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Automatic Watering of Potted Plants Using Arduino-Based Real-Time Clock

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ABSTRACT
In the era of rapid technological development, humans rely on tools and technology to make their work easier, making technology a basic need. This study aims to design a device for watering plants automatically with time settings. This tool uses RTC DS 3231 which functions to set the watering time that has been determined by the user and sends commands to the Arduino nano to turn on the bc547 transistor so that the pump can water according to the schedule that is set automatically. The research methodology is carried out by designing, creating, and implementing system components including Arduino nano as a controller, and bc547 transistor to turn the water pump on and off. The study's results prove that the tool made can function properly and be developed as expected by the researcher. This tool works automatically based on the watering time determined according to the user's wishes.

***Keywords**: Arduino nano, RTC (Real Time Clock), Transistor bc547.*

INTRODUCTION

Today, in our globalized world, we cannot ignore the advancements and impact of technology. We must be adept at using technology to stay competitive with other nations. In our daily lives, we prioritize convenience and efficiency in our activities (Dian Hansen dkk., 2017). Thanks to the rapid progress of technology, many tasks have become easier for us humans. That's why the author has designed an automatic plant watering system using the RTC DS 3231 and Arduino Nano components as the main control. This project aims to improve the efficiency of plant care. (Wahyu Dwi Meilianto dkk., 2022) .

This tool is made to function to water plants automatically using RTC (Real Time Clock) and Arduino Nano. Based on the time that has been set according to the needs of the plant, this tool is also equipped with a BC547 Transistor Module which can be used to control electronic devices that require a large voltage source or AC (Setiawan & Anggraen, 2019). This tool is also equipped with a water pump for watering, this tool is very useful for humans today, because with this tool humans no longer need to water plants manually, this tool can be applied to individuals who like to plant plants indoors, or even for those who have a small garden in front of the terrace of the house or elsewhere. With an automatic plant watering system using RTC DS 3231 and Arduino Nanotechnology, plant care becomes easier and more efficient, without having to worry about the right watering time. With this background, an automatic plant watering tool will be designed using RTC (Real Time Clock) which is then processed by Arduino Nano and instructed to the Transistor bc547 module to ensure that it is under the specified schedule (Wulandari dkk., 2020).

In this study, the Researcher designed an automatic watering system using RTC (Real Time Clock) based on an Arduino microcontroller so that it can be utilized by farmers (Sulfiani R & Firmawati, 2019) . The automatic watering system designed in this study works automatically based on the scheduled time setting that can be set according to the user's wishes. So that it makes it easier for farmers to operate in setting the desired time to carry out the process of watering their plants. The design of an automatic watering device, it is expected to provide convenience both in the process of setting the device and the automatic watering process for farmers. Based on the background, a problem formulation can be made, namely how to design an automatic watering device using time settings and testing its reliability. (Sugandi & Armentaria, 2021).

RESEARCH METHOD

Type of Research

This study is a quantitative approach with an experimental method. This type of research focuses on data collection and data analysis to find certain patterns, relationships, or effects. This research often involves measuring parameters such as watering frequency, the amount of water released during the watering process, and plant growth. This data is collected systematically to evaluate the effectiveness of the automatic watering system in pots using RTC (Arduino-based real-time clock) in maintaining optimal conditions for plant growth(Eko Haryadi dkk., 2022).

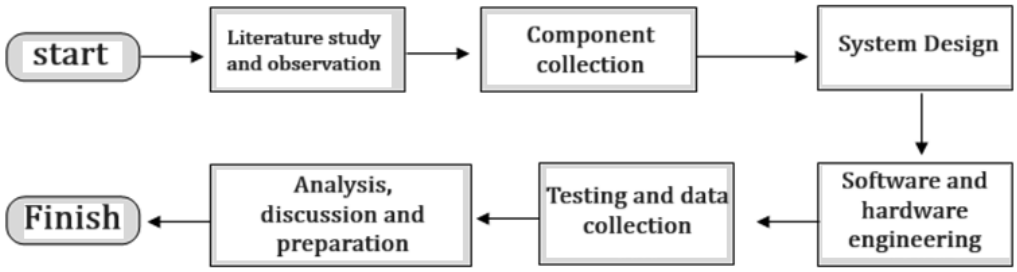

Figure 1. Stages of Research

The flow of this system design analysis aims to make the system process flow easy to understand and comprehend.

