Haiwell Scada-Based Rice Field Irrigation Control and Monitoring System

Heri[1], Hasan*[2], Rusman[3], Nurul Fadilah[4], Eko Mardianto[5]
Pontianak State Polytechnic; Jl. General Ahmad Yani, Bansir Laut, Pontianak, 0561-736180
Department of Electrical Engineering, Pontianak State Polytechnic

e-mail: *[1] heriprasetyo417@gmail.com, [2] indra_elka@yahoo.co.id, [3] rusman.dn@gmail.com,

[4] nurulfadillah@polnep.ac.id, [5] emardianto74@gmail.com

Abstract
Control systems play a crucial role in the development of increasingly advanced technology. They are not only needed in industry but also as a key component in integrated and automated systems, including in agriculture. One application is in a Haiwell SCADA-based rice field irrigation system to improve the efficiency of water distribution across the fields. This research aims to design and realize a Haiwell SCADA-based rice field irrigation control and monitoring system that can be accessed via Human Machine Interface (HMI) and Via Android. This system works automatically to monitor and regulate the water level in two rice fields using a water level sensor, and water as a potentiometer controller. The water level is regulated through the scale parameter in the Outseal Studio software, which allows users to set minimum (10centim) and maximum (1meters) limits. When the water is below the minimum limit, the sensor will send a signal to the PLC to activate the pump and open the solenoid valve. Once the water reaches the maximum limit, the system will turn off the pump and close the valve automatically. This process runs on both rice fields. With this system, farmers can control and monitor irrigation conditions in real time and remotely, increasing water efficiency, streamlining workloads, and minimizing the risk of water shortages.

Keywords: Control System, Haiwell SCADA, Monitoring via HMI, Monitoring via Android, Rice Field Irrigation, PLC Outseal Mega V.2, Remote Control, Outseal

INTRODUCTION
Water plays a vital role in various aspects of life, such as household needs, agriculture, industry, and ecosystems. Without water, humans, animals, and plants cannot survive. For example, in rice fields, water has a significant impact on plants. Without water, the ground will dry out, and plants will suffer similar consequences, resulting in wilting and leaf drying. Meeting water needs according to requirements will have a significant impact and produce satisfactory results.

A properly implemented irrigation system will increase crop productivity in rice fields. Currently, irrigation systems are manual, requiring significant time and effort from farmers, and ensuring sufficient water availability throughout the season is crucial.

SCADA (Supervisory Control and Data Acquisition) is a monitoring, control, and data acquisition system used to remotely control processes. Using a SCADA system allows users to remotely control and monitor water levels in fields.

Because manual irrigation requires a significant amount of time and effort for farmers, an automated system was designed to simplify and automate the irrigation process, maintain water stability in the fields, innovate agricultural technology, and monitor water quality in real time.

Based on the aforementioned issues, a solution can be proposed: implementing a Haiwell Scada- based Rice Field Irrigation Control and Monitoring System. This system operates automatically and can be monitored from an Android device to support farmers' performance from home.

METHOD

Figure 1 Research Process Flowchart

The paper should contain an Introduction, Methods, Results and Discussion, then Conclusions and Suggestions for future research. Each paragraph can consist of several subparagraphs written with numerical numbering as shown in the following section.

Literature Study
At this stage, literature studies are conducted based on sources cited from various sources, including books, journals, final projects, theses, and research that have been

selected for study and reference. By understanding the concept and studying the irrigation control system to be built, solutions are sought using tools and materials to achieve the desired solution, and then developed.

Survey and Observation
This project was developed as a prototype as a first step in developing an irrigation system solution for rice fields. The prototype was developed based on direct field observations and mapping of problems experienced by farmers, with the goal of evaluating the system's performance before its full implementation.

