself, which affects its lifespan. The usage is often not well controlled, with uncertainty in the operating times and operator negligence, such as forgetting to turn off the pump. The limitation of this research is that the operation is conducted automatically based on previous pump usage data, ignoring the size of the pipes used in irrigation and focusing on simplifying the operation of the water pump. The system was installed in rainfed fields in Pagergunung hamlet, where farmers used it to operate water pumps via smartphones with the Ubidots application installed and logged in. The results showed that two farmer groups found the automated pump system helpful. The system was built with several components, including the ESP8266 microcontroller, a rain sensor, a relay/power switch, and other supporting components. The system operates automatically according to the morning operational schedule, and operators from each farmer group can control the pump remotely. The pump operates automatically at 6:00 AM, 6:30 AM, and 7:00 AM. If the rain sensor does not detect water drops/rain, the pump will typically run for 1.5 hours. The innovation in this research lies in implementing an automated pump system that operates according to a schedule while allowing remote control of the pump to irrigate rainfed fields.

Keywords: Automatic Water Pump; Internet of Things; Rainfed Rice Fields; Rain Sensor; Renewable Energy Solar Power Plant; PLTS.

Article History

Received : Sept, 13th 2024	Accepted : Nov, 27th 2024	Published : Dec, 07th 2024

I. INTRODUCTION

Rainfed agricultural areas are fields or rice paddies with dams that cannot be continuously irrigated at certain heights and times [1]. These areas are highly dependent on rainfall [2]. For instance, in Pagergunung hamlet, Piyungan, Bantul, the agricultural areas are rainfed, situated geographically below hills and above river streams, which necessitates the use of water pumps to channel water from the river to the agricultural areas [3][4]. In Bulakelor and Luwunggede, Brebes Regency, the rainfed agricultural areas also require water supply through pumps to irrigate the land and allow planting.

In these cases, the water pumps used are diesel pumps, still operated manually by the villagers [5][6]. Typically, these pumps are located near or along the riverbanks [4][6][7]. Similar setups can be found in some agricultural points in Sendangadi, Mlati, Sleman, and Piyungan, Bantul, where irrigation pumps for rice fields are placed near or along the river. According to the residents, this setup reduces the suction power needed. Still, it also affects the terrain conditions, making the ground moist and the paths muddy or slippery, thus making the journey to the pump location difficult and risky.

DOI: http://dx.doi.org/10.25139/ijair.v6i2.9027

Additionally, the age of the pump itself impacts its operational lifespan. The pump operation process still uses conventional methods requiring direct human labour [6][7][8], with only certain individuals being able to operate the pumps [4]. One example is using diesel pumps that are started by cranking, which requires significant physical strength. The community generally manages these pumps collectively, with villagers operating the pumps. The operation is often poorly controlled, with uncertain pump operation times and operator negligence, such as forgetting to turn off the pump, leading to wasted energy consumption.

Based on the above background, the research problem is implementing a smart energy system with the IoT concept on river water distribution pumps for irrigating rainfed agricultural areas. The intelligent system referred to in this research is the design of an automated system that minimizes direct user operation. The operation in question includes turning the pump on and off. If the pump is turned off on time or as scheduled, it positively impacts energy usage efficiency. The IoT concept is used to support remote operation of the system via the internet with smart devices such as smartphones. This technology aims to simplify pump operation for users, particularly operators, reduce the risks associated with direct operation, enable remote control, streamline monitoring and control of the pump, and improve energy efficiency by minimizing excessive use. This technology is expected to ease the operation of the water distribution pumps for users, especially operators, reduce operational risks, enable remote control, simplify pump monitoring and control, and increase energy efficiency.