System Design

At the system design stage, an analysis will be carried out related to the data retrieval process contained in the automatic watering device using the DS3231 sensor which is run by the system contained in the Arduino Nano microcontroller (Eko Haryadi dkk., 2022). In this phase, the researcher created a design for the tool to be built by creating a series of devices in the form of tables, block diagrams and the entire series of devices as follows.

RTC DS 3231 Design to Arduino nano

Table 1. RTC DS 3231 Design to Arduino nano

RTC DS 3231	Arduino Nano
VCC	5V
GND	GND
SDA	PIN A4
SCL	PIN A5

LCD 12C Design to Arduino nano

Table 2. LCD 12C Design to Arduino nano

LCD 12C	Arduino Nano
VCC	5V
GND	GND
SDA	PIN A4
SCL	PIN A5

Design of Block Diagram

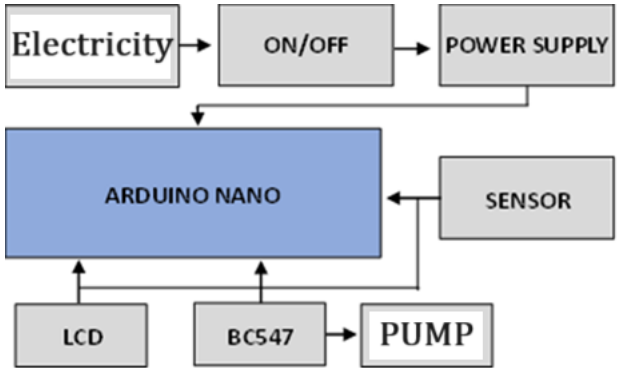

Figure 2. Block Diagram

The block diagram above explains the components that are the input process, the tool controller, and the components that are the output of the device system used and designed as shown in the image above.

Overall Electronic Circuit Design

In this study, the creation of an automatic watering circuit for potted plants using an Arduino-based Real Time Clock (RTC) was carried out using Fritzing software. This software is used to design electronic circuits so that they can be used as a benchmark in making real circuits.

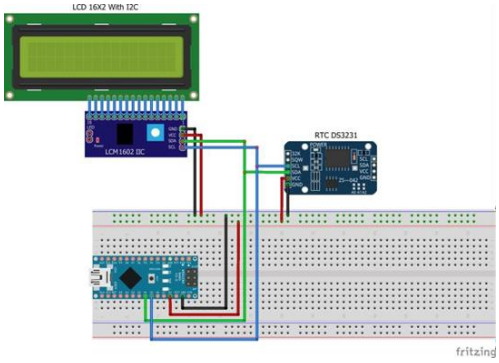

Figure 3. Overall Electronic Circuits

Procedure

In this study, the procedures that will be carried out by the researcher are as follows: Preparation Stage: At this stage, what is done is the devices and components used. In this activity, there are two types of tools that must be provided, software and hardware. The software is from the Arduino IDE Application which is an Arduino application to be used as a command to the device being worked on and the Frizting Application, which is an application for designing device components. Then the hardware which includes device components, namely Arduino Nano, RTC DS3231, LCD, Power Supply Module, 9V Adapter, 6 Jumper Cables, bc547 Transistor, Resistor, Breadboard, and Mini Water Pump. Data collection stage: In the data collection stage, data is obtained by setting the time settings including day, date, hour, and how long it takes for the watering process to get the data sample desired by the researcher (Agriawan dkk., 2021).