Planning
After conducting observations, identify the components needed to design the device. Here are some of the components needed to design the device:
PLC Outseal Mega V2
Used as the brain or control center in a rice field irrigation system.
Water level sensor
Used to read the water level and then give the command to open or close the solenoid valve when the water level in the field reaches the minimum or maximum limit.
24-volt power supply
Used to convert AC voltage to DC. Prototyping requires 24-volt DC current to operate the components, ensuring the stability of each component and ensuring safety for other components.
5-volt relay
This switch, used in this design, acts as an open-close contact to disconnect and connect the electric current to the pump motor, which is used to open and close the valve and the water level indicator light.
Pilot lamp
Used to indicate the water level in the system at the maximum and minimum limits.
Push button
Used to manually activate or deactivate the system.
Water pump
Used to supply water to the field and to open the valve when the field is dry and close it when the water level reaches a predetermined level.
Human Machine Interface (HMI)
This is a local monitoring system and can also be used as a remote control system and can be connected to an Android device.
Buck Converter
Converts the voltage from 220 Volt AC to 5 Volt DC for the power relay.
Solenoid valve
This is used to open and close the water line leading to the field.
Prototype Maker
The construction phase of an irrigation system begins with the design of the model, which begins with the hardware, and continues through to the software development. During construction, careful reading of the schematics and measurements of specific components are essential to ensure the desired results. Components must be assembled according to the manual to achieve optimal results.
To facilitate tool construction, consider the following:
System Block Diagram, Flowchart and Wring System
This block diagram illustrates how the components in an irrigation system work, starting with a 24-volt input voltage and producing outputs, such as opening a valve and turning on the pump motor, which initiates the

irrigation process. The flowchart represents the hardware's workings, organized in a simplified format to facilitate understanding.
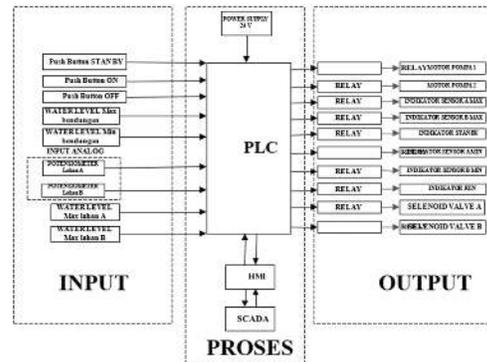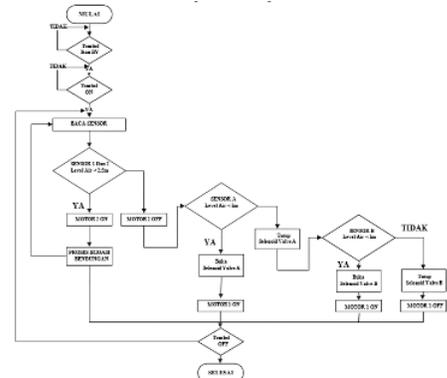

Figure 2 Block Diagram

Figure 3 Flow Chart

Based on Figure 3, the flowchart above explains each structure as follows:
Start
Read the water level sensor float switch
When the water in the dam is dry, the water level sensor float switch at the minimum level will activate and send a command to the PLC to turn on the pump. Once the water reaches the maximum level and the water reaches the water level sensor at the maximum level, the pump will turn off.
Read the potentiometer
When the water in field A reaches the minimum level, potentiometer A will read the signal and send a command to the PLC to open solenoid valve A and turn on the pump motor. Once the water reaches the maximum level, the potentiometer will move according to the predetermined maximum level, then potentiometer A will send a command to the PLC to close solenoid valve A again, turning off the pump motor.
Water level
When the water reaches the minimum level, the solenoid valve opens. Once the water reaches the maximum level, the solenoid valve closes.
Open the solenoid valve
When the command is received from the PLC to open and close the valve during the irrigation process.
PLC Commands
To control which systems will operate after receiving an input signal from the water level sensor.

Pump ON

During the irrigation process on the land.

When the water level reaches the maximum limit, the potentiometer controlled by the water moves according to the predetermined minimum and maximum limits, then sends a command to the PLC to close the solenoid valve and to turn the pump OFF.

The design image above is the overall design of the tool, this circuit consists of several electronic components in the form of inputs and outputs to fully support the manufacture of the tool to obtain satisfactory results.
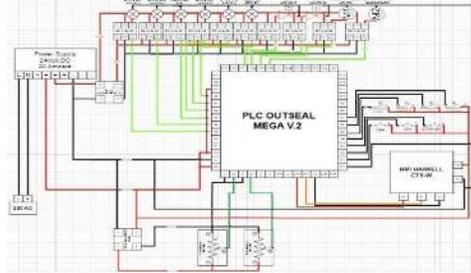

Figure 4 Overall System Wiring

Testing

Once the item is clear, testing will be conducted to determine whether it performs as expected. The testing steps are as follows:

Test the water level sensor to see if it is working as intended.