The researchers propose to develop a system for automatic and remotely controlled water pump operation using the IoT concept. The automation will be achieved using microcontrollers, sensors, and other control system components [9][10]. This will allow anyone chosen to operate and monitor the pump. The entire device setup will include an Arduino microcontroller with its connection modules, a rain sensor, a Relay Switch Module, and other control components [11][12][13]. Monitoring and controlling activities will also be easily conducted using the IoT concept. The pump will automatically turn on at predetermined times, and conventional ON/OFF functionality will be embedded, stopping within the designated time frame. The system also has a rain sensor to prevent irrigation during rainfall. This ensures that the pump remains off if it rains. Using a solar power plant (PLTS) is deemed necessary to anticipate power outages that could hinder the system's performance. This will ensure the system remains operational even during power outages from conventional electricity sources [3][14].

This research categorizes previous research into three categories as a reference for this research's innovations. The categories include Renewable Energy, Smart Water Pumps, and Sensors & IoT. The main points of previous studies are summarized in Table I.

TABLE I
THE TABLE OF PREVIOUS RESEARCH COMPARISON

Year	Authors	Objective, Method & Components	Result
Smart Water Pump			
2023	[8]	Design of an automatic pump control system/device using a mobile application for pump monitoring.	An automatic pump control device was created and used, utilizing Blynk as the IoT Dashboard.
2023	[9]	Implementation of a semi-automatic pump control system for irrigation in rainfed paddy fields.	A semi-automatic water pump control device was implemented to irrigate rainfed paddy fields.
2022	[5]	Design of an automatic water scheduling device for aquaponics.	The design resulted in an automatic water supply system for aquaponics, operating four times a day.
2021	[17]	Design an automatic irrigation system based on soil moisture using a YL-69 sensor.	The system successfully automated plant watering based on soil moisture levels.
2021	[12]	Design an automatic water pump using artificial intelligence for easy operation and electrical power efficiency.	The water pump operated automatically and could be controlled remotely using a mobile device.
2021	[18]	Autonomous Smart Water Tank pump for water usage efficiency and ease of operation.	The autonomous pump could be controlled via mobile devices with LED indicators.
2021	[19]	Real-time monitoring of continuous water supply to ensure proper distribution.	Water supply monitoring in storage tanks could be done remotely, leveraging IoT technology.
2021	[11]	Design of an IoT-based automatic water pump to address water wastage and improve efficiency.	The pump was fully automated and cost-efficient.
Sensor & IOT			
2023	[4]	Implementation of a water quality monitoring tool using machine learning to ensure optimal water pH.	The water quality monitoring tool was successfully implemented and functioned well using IoT and machine learning.
2023	[7]	Design of a current and voltage control device with Blynk as the IoT Dashboard.	Current and voltage could be monitored using the prepared mobile application.
2023	[21]	Design of a real-time rain detection monitoring system using IoT and maps.	The rain detection monitoring system using maps and IoT was successfully implemented.
2023	[13]	Design of a rain detection system using a rain sensor.	The buzzer and red light activate when the sensor value is <500.
2021	[22]	Creation of a miniature weather station to monitor rainfall, temperature, and humidity.	A mobile application, the system could measure rainfall, temperature, and humidity.
2022	[23]	Design an automatic irrigation system based on soil moisture to enhance watering efficiency.	The tool lightened the workload of farmers and provided additional information about soil conditions.

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Year	Authors	Objective, Method & Components	Result
2021	[24]	Design of a rain and flood detection system using MQTT Over WebSocket and ESP8266 Module.	The device could be installed on highways prone to flooding to detect early signs of flooding during rain.
2021	[25]	Design of a rain detector to detect rain.	The wetter the raindrop sensor, the higher the buzzer intensity.
Renewable Energy for Smart System			
2024	[26]	Solar panel for powering water pumps and calculating solar panel performance.	The highest voltage obtained by the panel was around 12:00 PM, with a voltage of approximately 20V.
2023	[3]	Utilization of renewable energy for smart farming, designing an automatic fish feeder, and monitoring water pH.	Renewable energy was installed in the smart farming area to enhance agricultural and fish farming outcomes.
2023	[8]	Design of a solar-powered water pump to address power outages.	The power supply indicator indicated that the water volume increased by 2 meters.
2021	[6]	Design of a solar-powered water pump to address irrigation drought problems.	The water pump could be used with the help of solar panels to supply electrical energy.
2021	[27]	Innovation in utilizing solar energy as a substitute for conventional electricity to power water pumps.	It took 29 minutes to fill a 520-litre water tank, requiring an average power of 60 Wh.