Data Collection Techniques

In the data collection process, researchers use a literature study method, namely collecting data by searching for and studying references to books, articles, journals, and websites related to the case being studied by the researcher. So that researchers can collect data that can be used to achieve the desired goal stage by the researcher. Where during the data collection process and achieving the desired goal, an automatic watering device was created using a real-time clock, the researcher's data collection technique

uses a combination of observation and literature study techniques, the data obtained tends to be quantitative data, and data analysis is Inferential/Quantitative. The results of this data collection aim to gain a deeper understanding of the phenomenon being studied and make valid generalizations about the population based on the sample data analyzed. In addition, this analysis is also used to predict results and determine the relationship between variables. By using the right analysis method, researchers can ensure that the conclusions drawn are accurate and reliable (Sinaga & Melisa Teresia Soiciyen, 2021).

RESULTS AND DISCUSSION

This study aims to develop and evaluate an automatic watering system for potted plants using an Arduino-based Real Time Clock (RTC). This system is designed to improve watering efficiency by ensuring that plants receive the right volume of water at the right time automatically (Roy Harry Syidiq Pamungkas dkk., 2020). This section will also present the results of the experiments that have been carried out, including testing the hardware and software functions, as well as the effectiveness of the system in real conditions. The analysis of the results is presented in the form of tables and graphs to provide a comprehensive overview of the research findings. Furthermore, the results will be discussed in depth by linking them to the initial hypothesis, previous studies, and their practical and theoretical implications. This section will also discuss the limitations of the study and provide recommendations for further research.

Functional Testing

The following is a complete test of the components that work from the device designed by previous researchers.

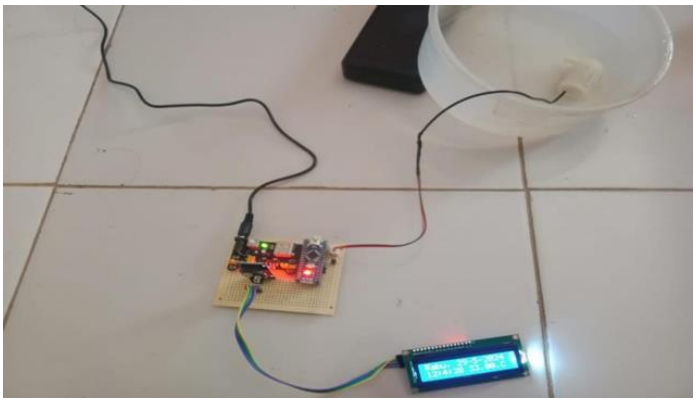

Figure 4. Device display

LCD Testing

In this test, researchers took the results that were read during the process before watering began and were specifically designed to send and receive data (Al Hafiz & Erlinda, 2020). This LCD aims to display the day, date, month, year, time and temperature..

Figure 5. LCD

User Interaction Testing

In this test, the researcher took the results that were read during the process before watering began, namely

only displaying the words "Morning Watering" and vice versa..

Figure 6. Watering Display

Watering time accuracy test

In this test, researchers recorded the watering time that occurred for 10 days. Researchers watered at predetermined times, namely in the morning and evening, to test the consistency of watering time. The results are summarized in Table 3..

Table 3. Watering time accuracy test

Time	Moning	Evening
31/05/2024	07.00	16.30
01/06/2024	07.00	16.30
02/06/2024	07.00	16.30
03/06/2024	07.00	16.30
04/06/2024	07.00	16.30
05/06/2024	07.00	16.30
06/06/2024	07.00	16.30
07/06/2024	07.00	16.30
08/06/2024	07.00	16.30
09/06/2024	07.00	16.30

Discussion

The results of the above tests show that the programming can run stably and consistently, there are no problems or damage to the device and the relay can function according to the specified time, there is no failure in the relay control process. The results of the flushing time accuracy test show that the watering time is relatively consistent every day, with morning watering times at 07.00 and afternoon at 16.30. This shows that the sensor work device is functioning well and consistently so that it can improve the performance of the watering tool better (Zulfikar et al., 2024).

