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Development of Control System for Monitoring the Function of Drip Irrigation Equipment in Plant Nurseries

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Abstract. The development of renewable technology systems for irrigation in agriculture is still lacking in Indonesia, especially in plant nurseries, the lack of technology that can be used to make it easier for farmers to monitor the performance / function of irrigation tools used every day to function optimally. The purpose of this study was to develop a control system for monitoring the function of drip irrigation equipment in plant nurseries. The method used in completing this research is the research and development (R&D) method, which starts from the control system design, prototyping, functional testing, field testing, and data analysis. Testing the drip irrigation function monitoring tool that has been made obtained some test data, such as the sensitivity data of the selenoid valve function response has a very good regression value, which is around 0.99% where the difference between the time of the selenoid valve function and the time at the stopwach is around 2.6 seconds, and the monitoring response data for the function of the irrigation tool that can send messages from the SIM800l module to the HP according to the specified time, namely 07.00 for the ON function and 07.30 for the OFF function. Based on the results of the research and the objectives to be achieved, it can be concluded that the monitoring ability of the prototype drip irrigation control device in plant watering with the SIM800L module can send messages properly according to the specified spray time.

Keywords: Control System, Drip Irrigation

INTRODUCTION

Plantation crops are plants that have a fairly high economic value, such as cloves, coffee, cocoa and other plantation crops. However, plantation crops usually have significant obstacles during the plant nursery process. Where the growing needs are very difficult to meet according to plant needs such as plant nutritional needs, water needs, and light needs for the photosynthetic process. In addition, the need for water for plantation crops is often a serious problem, especially during the dry season, which results in lower crop productivity. This is consistent with the statement that water deficit negatively affects the development of flowers and seeds. Water stress is reported as one of the causes of low plant productivity (Hafif, 2017).

Therefore, these problems can cause a decrease in the quality of growth of plant seeds.

One of the efforts that can be made to improve plantation activities, especially for plant nurseries and plant production, is to increase the application of plantation crop production technology. The application of appropriate agricultural technology can increase production and motivation of farmers in carrying out effective and efficient plant nurseries. With high motivation, it will be easy to provide an innovation for farmers, and vice versa. Until now, the application of technology for precision farming in plant nurseries is still minimal, so it becomes a limitation in future cocoa development (Kasim, 2019).

One of the technologies that can be applied to improve plant nurseries is a drip irrigation control system. Controlled drip irrigation is one of the irrigation technology solutions that can be used to save water during watering, because this irrigation has a low pressure and small discharge with the water supply system applied only to the area around plant roots through an emitter system. This system can streamline and streamline the production process of plant seeds, but the development of this system is still lacking in Indonesia, especially in the nurseries of plantation crops.

Another problem that is often faced by plantation farmers is monitoring the performance / function of the tools used every day to ensure the function of the tools is working optimally. Where farmers need more time to check or function the tools during the watering process. This is done to support increased productivity of plantation crops.

Therefore, to solve the problem of monitoring the function of the tool which requires a relatively long time and must be checked every day, the researcher intends to develop a control system for monitoring the function of the drip irrigation tool in plant nurseries. So that it becomes one solution that can be used to reduce the problems of plantation farmers in the area of monitoring or monitoring the function of the tools.

MATERIAL AND METHODS

This study is a research and development (R&D) study. The development of controlled drip irrigation with lock time system starts from the designing control system, prototyping, functional testing, field testing, and data analysis.

Time and place

This research was conducted from January 2020 to December 2020, which took place in the laboratory and experimental garden of Department of Agricultural Technology Education, Faculty of Engineering, Universitas Negeri Makassar.

Tools and materials

The equipment used in this research is a multimeter, Arduino microcontroller, SD Card, RTC DS3230, measuring cup, selenoid valve and SIM800L module. The materials used in this research are water tanks, pipes, pipe joints, water, emitters.

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Drip irrigation design

The prototype of drip irrigation is designed to have one water reservoir and three block irrigation systems. The irrigation system block path is made of ½ inch PVC pipe, with a water-holding volume of 300 L (Figure 1). Each line/block of the irrigation system is controlled by using a solenoid valve which regulates the volume of water entering the irrigation system block line. Each irrigation system block has ten emitters with a distance of 35 cm per emitter. Planting media using polybags with a diameter of 30 cm.

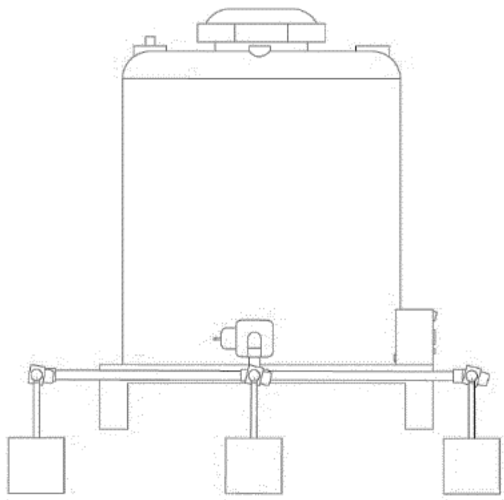

Figure 1. Drip irrigation prototype design

Control system mechanism

The control system mechanism used in this study is the open-loop control system, where the watering time set point written in the program is inputted on the microcontroller. The set-point is used to adjust the function of the actuator (solenoid valve) during the watering process with the aim that the watering process can be on time and the volume of watering is in accordance with what the plants need. The mechanism of the control system can be seen in Figure 2. In addition, this control system also functions as a monitoring of the function of the tool during the watering process by sending information on the function of the tool via SMS. The function mechanism of the control system can be seen in Figure 2