Based on the results of previous studies presented in the Table above, the author proposes a system improvement by integrating the three categories mentioned above into a single comprehensive system, namely a Smart Water Pump, Sensor, and IoT Concept, and the application of renewable energy. The author implements a smart system and IoT concept in the river water distribution pump by utilizing solar energy as a renewable energy source.

II. METHOD

The research method is divided into ten stages: problem analysis and formulation, needs identification, electronic circuit design, electronic circuit assembly, system interface design, system interface development, system integration, system testing, system evaluation, and reporting. Briefly, the research stages are illustrated as shown in Fig.1

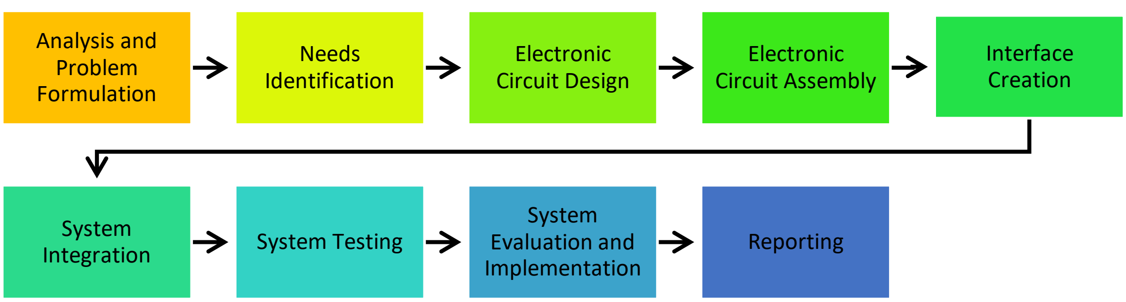

Fig.1. Research Stage

The explanation of each research stage is presented in detail, covering the process, outputs, and achievement indicators, as shown in Table II.

TABLE II
THE EXPLANATION OF RESEARCH STAGE (RESEARCH STAGES, PROCESSES AND OUTPUTS, AND ACHIEVEMENT INDICATORS)

Research Stage	Achievement Indicators
Analysis and Problem Formulation	a) Identifying and understanding the problems in the field, challenges in operating the manual pump currently in use, b) Understanding that rain-fed fields/farms rely solely on rainfall during the rainy season and water from pumps during the dry season, c) Farmers need a system that is easy to operate and suitable for rain-fed fields/farms.
Needs Identification	System requirements based on problem analysis include: a) An electric pump with modifications to enable automatic on/off functionality, b) Remote control capabilities to simplify operation, especially for pumps located approximately 500 meters from residential areas, c) Required components include a controller and its supporting elements, networking devices, and a power supply to ensure system operation without conventional electricity.
Electronic Circuit Design	Designing the electronic circuit for the automatic pump system, simulating the system virtually, and creating the system control board.
Electronic Circuit Assembly	Installing solar power systems networking devices, printing the system control board, and assembling system components into an integrated unit.
Interface Creation	Creating an account on the Ubidots IoT dashboard platform, designing the IoT dashboard interface, and configuring the dashboard with the pre-established network.

DOI: http://dx.doi.org/10.25139/ijair.v6i2.9027

 E - ISSN : 2686-6269

Research Stage	Achievement Indicators
System Integration	Writing the automatic pump and IoT communication program code, calibrating the system, and connecting control devices with the network.
System Testing	a) Testing the relay's operation based on the predetermined pump schedule. b) Testing data input conditions from the rain sensor to the controller. c) Assessing the connectivity level between the Internet of Things application, networking devices, and the automatic pump system to facilitate remote control. d) Recording test results.
System Evaluation and Implementation	Analyzing test results, installing the system on-site, conducting post-correction testing, and refining any operational discrepancies.
Reporting	Preparing a user manual and troubleshooting guide, writing scientific articles about the system, and compiling other documents as part of the research report.