Test the solenoid valve to see if it responds to the water sensor's command to open and close the valve.

Test the solenoid valve to see if it responds to the specified minimum and maximum water levels.

Test the PLC to see if it is working properly to ensure there are no bugs or no response at all, ensuring the components are in good condition.

Test the Haiwell Cloud SCADA to see if it can connect to the PLC and ensure it can be configured to connect to Android.

Test each component to minimize the risk of failure during public trials.

Test the program to ensure the system is running as intended.

Analysis of Results

After testing the tool, an analysis is carried out to determine whether the tool is working according to requirements or not.

The following stage is to carry out an analysis of all parts of the system that have been completed, the analysis includes the following:

System testing

Based on the tool to be created, namely the Haiwell Scada-Based Rice Field Irrigation Control and Monitoring System, the problem is formulated into an analysis to determine why the system is not working as intended.

Control and Monitoring System Testing

This system is designed for remote monitoring, making it easier for farmers to monitor remotely from anywhere, as long as their Android device remains connected to the SCADA. This system not only monitors but also allows remote control. This significantly reduces the need for farmers to visit the fields to monitor the land directly.

Tool Performance Testing

This testing is conducted by running the tool continuously to ensure that the tool is problem- free during prolonged use. If no problems are encountered during testing, the tool is functioning normally as intended, and the system is ready for implementation in the community.

RESULTS AND DISCUSSION

For this stage, as a result and discussion that we have examined from testing the tools and systems that we have created, there are these results and conclusions.
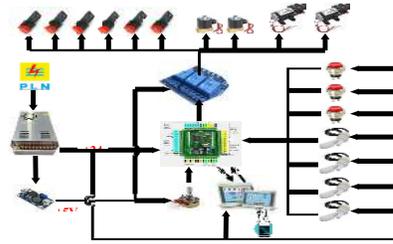

Figure 5 Wiring diagrams

At this stage is a schematic of the wiring diagram which connects each component and sensor used such as the potentiometer water level, Water Float Tank as input and pump, solenoid valve, pilot lamp and relay as output.

The potentiometer functions as a water level sensor at the minimum and maximum levels in fields A and B. When the water level in the field is at the minimum level, the solenoid valve is ready or open, and the pump is turned on. Conversely, when the water level is at the maximum level, the solenoid valve is closed, and the pump is turned off.

The test results for field A show the values based on the water level, starting from a minimum of 10 cm and a maximum of 1 m. The measurement results can be seen in Table 3.1 below.

Table 3.1 Test Data on Land A

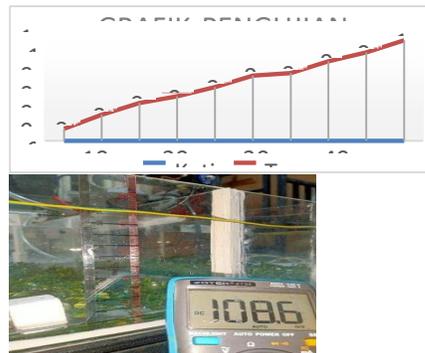| No	Tegangan (V) Lahan A	Tinggi (M)	Volume Air(L)
1	0,127V	10cm	920ml
2	0,278V	20cm	1840ml
3	0,405V	30cm	2760ml
4	0,474V	40cm	3680ml
5	0,576V	50cm	5520ml
6	0,698V	60cm	6440ml
7	0,726V	70cm	6440ml
8	0,850V	80cm	7360ml
9	0,948V	90cm	8200ml
10	1,075V	1m	9200ml

Figure 6 Voltage Graph Based on Land Height A

Figure 7 Measurement Results of Minimum Limit of 10cm for Land A

Figure 8 Test Results on HMI Minimum Limit 10cm Land A

In Figure 7 above, there are the results of the HMI test based on land water at a minimum limit of 10 cm, indicated by the indicator light for the minimum limit of Land A being lit.
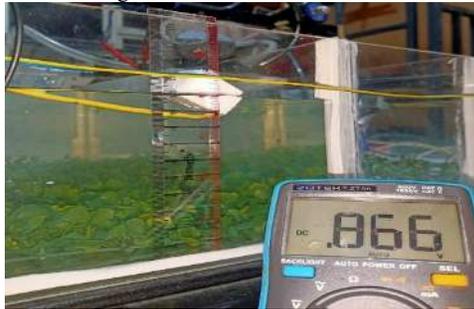

