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PROTOTYPE OF IRRIGATION SLUICE GATE DISTRIBUTION USING ARDUINO-BASED TINY RTC MODULE

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Abstract
Technological advances in the era of globalization have been increasing rapidly, especially in agriculture. Currently, many robotics companies around the world are competing to create sophisticated equipment in an effort to increase agricultural productivity. Irrigation is an important part of agriculture. With the irrigation channels, it makes it easier for farmers to water crops. To distribute water fairly and evenly, this requires primary irrigation channels that are continuous. Also, in order to align cropping patterns, an irrigation sluice gate is needed in the primary canal that can be opened and closed automatically according to a predetermined schedule. The purpose of this research is to produce a tool in the form of a prototype for water distribution and automatic opening and closing of irrigation doors using the Arduino-based Tiny RTC module. The method used in this study is a method of drawing using flowcharts and making programs using the Arduino IDE. The results of this study are a prototype of water distribution and automatic opening and closing of irrigation doors using the Arduino-based Tiny RTC module.

I. INTRODUCTION

Technological advances in the era of globalization have been increasing rapidly, especially in agriculture. Currently, many robotics companies around the world are competing to create sophisticated equipment in an effort to increase agricultural productivity. Farmers in developed countries have used sophisticated equipment to manage agricultural land. Starting with land management, planting, irrigation, and harvesting, they have used smart machines. The use of smart machines is carried out to support the effectiveness and efficiency of agricultural products. Agriculture and plants really need water because water is the source of life for all living things in the world. Therefore, plants are very dependent on water. Watering or irrigation systems are very important for the survival of plants. Irrigation is one way or method

for irrigating land. The source of water that flows through irrigation canals usually comes from the ground, water reservoirs, dams, lakes, or rivers [1].

Irrigation is an important part of agriculture. With the irrigation canals, this makes it easier for farmers to water their crops. Farmers no longer rely on rain to irrigate agricultural land because, with irrigation canals, water can be brought in at any time for the process of irrigating crops. Pekon Panjerejo is a village located in Gadingrejo District, Pringsewu Regency. This village has a primary irrigation canal. This irrigation canal carries water from Way Gatel dam to be distributed to secondary irrigation canals and functions to irrigate paddy fields in several villages, such as Pekon Panjerejo, Pekon Wates, Pekon Bulukarto, and Pekon Bulurejo. The total agricultural land or rice fields that are irrigated is around 650 hectares. The method of distributing water is by opening and closing the floodgates in turn for each village. Meanwhile, the length of time the floodgates are opened is adjusted to the area of agricultural land owned by each village. The distribution of water is regulated based on deliberations with the Association of Water User Farmers among villages [2].

The distribution of water in the irrigation canals is carried out by ili-ili officers. Each group has an ili-ili officer who is responsible for opening and closing the irrigation gates to distribute water to the paddy fields. The ili-ili officers, in carrying out their duties, are assisted by the Floodgate Supervisor. The distribution of water that was done manually by the ili-ili officers was often not carried out according to the schedule because the ili-ili officers from each group between villages could open and close the irrigation gates at any time. The cause of the discrepancy in the schedule for distributing water is also caused by farming communities that do not have scheduled planting. Thus, the need for water on agricultural land located in secondary irrigation coverage is not the same. The discrepancy between the soil schedule in one coverage area of secondary irrigation causes the distribution of water at the primary irrigation gate to not run according to schedule and causes the distribution of water to be less than optimal and equitable.