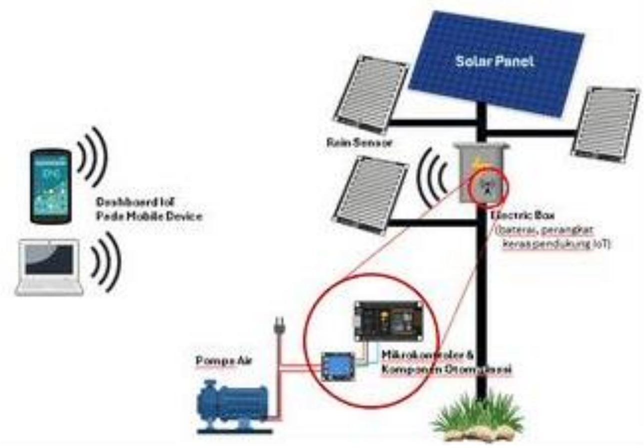

Fig.2. The Design Diagram of The System Being Developed

The smart energy system design for water distribution pumps using the IoT concept is illustrated in Fig.2. The smart energy system design for the water distribution pump with the IoT concept, as illustrated in the image above, is supported by several components. The system components are to be designed.

1) *Solar Power System (PLTS) Components:* These include solar panels, inverters, solar cell controllers (SCC), and batteries. Supplies power to IoT devices installed at the pump site, including the control system and networking devices. Solar panels are a technology designed to convert solar energy into electrical energy through photovoltaics. This technology utilizes semiconductor materials to capture sunlight and generate an electric current. Solar panels provide a sustainable solution to reduce dependency on fossil fuel energy sources while minimizing carbon emissions and environmental impact. In this research, solar panels support the power supply for the control system and networking devices, ensuring they remain operational even when the surrounding environment, which uses conventional electricity, experiences power outages. The solar panels used in this study have a power rating of 50 WP each, with three panels in total, generating a maximum of 150 WP to charge a 1200V battery with a 1000-watt hybrid inverter.

2) *Smart System Components:* These include a microcontroller, relays, sensors, water pump, and other supporting components. This component is the main component in the implementation of intelligent systems. The following are some of the components in question.

a) The microcontroller used in this research is the ESP8266, which features a low-power system for a microcontroller chip equipped with a WiFi module and Bluetooth. The ESP8266 serves as the primary board to connect all the designed sensors. It is programmed with source code to perform the project's operations. This source code is stored in the on-chip memory available in the ESP8266. In the left picture in Fig.3, the ESP8266 microcontroller is connected to various components in the system. Fig.3 shows that the microcontroller is the main testing component.

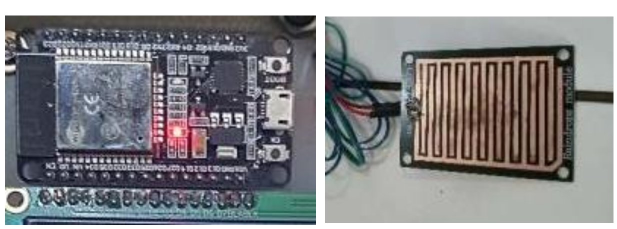
Fig.3. ESP8266 Microcontroller (Left) and Rain Sensor (Right)

DOI: http://dx.doi.org/10.25139/ijair.v6i2.9027

E - ISSN : 2686-6269

b) The rain sensor acts as an input component in the designed system. The rain sensor will send rain information when it detects water droplets interpreted as rainwater. This information will subsequently influence the system's output. The rain sensor detects rainfall and has four pins: Ground (GND), Voltage (VCC), Digital Output (DO), and Analog Output (AO). The rain sensor in this research is on the right in Fig.2.

c) The relay functions as a switch that connects or disconnects power based on the microcontroller's control. In this study, the relay is controlled by the real-time clock within the system itself and by the IoT platform. The relay used in this research is a 2-channel relay with four pins: GND, VCC, IN1, and IN2. GND on the relay is connected to GND on the ESP8266, VCC to VIN on the ESP8266, and IN1 to pin D14 on the ESP8266. The relay operates with a trigger signal of "0," meaning the relay is activated when the logic signal is LOW. The relay used in this research is shown in the left picture in Fig.4.

