Design and Implementation of Smart Garden System with Monitoring Based on Android as a Part of Application of Industrial Revolution 4.0 on Agriculture

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Abstract. A factors causing declining of agricultural production is the lack of using the technology in processing agricultural land. Along with technological advances in the field of control, with the development of the 4.0 industrial revolution based, the automation systems are developed in various fields, especially in agriculture. Microcontroller with supported by sensor devices, can be developed automatic watering systems and monitoring the condition of agricultural land in real time. In this research, the control system for smart gardens was developed. Through this system, conditions of temperature, humidity and water use on agricultural land can be monitored with a system of watering plants automatically based on soil drought. All of these systems can be monitored directly on an Android Mobile Phone as the application of the 4.0 industrial revolution in agriculture. With this system it can save water use up to 45.20% and land management more effectively and efficiently.

Keywords: Smart Garden System; Arduino; Android; Industrial Revolution 4.0.

1 Introduction

According to the Official Gazette of Statistics on the State of Indonesian Employment in February 2018, the main occupation of the Indonesian population is in agriculture which is 30.46% [1]. Yet, Indonesia is no longer fitting to be called an agrarian country. The highest Gross Domestic Product (GDP) in Indonesia is the industrial sector, not agriculture[2].

One of the factors causing less than optimal agricultural production is the lack of using the technology in agricultural processing. This has led to the birth of various innovations in agriculture, for example by using Tractor or Hand Tractor to cultivate land, using transplants, to grow rice quickly, to harvest padding using a combined harvester, which can cut rice faster than by manual cutting[3].

Along with technological advances in the field of control, with the development of the 4.0 industrial revolution based, also developed an automation system in agriculture. The use of a microcontroller as the automatic control center supported by appropriate sensor devices, can be developed automatically in irrigation systems, automatic watering systems and monitoring the condition of agricultural land in real time. Therefore in this study, a control system for smart gardens will be developed that will work automatically by monitoring air temperature and humidity, soil moisture conditions, and water usage volumes. All of these systems can be monitored in real time on the Android basis or through the Android Mobile as the application of the industrial revolution 4.0 in agriculture..

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2 Related Work

The previous research on smart gardens has been done by several previous researchers. The concept of smart gardens is basically developed based on the detection of soil drought using Soil Moisture Sensor as developed by Husdi [4], in his research entitled Monitoring of Agricultural Soil Moisture Using Soil Moisture Sensor FC-28 and Arduino Uno and Caesar Pats Yahwe et al. [5], in article entitled Design of Prototype Monitoring System for Soil Moisture through SMS Based on the Results of Watering Plants "Case Study of Chilli and Tomato Plants". Furthermore, Ray Kasful Ghito et al [6], developed a smart garden system, in a study entitled Designing a smart garden system Using an Android-based soil moisture sensor and Arduino (case study: in the Narnea Cikijing Seed Outlet), developed a smart garden system that can detect soil moisture and reservoir water level height, and use that information to automatically fill in the reservoir and perform automatic watering. This system is also equipped with an Android-based monitoring with communication media using Bluetooth. Calvien Pradiptha Giovannie et al [7], conducted research under the title Watering and Lighting Systems in Smart Gardens Using Context Aware Based Technology, where the system is used for farming equipment in the home using a moisture sensor (Soil Moisture Sensor) and a DHT11 sensor so that during resistance soil of a certain size will do watering automatically and on the lighting system to help provide lighting assistance to plants by using the Growth Led lamp which has been set at a temperature regulated by DHT11. This system is not equipped with an Android-based monitoring system. Diana Rahmawati et al [8], in her research entitled Designing Mini Water Saving Gardens with Automatic Fuzzy Microirrigation System Using Arduino, designing a mini garden watering system automatically based on the reading of soil moisture sensors and temperature sensors to regulate watering plants using fuzzy logic. This system is also not equipped with monitoring using an Android device.

In this research, a smart garden system will be developed which will automatically water the plants based on the detection of soil drought using the FC-28 soil moisture sensor using the Arduino Mega microcontroller [9]. In addition, the system can monitor room temperature and humidity information using DHT11 temperature and humidity sensors [7]. Garden monitoring can be done directly using an Android mobile phone using Bluetooth communication namely HC-05 module [10].

3 Proposed System

Automatic Smart Garden System design as in the following block diagram in Figure 1. From the block diagram, it can be explained as follows:

a. The input section consists of several sensors to monitor temperature and humidity, soil humidity and Real Time Clock (RTC) to determine the working system based on time in real time. There is also a Fluid Flow Sensor to measure the volume of water used.
b. In the process section, it consists of an Arduino Mega microcontroller with more Input/Output (I/O) ports according to system requirements. At this microcontroller programming will be done to regulate the work of the hardware.
c. In the output section, the processing results in the process section are used to control several devices such as, water pumps to pump water from water tanks to garden land using sprinkles dan record data on Data Logger. Besides that, there is also a Bluetooth module as a wireless transmision between Arduino and Android phones, for system monitoring.