Researchers in the field of technology have done a lot of research in agriculture. Some of these technologies include a microcontroller-based automatic irrigation system, either in the form of a prototype or implemented directly on plants or agricultural land. Previous research was conducted by I Putu Lingga Dharma et al. (2019) regarding the Design of an Automatic Water Gate Control Tool with SIM800l Based on the Arduino Uno Microcontroller. This tool is able to open and close irrigation gates automatically using SIM800I and a Water Level Sensor as input, an Arduino Uno as the process, an LCD as the information output, a servo motor as the output whose job it is to open and close the floodgates, and a relay as the output used to turn on and off the water pump [3]. Subsequent research was conducted by Dwi Waluyo Putranto, Feni Budi Antono, et al. (2018) regarding the Design of an Automatic Irrigation System with a Solar Energy-Based Wireless Sensor Network (WSN). This study states that the irrigation system using WSN can control irrigation distribution based on the area of the soil moisture sensor point. The size of the soil moisture set point can be determined so that irrigation control can be adjusted according to the needs of plants and soil conditions [4]. Based on the previous research above that the authors have described, there are similarities and differences. The equation that exists is that each tool uses the same microcontroller, Arduino, and can carry out the irrigation or watering process automatically. The difference lies in the use of the module, which is used as input data. The first study used a water level sensor as data input, while the second study used a soil moisture sensor as data input. Based on the similarities and differences in previous research, the authors can conclude that the use of the Arduino microcontroller can be used in automatic irrigation control. The difference in the research conducted by the authors lies in the data input module used. The previous research described above used a water level sensor module and a soil moisture sensor as input data, so the authors in this study used the Tiny RTC (Real Time Clock) module as data input. [5][6].

The method used in solving the problem of water distribution in Pekon Panjerejo irrigation is to make an automatic irrigation gate controller in the form of a prototype that can work independently according to a predetermined schedule. The Tiny RTC timer module, which is programmed using an Arduino microcontroller, is used as a time data store. The time data stored in the module is processed and used for the motor driver control process. The motor driver is used to provide DC current while at the same time reversing DC current on the DC motor as the driver of the irrigation gate on the prototype.

In order to distribute water in a fair and equitable manner in primary irrigation canals, which are continuous, and to align cropping patterns, an irrigation sluice gate is needed in primary canals that can be opened and closed automatically according to a predetermined schedule. Prototype of the distribution of irrigation doors as a solution to make it easier for farmers in the process of distributing water based on a predetermined schedule on primary irrigation channels and is expected to align cropping patterns.

II. RESEARCH METHODS

Prototyping is an iterative process in system development in which requirements are converted into a working system that is continuously improved through collaboration between users and analysts. Prototypes can be built using several development

tools to simplify the process. Prototyping is also a form of Rapid Application Development (RAD) [7].

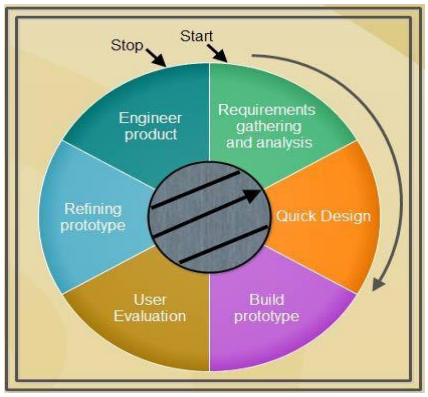


Figure 1. Prototyping Model

Tahap-tahap dalam pengembangan prototype:

1. Requirements gathering and analysis
   The prototyping model begins with a needs analysis, and system requirements are defined in detail. Users are interviewed to find out the system requirements.
2. Quick design
   When the requirements are known, a preliminary or rapid design for the system is immediately made. It is not a detailed design and covers only the important aspects of the system, which gives the user an overview of the system; rather, a quick design helps in developing prototypes.
3. Build prototype
   The information gathered from the design is quickly modified to form the first prototype, which is a working model of the required system.
4. User evaluation
   Next, the system that has been proposed is presented to the users to be thoroughly evaluated against the prototype so that the users recognize its strengths and weaknesses as to what needs to be added or removed. Comments and suggestions are collected from users and provided to developers.
5. Refining prototype
   After users evaluate the prototype, if they are not satisfied, the current prototype is refined according to the requirements. That is, a new prototype is developed with additional information provided by the users. The new prototype is evaluated like the previous prototype. This process continues until all the requirements specified by the users are met. Once the users are satisfied with the prototype, the final system is developed based on the prototype.
6. Engineer product
   Once the requirements are met, the users receive the final prototype. The final system is thoroughly evaluated, followed by routine maintenance on a regular basis to prevent large-scale failures and minimize downtime.