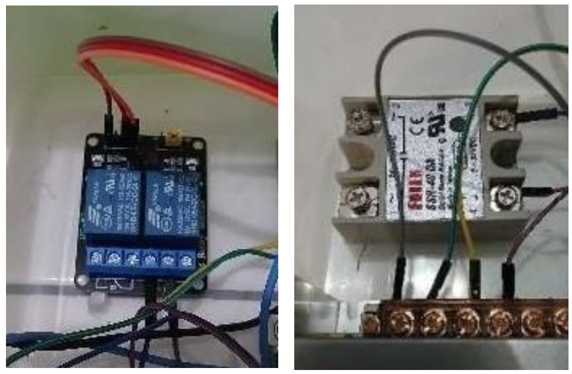

Fig.4. Relay (left) and Solid-State Relay or SSR (right)

d) SSR (Solid State Relay) is an electronic switch similar to a mechanical relay but uses semiconductors. It controls larger currents using small control currents. Unlike mechanical relays, SSRs do not have moving parts or coils. Fig.4 right is the SSR used in this system. The SSR used in this research is the Fotek type, with a 40 DA (DC and AC) rating, connected to the power supply to control the incoming electrical current.

e) The water pump serves as a tool for distributing water from the water source to rain-fed fields/farms. Initially, the pump was a standard water pump powered by an electrical outlet. In this study, modifications were made to its power cable, which was connected to the relay to control its operation following the system's flow.

f) The power supply provides a stable and appropriate source of electricity for the system or devices. It can convert voltage from AC to DC or vice versa, the power supply used in this system. The power supply used in this research provides 5V/10A. Components connected to the power supply include the power cables, on/off push button, and SSR.

3) Mobile Components: These include smartphones, computers, and/or laptops with the system control application installed. The application used in the IoT concept for this study is Ubidots. Users can operate the water pump using their devices by having an account on the Ubidots platform conFig.d with the system. Ubidots is a cloud-based platform for managing Internet of Things (IoT) data. Ubidots were used in this study as a differentiator from previous research. It also offers features like flexible APIs and integration with various IoT protocols. The interface is user-friendly, making it easier for users, including farmers in the Pagergunung village, to operate.

4) Network Components include WiFi routers and access points to ensure communication remains operational. This component provides an internet connection to the microcontroller, enabling it to connect to the internet and ensuring data communication between the user device and the developed system remains established. The networking equipment components include routers, switches, hubs, and access points, which connect and manage traffic between devices. This study's networking components support communication between the control system and users outside the farm/field environment.

The system starts in an OFF state or inactive mode for the pump, but the Real Time Clock (RTC) or timer remains ON. The RTC is used to keep track of time within the system. On the other hand, the rain sensor detects the environmental conditions by determining whether it is raining. If no rain is detected, the system will notify the IoT device with a confirmation message saying, "Should the pump be turned on now?" If the response is "yes," the pump will be activated. However, if the response is "no," the system will delay for ten minutes before sending the same confirmation for the second time. If the response is still "no," the system will delay for five minutes before automatically turning the pump on. If rain occurs while the pump is running, the pump will automatically stop. If no rain occurs, the pump will continue to operate until its scheduled stop time. There are two opportunities to delay stopping the pump if the response is "no" or ignored. After that, the system will automatically stop the pump and notify the IoT device. The IoT devices that can be used include smartphones, computers, or laptops with the IoT dashboard application installed, specifically from the Ubidots platform.