Figure 9 Measurement Results of the Maximum Limit of 1m of Land A

Figure 10 Test Results on HMI Maximum Limit 1m Land A

In Figure 8 above, there are the results of the HMI test based on land water at a maximum limit of 1m, indicated by the maximum limit indicator light for Land A being lit.
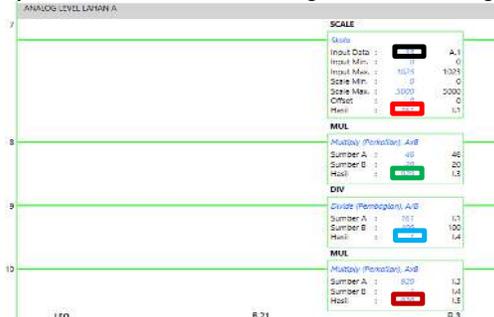

Figure 11 Minimum Limit Test of 10cm Land A

In Figure 8 above, at a height of 10 cm, there is a minimum limit indicator light that lights up, indicating that the water in field A is at the minimum limit. In the image above, there are columns, the black one is (Bit), the red one is (voltage), the green one is (area), the blue one is (height), and the brown one is (water volume).
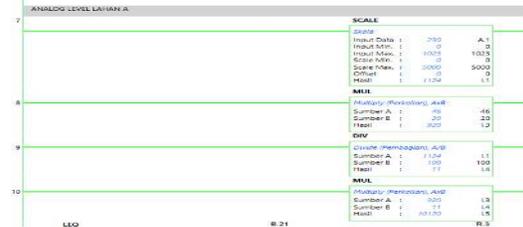

Figure 12 Maximum Limit Testing of 1m Land A

In Figure 8 above, at a height of 1 m, a maximum limit indicator light will illuminate and the solenoid valve will turn off. To indicate that the water level in field A has reached its maximum level, the maximum limit indicator light will illuminate.

Human Machine Interface (HMI) Testing

HMI (Human Machine Interface) testing was conducted to ensure proper communication between the Outseal Mega V.2 PLC and the HMI. The steps involved uploading the visual interface animations to the HMI and testing the functionality of each visual interface animation.

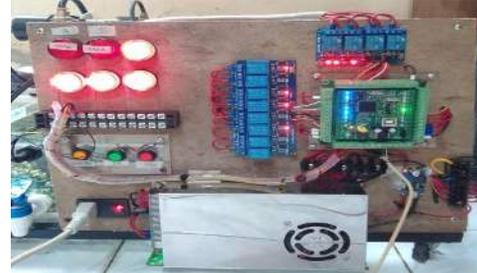Figure 13 HMI Visual Animation Download Results

Figure 14 HMI and PLC Have Been Connected Well

Testing Via Android

Monitoring via Android involves communicating between the HMI and Android via a Wide Area Network (WAN). This testing is performed to ensure proper communication between the PLC as slave, the HMI, and the Android as master within the SCADA system. To access the HMI via Android, proceed as follows:

The monitoring results accessed via the HMI via Android can be seen below.

Figure 15 Monitoring via Android via Wide Area Network (WAN)

Figure 16 Monitoring Prototype Via Android

Figure 17 Physical Form Of The Haiwell SCADA-Based Rice Field Control And Monitoring System

CONCLUSION AND SUGGESTIONS

Conclusion

Based on the analysis and testing results, the following conclusions can be drawn:

A prototype of a Haiwell Scada-based rice field irrigation control and monitoring system was successfully created.

The control system uses an Outseal Mega V.2 PLC.

A water level sensor with a 10K mono potentiometer serves as an analog input and also activates and deactivates the pump and solenoid valve in fields A and B. During testing, the potentiometer was found to be inaccurate.

When the water level in field A reaches a maximum of 10 cm, the solenoid valve in field A closes, while the water level in field B is still being irrigated. When the water level reaches the maximum of 10 cm, the solenoid valve closes and turns off the pump.