III. DISCUSSION

The design stage of the water distribution tool and the automatic opening and closing of the irrigation door includes an analysis of system requirements. The system requirements used in the design of the water distribution prototype and opening and closing automatic irrigation doors are:

Hardware

1. Arduino Uno R3 (1 Piece)
   Arduino Uno R3 is used as a microcontroller or for data processing that has been input by the RTC DS1307 in the form of timing. The input data is then processed by the Arduino Uno R3. The result of the process in the form of time is used as a schedule for the process of providing DC (Direct Current) electric current and sent to the L298n Motor Driver as an output to change the 9 Volt DC electric current at the 4 output pins of the L298 Motor Driver. The electric current can be changed from positive to negative, or vice versa, according to the settings made on the Arduino Uno R3.
2. L298n Motor Drivers (2 Pieces)
   The L298n Motor Driver has 4 output pins, out1, out2, out3, and out4, which are used to receive input from the Arduino Uno R3 in the form of a change in current, which can change the positive output pin to negative or vice versa. This current change is used to control a 12V DC motor so that it can rotate back and forth and stop rotating according to the command received from the Arduino Uno R3.
3. 12V DC Motors (3 Pieces)
   The 12V DC motor is used to receive current from the L298n Motor Driver. A 12V DC motor has two input pins. The two input pins on the 12V DC motor can be supplied with positive or negative electricity according to what is provided by the L298n motor driver to rotate right, left, or stop.
4. RTC DS1307 (1 Piece)
   RTC DS1307, which is connected to Arduino Uno R3, is used as an input to set the time setpoint as well as to store the time that has been set so that it can be used as a schedule for opening and closing irrigation gates automatically.
5. Custom PCB (1 Piece)
   A custom PCB (Printed Circuit Board) is used to attach all electronic circuits in the form of the Arduino Uo R3, Motor Driver L298n, Tinny RTC DS1307, and LCD 1602.
6. Bevel Gear (4 Pieces)
   A bevel gear is a pair of vertical and horizontal gears that are connected to each other. In this study, the authors use a bevel gear in the form of one pair of vertical gears or small gears

connected to a 12V DC motor, while horizontal gears or large gears that have a hole in the middle are attached with a nut connected to a bolt as the Prototype irrigation door handle. When the 12V DC Motor rotates, the small gear connected to the large gear will raise or lower the prototype door handle bolt, which is used to open or close the irrigation door on the prototype. [8], [9].

In hardware design in this study, accuracy and understanding are needed so that errors do not occur. So, the hardware can run properly when operated later. The hardware design can be seen in Figure below:

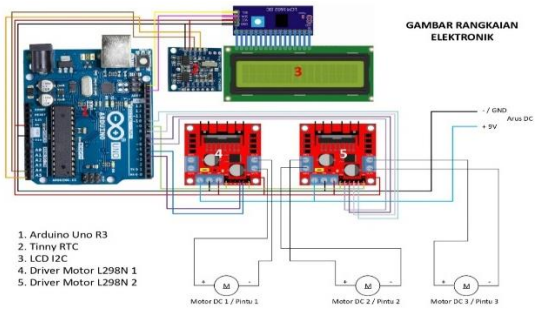


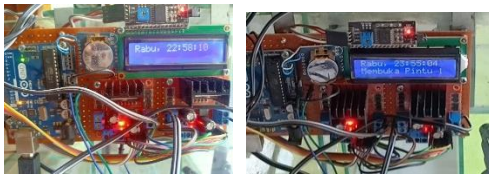
Figure 2. Hardware Design

Based on the picture of hardware design above, the Arduino Uno R3 is used as a means of processing the time, date, and day that have been input from the Tiny RTC DS1307. The output that has been processed will then be displayed on the LCD, which is used as information and output to the Motor Driver to drive a 12V DC motor, which is then used to open and close the irrigation door.