However, in the volume of water produced, researchers found fluctuations in the amount of water released during the watering process. However, the average volume of water received during watering was relatively stable at both time intervals tested. In this test, the volume of water produced in the watering process, so the researchers tried to make 2 different flushing experiments to compare the accumulation of data collection received, which means 2 different intervals as follows:

- For 2 seconds measure the volume of water released during the watering process as shown in the bar diagram in Figure 7.

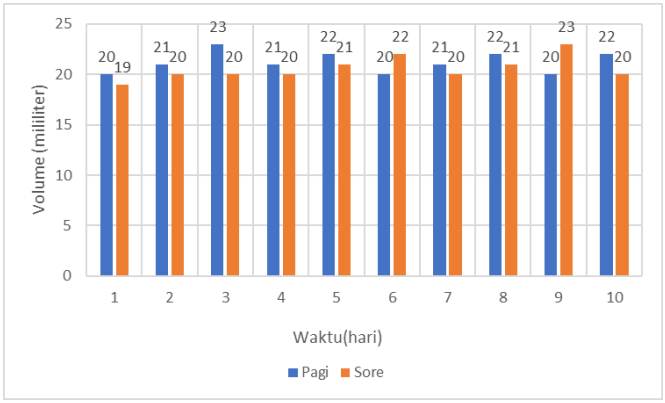

Figure 7. Water Volume 2 Seconds

The bar chart above shows the variation in the volume of water released during the 2-second measurement period. From this chart, it can be seen that the volume of water released varies from interval to interval, with the highest volume reaching 23 milliliters and the lowest volume reaching 19 milliliters. The average volume in the morning is 21.2 milliliters, while in the afternoon it is 20.6 milliliters. The fluctuation pattern shows that the volume of water is unstable and tends to change from one interval to the next.

- For 20 minutes measure the volume of water received during the watering process, as shown in the bar diagram in Figure 8.

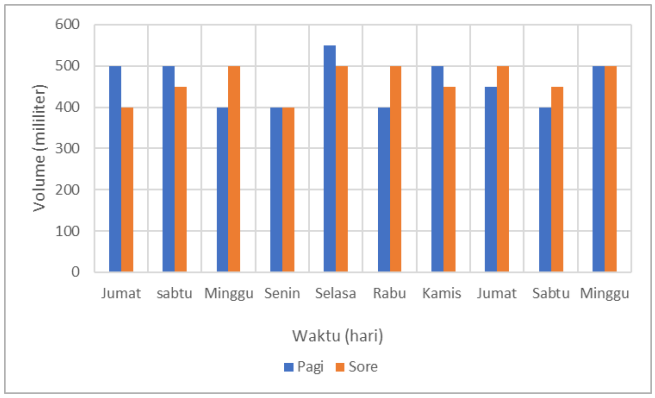

Figure 8. Water Volume 20 Second

Despite slight but significant fluctuations, the volume of water received during irrigation was relatively stable with an average of 460 ml in the morning and 465 ml in the afternoon. However, there were differences and variations between morning and afternoon, with some days showing consistency in the pattern of water volume received while on other days there were significant fluctuations.

CONCLUSION

Based on the results and discussions of the device, the following conclusions can be drawn:

1. Through the use of Arduino-based Real Time Clock (RTC), this study has succeeded in creating a revolutionary automatic plant watering system. This tool not only frees farmers from the task of watering manually but also ensures that watering is done at the right time, increasing overall agricultural efficiency.
2. Functional testing demonstrated the reliability of the system in carrying out its tasks without interruption. However, although the watering time was maintained consistently, fluctuations in the

volume of water released indicated areas for future improvement. Thus, this system is the first step towards more efficient and sustainable agriculture.

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