The system design is a simulation model before the actual hardware assembly. Fig.5 is a complex electronic circuit diagram

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integrating several key components. The circuit consists of a relay, LCD, microcontroller, rain sensor, water flow sensor, and push button.

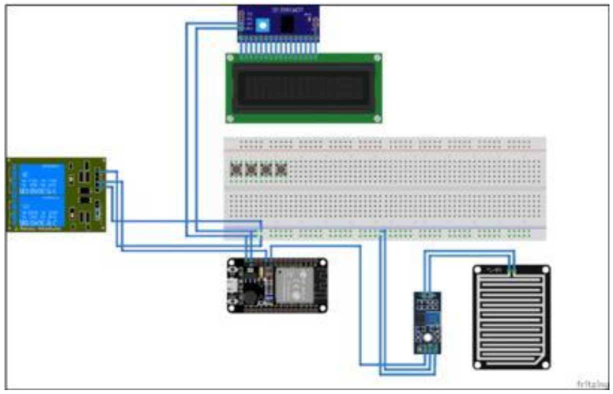

Fig.5. System Design

III. RESULT AND DISCUSSION

The investigation found that the intelligent system was applied to the water pump, when the Internet of Things concept was utilized. The designed system hardware was then assembled in reality. The assembly was done according to the previously developed design and pin configuration. Fig.6 is the prototype system, a circuit of the automatic water pump system that was designed, where the circuit includes a microcontroller (NodeMCU ESP8266), rain sensor, water flow sensor, relay, power supply, SSR, LCD, and push button. All components are housed inside a transparent box with a green cover.

Fig.6. Hardware System

The rain sensor is tested by splashing or wetting it in this test. In this system, the rain sensor is closely connected to the relay. This is because the relay operates based on weather conditions the rain sensor detects. The relay functions as a switch, enabling remote control of devices. Automation systems commonly use it to turn devices on or off based on specific conditions automatically. Table III is the testing Table for the rain sensor, showing the results of the rain sensor test.

TABLE III
RAIN SENSOR TESTING

ADC Rain Sensor	Weather Condition	Description	Status
4049	No rain	Relay off	Error
4049	No rain	Relay off	Error
4049	No rain	Relay off	Error
81	Rain	Relay off	The rain sensor detects rain.
85	Rain	Relay off	
84	Rain	Relay off	
4045	No rain	Relay on	The rain sensor is dried off from water
4045	No rain	Relay on	
4049	No rain	Relay on	

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ADC Rain Sensor	Weather Condition	Description	Status
4049	No rain	Relay on	
80	Rain	Relay off	The rain sensor detects rain.
87	Rain	Relay off	
81	Rain	Relay off	
84	Rain	Relay off	
83	Rain	Relay off	

The rain sensor will output a HIGH signal when exposed to rain, causing the water pump to stop, and it will output a LOW signal when no rain is detected. The testing of the rain sensor initially resulted in errors. This was due to some components being improperly or incompletely connected, causing disruptions. After addressing these issues, further testing was conducted by dripping water onto the rain sensor, successfully detecting rain conditions. The rain sensor needed to be dried from water to revert the system and detect clear weather.

System Testing: The IoT-based automatic pump system was tested to evaluate the pump's performance regarding weather conditions and the predetermined schedule. The system was designed to automatically activate the pump at 06:00, 06:30, and 07:00 daily, with each activation lasting 30 minutes. Weather conditions, particularly rain, also influence the pump's operation. If the rain sensor detects rain during a scheduled activation, the pump will remain off until the next scheduled time. Users can manually operate the pump remotely using the Ubidots application on a smartphone, laptop, or computer if all three sessions are skipped without the pump being activated.

The Table below records the results of testing the automatic pump system, considering weather conditions (rain or no rain) during each scheduled time. In the testing process, the system could function automatically by adjusting the pump operation based on the weather conditions.