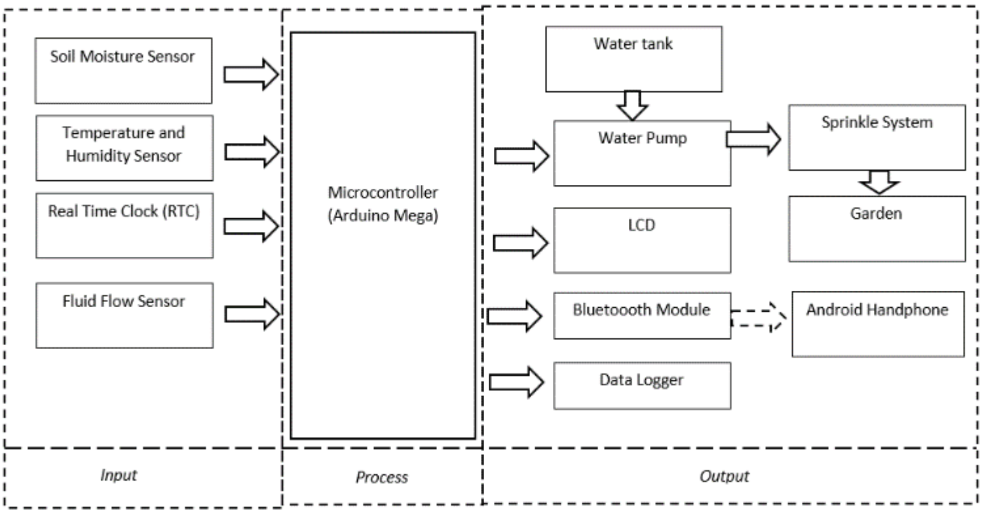

Fig. 1. Block Diagram of Proposed System

This research is doing by two stages i.e. hardware design and manufacturing, software design and manufacturing. The hardware design in accordance with the block diagram above, can be seen in Figure 2. The software design is done in two parts. The first part is the design and manufacture of Arduino software using IDE (Integrated Development Environment) as the central control system. Flow Chart of software design can be seen in Figure 3.

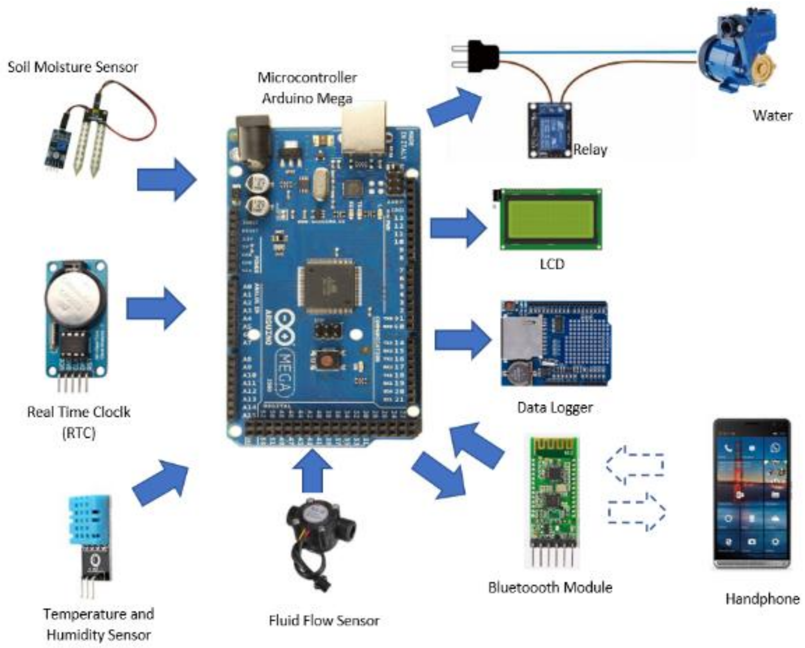

Fig. 2. Hardware Design

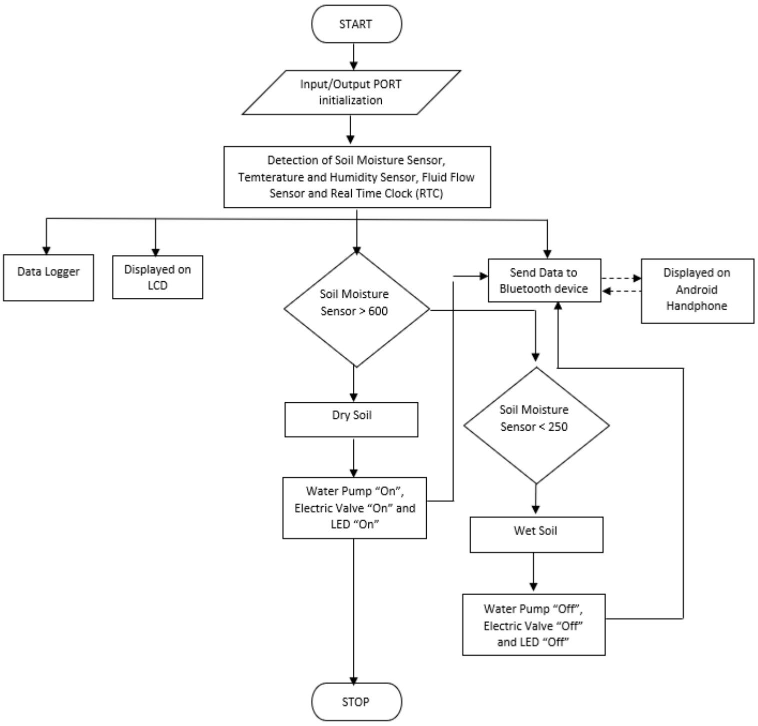

Fig. 3. Software Design Flow Chart

The second part is the design of android software as an android-based system interface using the inventor app. User interface design using the app inventor can be seen in Figure 4.