The communication mode between the PLC and the HMI is serial communication with RS485, which can accommodate many-to-many communication. The Haiwell Scada-based rice field irrigation control and monitoring system prototype can use an Android device that communicates with the HMI via a wide area network (WAN).

To simplify water level control and monitoring, the system can be used to monitor and control the water level. By maintaining a stable, manageable water level, this reduces pests that disrupt rice growth.

The protocol used is Modbus RTU/ASCII serial communication 485 (RS485).

Suggestion

The following suggestions were provided for further development of the Haiwell SCADA-based rice field irrigation control and monitoring system prototype:

For mechanical engineering, it is recommended to add a panel box to maintain component durability and use sturdy materials for long-term use.

For water level sensors that use 10K mono potentiometers, it is recommended to use high-quality potentiometers to produce accurate analog data.

For solenoid valves, it is recommended to use them as needed to prevent overheating during testing.

Prioritize neatness when wiring to facilitate inspections if wiring issues occur.

For communication between the HMI and the Outseal PLC, always refer to the Outseal PLC datasheet to ensure the system runs as intended.

When uploading a program, ensure the COM port matches the COM port used between the laptop and the PLC.

For implementation, use an accurate water level sensor to ensure optimal system performance.

REFERENCES

[1]. Adani, M. F., Jusak, & Pratikno, H. (2016). Journal of Control and Network Systems. Journal of Control and Network Systems, 5(1), 119–125.

[2]. Alel, C. D., & Aswardi, A. (2020). Design and Construction of Automatic Water Gate Opening and Closing for Rice Field Irrigation Based on Arduino and Monitoring Using Android. JTEV (Journal of Electrical and Vocational Engineering), 6(1), 167. https://doi.org/10.24036/jtev.v6i1.107924

[3]. Baco, S. S., Sajiah, S., Suradi, S., A., N. A., & Suluwetang, W. (2023). Design and Construction of Rice Field Irrigation Monitoring System Using ESP8266 Based on Android with Telegram Bot Mode. Journal of System and Computer Engineering (JSCE), 4(1), 50–61. https://doi.org/10.47650/jsce.v4i1.708

[4]. Putra, Y. A., & Yuhendri, M. (2023). Smart Automatic Water Pump Monitoring Based on Human Machine Interface and Internet of Things. JTEIN: Indonesian Journal of Electrical Engineering, 4(2), 863–876. https://doi.org/10.24036/jtein.v4i2.514

[5]. Ratnaya, I. G., & Adiarta, A. (2023). Learning Media for Rice Field Irrigation Control System Based on Esp32 in Microcontroller Application Course. Journal of Electrical Engineering Education …, 12, 156–166. https://ejournal.undiksha.ac.id/index.php/JJPTE/article/view/66404%0Ahttps://ejournal.undiksha.ac.id/index.php/JJPTE/article/download/66404/27636

[6]. Rizki Faulianur, Rouhillah, & Bariq Fajar Musaid. (2021). Prototype of Automatic Dam Sluice Gate Opening and Closing Based on PLC and HMI Configuration. J-Innovation, 10(2), 57–62. https://doi.org/10.55600/jipa.v10i2.93

[7]. Satria Wibawa, E., Provisi, S., & Provisi Jalan Majapahit, S. (2020). Monitoring and Control System for Paddy Field Irrigation Using Wemos D1 Microcontroller Based on Internet of Things. Scientific Journal of Electronics and Computers, 13(2), 87–93. http://journal.stekom.ac.id/index.php/elkom■page87

[8]. Sugiono, S., Indriyani, T., & Ruswiansari, M. (2017). Remote Control of an Internet of Things (IoT)-Based Rice Field Irrigation System. INTEGER: Journal of Information Technology, 2(2), 41–48. https://doi.org/10.31284/j.integer.2017.v2i2.178

[9]. Sutawan, I. K. E. (2018). Design of an Irrigation Water Storage Monitoring System Using a Microcontroller-Based SCADA System. 1–7. https://repository.pnb.ac.id/3651/1/RAMA_36304_18153 44013_artikel.pdf

[10].Syelly, R., Hati, I., Laksmana, I., & Rozi, S. (2021). Conceptual Model of an Automatic Rice Field Irrigation System Using Android-Based Arduino. Progresif: Jurnal Ilmiah Komputer, 17(2), 51. https://doi.org/10.35889/progresif.v17i2.647