TABLE IV
SYSTEM TESTING

Day	Method	Time	Duration (minutes)	Remarks
Day 1	Timer	06:00	30	The pump operates as scheduled, the rain sensor is dry, and no rain is detected.
	Timer	06:30	30	The pump operates as scheduled, the rain sensor is dry, and no rain is detected.
	Timer	07:00	30	The pump operates as scheduled, the rain sensor is dry, and no rain is detected.
	Smartphone	08:35	30	The pump runs for 30 minutes via Ubidots, and the rain sensor dry.
	Smartphone	09:40	10	Pump activated and deactivated via Ubidots.
Day 2	Timer	06:00	30	The pump is off, the rain sensor is moist, and rain is detected.
	Timer	06:30	30	The pump operates as scheduled, the rain sensor is dry, and no rain is detected.
	Timer	07:00	30	The pump operates as scheduled, the rain sensor is dry, and no rain is detected.
	Smartphone	08:00	10	Pump activated and deactivated via Ubidots.
	Smartphone	08:15	30	The pump was activated via Ubidots, and the rain sensor was dry; no rain was detected.
	Laptop	08:55	5	The pump runs for 5 minutes via Ubidots, and the rain sensor moistens and detects rain.
	Computer	09:30	15	The pump runs for 15 minutes via Ubidots, the rain sensor is moistened, and rain is detected.
Day 3	Timer	06:00	30	The pump runs for 30 minutes.
	Timer	06:30	30	Pump off, rain sensor moist.
	Timer	07:00	30	The pump runs for 30 minutes, and the rain sensor dries.
	Smartphone	10:45	10	Pump activated and deactivated via Ubidots.
	Laptop	11:00	20	Pump activated and deactivated via Ubidots.
	Computer	11:30	5	Pump activated and deactivated via Ubidots.

After refining the automatic pump system, comprehensive testing was conducted, including its intelligent system with operational scheduling timers, network connections, and the rain sensor. Based on the test results in the Table above, all devices used during the testing operated smoothly. Devices supporting the IoT concept and the Ubidots application included laptops, computers, and smartphones. The testing also involved turning the pump on and off remotely to ensure the device connections functioned smoothly.

The creation of this system uses specialized software for IoT communication. The software used is the Ubidots application. In its implementation, the Ubidots application displays weather conditions and water volume indicators through a mobile device. Program code must first be written to connect the hardware with the system software. The code is written using the Arduino IDE.

The program code for configuring communication between the hardware and system software in the code.

```
LiquidCrystal_I2C lcd(0x27,16,2);
//=========================================================
const char *UBIDOTS_TOKEN = "";  // Put here your Ubidots TOKEN
const char* ssid     = "Asrama UNU PI";
const char* password = "@ppunupi22";
const char *DEVICE_LABEL = "";   // Put here your Device label to which data  will be published
const char *VARIABLE_LABEL = ""; // Put here your Variable label to which data will be published
const int PUBLISH_FREQUENCY = 5000; // Update rate in milliseconds
```

Several configurations are included based on the program structure displayed in the image, such as the Ubidots Token, WiFi SSID, WiFi Password, device label, variable label, and publishing frequency. In addition to configuring the Arduino IDE, the interface in Ubidots must also be set up. The first step is to create a device named "*Irigasi*." This device is then filled with two variables: a rain sensor and a water flow rate sensor, with data from the rain and water flow sensors. The program code below shows the device label (left) and the device variables (right). Both displays serve as the foundation for the smartphone interface, acting as the system's controller and monitor. Fig.7 is the device label (left) and device variables (right).