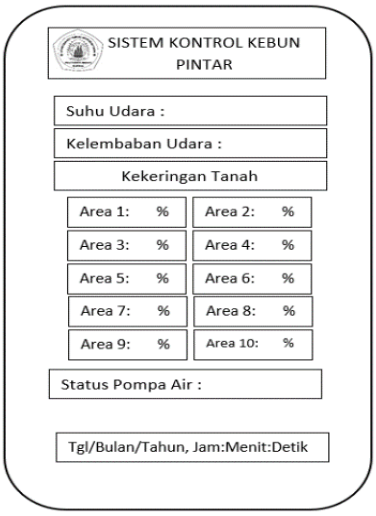

Fig. 4. User Interface Design Using App Inventor

After the system is design and manufactured, the next step is collecting data by observing the volume of water usage, before using the system and after using the system. It also observes the reading data of each sensor and records it in the Data Logger.

4. Results and discussion

4.1 Hardware and Software Manufacturing

After the system design is done, the next step is to make the system hardware and software. The results of hardware manufacturing can be seen in Figure 5, which is the central control system. Then the software is designed for Arduino devices using Arduino IDE and Android interface design using the Inventor app. The results of the software design can be seen in Figure 6.

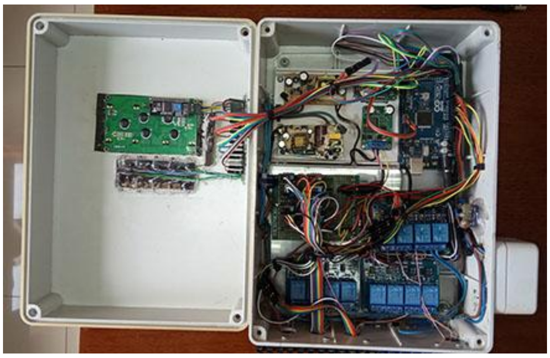

Fig. 5. Hardware Manufactured

(a) Welcome Screen (b) Monitoring System

Fig. 6. Software Manufactured

4.2 Testing and Implementation of Smart Garden System

After making the hardware and software, the system will be tested on agricultural land at the Kupang State Agricultural Polytechnic. The test results show that if the soil moisture value is greater than 600 (set point value1), it shows that the dry soil and water pump will live and the selenoid valve on the sensor will open so that plants can be watered. Conversely, if the soil moisture reaches a value of 250 (Sset point value 2), then the water pump will stop and the selenoid valve on the sensor will close and water will not flow to the plant. The indicators on the device will indicate whether the pump is on or off and which selenoid valve is on and off according to the respective soil moisture. The water pump will shut down only if all soil is detected wet. Figure 7. shows the demonstration of the control system panel.

Fig. 7. Demonstration of Control System

The system can also be monitored in real time through a monitoring application on an android mobile. Through this application, room temperature and humidity, soil moisture, water pump status and water use volume can be monitored. Application interface as shown in figure 8.

In this study, the comparison between water usage without using a system or manual method with water usage after using a smart garden system. The results are shown in Table 1. Based on Table 1, the volume of water usage after using the system is more economical when compared to the manual method, with a percentage of 45.2%.

Fig. 8. Monitoring System by Android Application

Table 1. Comparison of water use in watering plants

Days	Water Usage (Liter)	
	Manual Method	Using System
1	110.7	46.6
2	98.5	45.8
3	119.2	45.9
4	105.8	47.6
5	121.5	48.8
6	88.3	44.7
7	97.2	50.1
8	105.3	43.2
9	112.6	45.7
10	95.4	48.9
11	89.8	49.5
12	111.6	44.6
13	90.6	47.6
14	102.7	46.2
TOTAL	**103.5**	**46.8**

5 Conclusion

a. The smart garden system can be made using the ATmega 2560 (Arduino Mega) microcontroller as a control center, supported by various sensors such as temperature and humidity sensors, soil moisture sensors, Real Time Clock (RTC) and Flow Sensors with Android-based monitoring devices using Bluetooth .

b. The smart garden systems work based on soil moisture conditions. If soil moisture is detected by senors in dry conditions (above the threshold), the water pump will automatically start and the selenoid valve will also live to drain the water in the dry plant area and vice versa if the soil is detected wet at the threshold then the water pump will shut down and the selenoid valve will also close and no water will flow. The smart garden system is equipped with a temperature and humidity monitoring system that can be monitored directly through an Android-based cellular phone.
c. The use of smart garden systems can save 45.2 % of water usage.

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