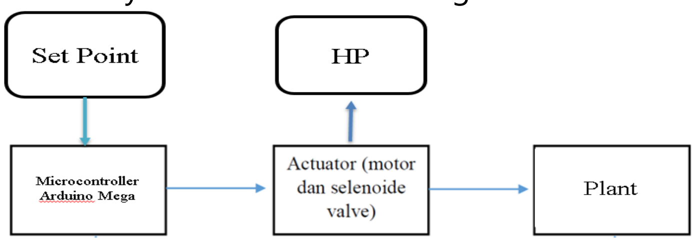

Figure 2. Mechanism of control system

Testing

The test is carried out in two stages, namely the functional test of control device components such as solenoid valves, sensors, and irrigation emitters. The second stage of the control system test is carried out by testing the response of the solenoid valve function based on the set-point time used which will function continuously every day based on the set point of watering time that has been deferred in the program. Then test the information sending response on the SIM800L module based on the predetermined watering time.

Data collection

The data collected in this study were data on the results of irrigation tools and control systems testing, which were carried out directly in the field. The data obtained from testing in the form of real time test data for selenoid valve function, SIM800l module response test data, data storage on SD card, and irrigation spray volume data based on set point time.

RESULTS AND DISCUSSION

Controlled drip irrigation prototype

The controlled drip irrigation prototype consists of several tool components. A water tank (reservoir) with a maximum water reservoir dimension specification of 300 l. The water from the storage tub is connected to a 1.5-inch PVC pipe in parallel that functions as an irrigation line. A 220 Volt solenoid valve installed at each inlet of the irrigation line pipe which is used to adjust the volume of water that comes out on/off based on the set-point time specified. The emitter can produce the volume of water according to the needs of the plant. The drip irrigation is needed to increase water use efficiency because drip irrigation can concentrate water supply in the root area so that plants will be easier to absorb water for their growth [5].

Figure 3. Controlled drip irrigation prototype

SIM800L module function response

The mechanism for sending information or monitoring the functions of the irrigation tool is carried out using two main components, namely with the help of the SIM800L module as the sender of the message / information and the cellphone as the recipient of messages from the function of the irrigation device based on the time of watering, namely the first watering in the morning from 07.00 to 07.30 WITA. With a message or information sent in the form of notification that the irrigation device is ON or the Irrigation device is OFF. This watering monitoring process takes place every day as long as the tools and control systems are functioning. The

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mismatch of message sending time with tool function time ranges from 1-2 seconds. This is most likely caused by network instability.

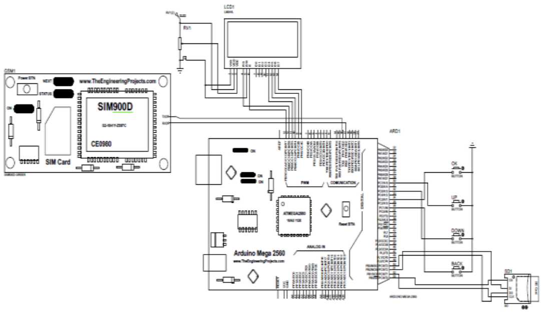

Figure 4. SIM800L module circuit

Solenoid valve response time

Based on the selenoid valve response test conducted with the set point time used, the regression value is 0.99 with an average time difference of 2.6 seconds, this difference is due to the function response path from the microcontroller to the selenoid valve takes a few seconds. This is in line with the statement (Setiawan & Saptomo, 2014) which states that the valve time response measurement is a measurement of the delay in water flowing when the valve is open and closed. The irrigation response produced when the valve is open has a delay of 2 seconds. This means that water flows after 2 seconds from the valve when the valve is on. This data can be seen in Figure 5.

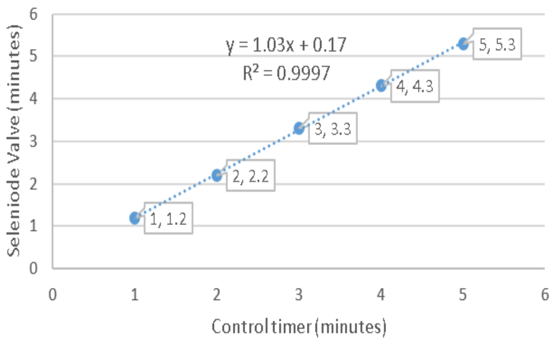

Figure 5.Selenoid valve response regression values.

Data storage

The data from the measurement of the time of spraying the irrigation device are obtained, received and stored in external memory (SD card) with a memory capacity of 4 GB. The data stored on the memory card is used in the form of an excel file according to the program commands used. The measurement data stored on the memory card is in the form of spray time data and spraying date data. Data is stored in real time and at each data receipt, the SD card module immediately saves data with date and time formats. This is in accordance with the statement (Winata et al., 2016) which states that the output monitoring system and data recording on the Arduino microcontroller-based actuator can record the output measurement results automatically on the SD Card every 15 minutes, where the data stored on the SD Card is date and time data, current values, voltage and power values generated by solar panels are then stored in Microsoft Excel format with csv (comma separated values) format. The following results of data storage using the SD card module can be seen in Table 1.

Table 1. Data on the module test time of SD Card

Date	Time	Fungsi
17.09.2020	7:00:00	ON
17.09.2020	7:30:30	OFF
18.09.2020	7:00:31	ON
18.09.2020	7:30:00	OFF
19.09.2020	7:00:10	ON
19.09.2020	7:30:10	OFF
20.09.2020	7:00:02	ON
20.09.2020	7:31:00	OFF

CONCLUSION

Based on the results of the research and the objectives to be achieved, it can be concluded that the monitoring ability of the prototype drip irrigation control device in plant watering with the SIM800L module can send messages on the function of the tool ON and OFF properly according to the specified spray time.

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