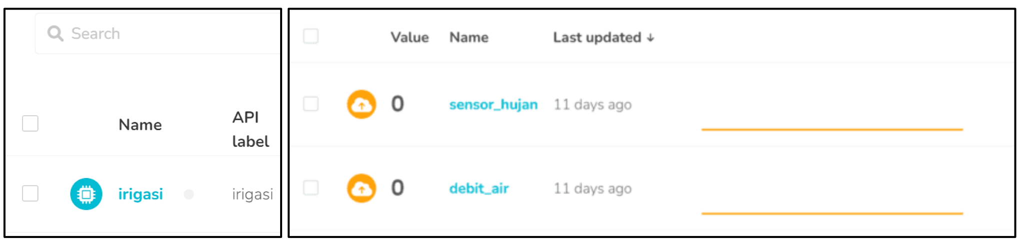

Fig.7. Device Label (Left) And Device Variables (Right)

The results of testing the IoT-based automatic pump system demonstrate that the system operates as intended. Based on the conducted tests, it is evident that the system can adjust the pump's operating time based on the schedule and weather conditions. During each scheduled session—06:00, 06:30, and 07:00—the pump operated for 30 minutes. This confirms the reliability of the system's scheduling and automatic control functions. During testing, when the sensor was moistened, the rain sensor successfully detected rain and automatically deactivated the pump, even if the scheduled activation time had been reached. This indicates that the rain sensor effectively aligns the pump's operational needs with environmental conditions.

When evaluated based on the pump's performance according to the schedule, the test results above indicate that the system successfully operated the pump as per the predefined schedule. This demonstrates that the time-based control functionality operated effectively. During the testing phase, the pump consistently operated for 30 minutes for each scheduled session, as conFig.d. When assessed based on its response to weather conditions, both rainy and non-rainy, the system showed that whenever the rain sensor detected moisture from rain or water droplets, the pump automatically turned off if it was running. If the pump was already off, it remained off. This response occurred when the pump was manually activated via a remote internet connection. This demonstrates that the rain sensor effectively influenced the pump's status based on prevailing weather conditions.

Regarding the manual control system via the IoT platform, the tests showed that the pump could be turned on and off remotely through the Ubidots application. This manual operation was conducted for either a full 30-minute duration or a duration customized by the user. This feature allows users to adjust irrigation duration based on their specific needs or to extend watering time in cases where the scheduled operation was interrupted due to rain detection. Overall, the system consistently demonstrated appropriate responses to both the schedule and weather conditions, whether in automatic or manual operation. Communication between devices functioned smoothly, as evidenced by the pump's controllability via Ubidots without any connectivity issues.

IV. CONCLUSION

In this research, the problem statement focuses on automating a water pump using rain and water flow sensors. The research stages include problem analysis and formulation, identification, reference collection, system design, system testing, success evaluation (yes/no), system evaluation, and reporting. The research produced a system design consisting of an ESP8266 microcontroller, rain sensor, water flow sensor, relay, power supply, SSR (Solid State Relay), and LCD. The data generated is displayed on the cloud-based IoT platform, Ubidots, with the programming tool being Arduino IDE.

This system effectively automates the water pump operation based on weather conditions by using a rain sensor to detect rain. If the rain sensor detects rain, the relay will cut off the power, causing the pump to shut down automatically. The water flow sensor calculates the water flow rate based on pre-conFig.d measurements. Weather conditions and water flow data are displayed on the LCD and can be accessed via a smartphone using the Ubidots application. The intelligent system developed in this research is designed to schedule the operation of water pumps used by farmers to irrigate rainfed fields in Pagergunung hamlet. The irrigation schedule is set for 6:00 AM, 6:30 AM, and 7:00 AM daily, with a watering duration of 30 minutes per session. Under normal conditions without rain detection, the pump will run for 90 minutes from 6:00 AM to 7:30 AM. If the rain sensor detects rain, the pump will automatically turn off, which may result in reduced operating time. Farmers can also manually stop the pump remotely if they feel that irrigation is sufficient before the 90-minute duration using the IoT platform application provided.

ACKNOWLEDGMENTS

The authors thank the Ministry of Education, Culture, Research, and Technology for funding the research team through the Beginner Lecturer Research program. The authors also thank Nahdlatul Ulama University for facilitating the research's administrative and technical aspects and supporting the smooth implementation of this study.

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