Analysis of Electronic Circuit Testing or Hardware

Testing of electronic or hardware circuits on the water distribution prototype and automatic irrigation door opening and closing is carried out to ensure that the electronic circuit can work as expected. If the hardware under test has not run as desired, then improvements are made to the program code or to the system in the wiring. Testing the water distribution prototype and opening and closing irrigation doors automatically uses the Arduino-based Tiny RTC Module. Arduino Uno R3 is used as a means of processing the time, date, and day that have been input from Tiny RTC. The output that has been processed then is displayed on the LCD, which is used as information, and the L298n 1 Motor Driver to control the 12V 1 DC Motor, as well as the L298n 2 Motor Driver to control the 12V DC Motor 2, and 3 as the irrigation gate drive.

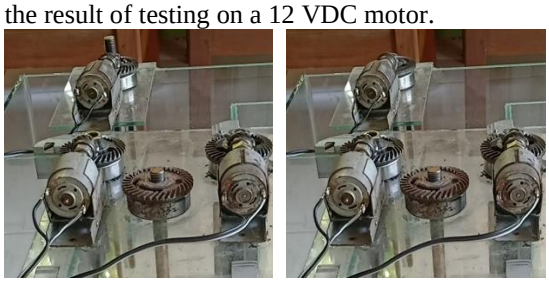
Testing the I2C 1602 LCD that has been connected to an electronic circuit or hardware aims to ensure that the LCD and electronic circuit used can function properly. Below are the results of testing on the I2C 1602 LCD, which has been connected to the electronic circuit.



(a). LCD 1602 displays day, hour, minutes and seconds.

Testing of 12 V DC Motor 1, 2, and 3

This test aims to ensure that each 12 VDC Motor can run properly so that it can open and close the irrigation door according to the commands given by Arduino through the L298n Motor Driver. Below is the result of testing on a 12 VDC motor.



(a). 12V DC motor when opening door 1

The results of the 12V DC Motor test can run well according to predetermined commands. Doors 1, 2, and 3 automatically and alternately open and close for two seconds each.

Prototype Implementation

The body and sluice prototypes were made using transparent glass with a thickness of 5 mm. The choice of glass as a prototype material is based on the fact that glass is easy to obtain, affordable, and easy to shape. As a simulation of a sluice gate, there are four door openings that have been assembled. Three doors are connected to a DC motor and work according to the program built, while one door is not connected to a DC motor because it is used as a drain door when excess water volume occurs. The following shows photos of the prototype that has been built.

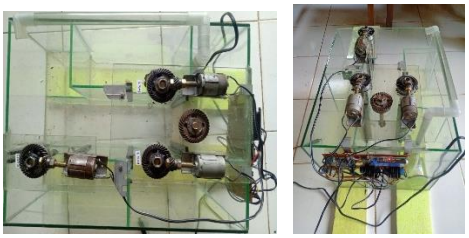


Figure 3. Overall Prototype

Figure 4. Irrigation Door Prototype

IV. CONCLUSION

Based on the problems and discussion on the prototype of water distribution and Automatic Irrigation Door Opening and Closing Using the Arduino-Based Tiny RTC Module, it can be concluded that the prototype of water distribution and automatic irrigation door opening and closing uses the Arduino IDE as software and the Arduino Uno R3 as the main process or control. The Tiny RTC DS1307 is used as a timer set point, the L298n Motor Driver is used as a dc current regulator, the DC Motor is used as an actuator to open and close the irrigation door, the 1602 LCD is used as a display of time, day, and date, and C Language is used as a programming or coding language in the Arduino IDE, as well as other supporting devices that have succeeded in making a prototype of water distribution and opening and closing irrigation doors automatically.

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