On-line monitoring system in greenhouse area for chrysanthemum cultivation based on raspberry pi and iot

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On-line monitoring system in greenhouse area for chrysanthemum cultivation based on raspberry pi and iot

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Abstract. Chrysanthemum plants generally grow well when cultivated at an altitude of 650-1200 m above sea level. Chrysanthemum plants come from subtropical climates, with temperatures ranging from 17-30 C. whereas, in Indonesia, which is a tropical region, it is 20-26 C. The humidity needed by chrysanthemum plants at the time of planting is 90-95%, while at the time of enlargement and chrysanthemum flower growth of 70-80%. To get optimal results, chrysanthemum plants need to be cultivated in a greenhouse area. In a greenhouse, temperature and humidity can be controlled. In addition, chrysanthemum plants are also more protected from pests. In this paper, an on-line greenhouse monitoring system is developed. The system is equipped with sensors for temperature, humidity, soil humidity, light intensity, and an RGB camera. Sensor data is sent to the cloud database via raspberry pi. Data is displayed in graphical form every 1 hour. The sensor data can be accessed from anywhere via the internet network and can be used for the analysis of crop yields based on greenhouse conditions during cultivation.

1. Introduction

Indonesia The IERC (European Research Cluster on the Internet of Things) defines the Internet of Things as a global infrastructure for public information media, which enables advanced interconnection services (physical and virtual) based on developing existing interoperable information and communication technologies [1]. It includes the concepts and paradigms of various kinds of communication networks connected via cable or wireless, and capable of interacting and communicating with each other in a minimal environment without human intervention. This concept revolutionizes the user experience and manufacturers' understanding of user requirements and production methods; which will revolutionize the way of life of society as a whole later. Since its inception, the Internet of Think has penetrated various elements, from large industrial scale [2] [3] to households [4]. Internet of Think can help optimize human work which makes it possible to monitor or control remotely in real-time [5].

Using the Internet of Think (IoT), a person can find out the condition of the house when he is left traveling [6] and control home appliances from outside the city [7]. Even when implemented in the agricultural industry, with the IoT feature, farmers can find out the condition of agricultural land from home for 24 hours non-stop [8]. Various data on land conditions such as soil moisture, pH levels, temperature, and rainfall can have a significant impact on agricultural production. Data from sensors installed in fields or greenhouses can help farmers plan the optimal time to harvest or ensure that the harvest time is ready with maximum results. Therefore, the application of IoT in agriculture is very important to use.

Based on these problems, an on-line greenhouse monitoring system based on the Raspberry Pi was designed in this study. Raspberry Pi is a mini-sized integrated computer device that can work at low power. Raspberry Pi can be connected to the internet network to send data on-line to the server. Furthermore, the data is displayed on the website page in real-time. This research was conducted in the Jember Polytechnic State Polytechnic Highlands Greenhouse area, which is a place for chrysanthemum cultivation. By utilizing the output product of this research, lecturers/technicians can find out the environmental conditions at the Greenhouse without having to visit the UPT Dataran Tinggi location directly. This can increase the effectiveness of the management of Chrysanthemum flower cultivation so that the productivity of Chrysanthemum flower cultivation can increase.

2. Related Work

Chrysanthemum (*Chrysanthemum morifolium*) is a commercially valuable ornamental species Worldwide. It is one among the top cut flowers and pot plants traded in the world [9] [10]. Chrysanthemum is important for its outstanding aesthetic beauty flower and the world's second most economically important floricultural crop following the rose [11]. The quality of chrysanthemum flowers is evaluated based on its color [12] [13] [14]. The compound inflorescence of the chrysanthemum flower, which are usually yellow or green, purple, green, red, pink, orange, and white [15]. In general, chrysanthemum plants can grow well if they are cultivated at an altitude of 650-1200 m above sea level. The optimal temperature for chrysanthemum plants in their native places, namely China and Japan, which are subtropical climates, is 17-30 C. Whereas in Indonesia, which is a tropical region, is 20-26 C. The humidity required by chrysanthemum plants at the time of planting is 90 -95%, whereas at the time of rearing and growth of chrysanthemum flowers were 70-80% [16]. The ideal amount of CO_2 content for the photosynthesis process in chrysanthemum plants is 600-900 ppm. A good planting medium for chrysanthemum cultivation is to use sandy clay textured soil with a density of 0.2-0.8 g / cm3 with total porosity of 50-75%. The good water content for the media ranges from 50-70% and 10-20% air content in the pores, and the dissolved salt content is 1-1.25 dS / m2 and a pH of around 5.5-6.5. This condition can be achieved by modifying the growing media in the beds and setting the water with a fertigation system. Chrysanthemum is a short-day plant (SDP) or also called a short-day plant [17] [18]. Short Day Plant (SDP) is a plant that will enter the generative phase if the length of the day it receives is less than its critical limit [19]. Photoperiodic control of the growth and flowering of chrysanthemum makes it possible to cultivate this crop all-year-round.

The conditions for growing chrysanthemum flowers will be optimally fulfilled if they are cultivated in greenhouses so that the growth of chrysanthemum plants is maximized. If planted conventionally, there will be several problems such as: setting the temperature and humidity required by chrysanthemums is difficult to do. the watering process becomes less efficient, especially on large land and greenhouses because it requires a lot of labor and a sufficient level of water for each plant that is not well controlled. Nutrition[21] is sometimes not optimal in terms of dosage/nutrition and the time of giving light is still manual so it requires more intensive attention by workers. Therefore, it is necessary to apply agricultural techniques by combining embedded system technology in order to produce an optimal microclimate for plant growth. This is expected to reduce negative environmental impacts such as high light intensity, direct exposure to rainwater, high daily temperatures, and pest disturbances.
Several GH monitoring system technologies have been applied, such as in research [20] where a greenhouse monitoring system was created using LabView. From this system, a realtime graph of temperature, humidity, and light intensity sensors is obtained. Meanwhile, research [22] used the application of the TOP COYS (Automated Plant Controlling Systems) system to increase crop productivity. By using the TOP COYS system, chrysanthemum flowers have a higher survival rate and have a better size.

3. System Design

3.1 Hardware Design

The GreenHouse monitoring system for chrysanthemum cultivation uses 3 types of sensors, namely: temperature-humidity sensor, soil moisture sensor, and light intensity sensor. Temperature and humidity sensor using the DHT11 sensor. Light intensity sensor using GY-49. The soil moisture sensor uses electrodes connected to a buffer. ATMega328 microcontroller is used to access the data of the three sensors. A 0.98 "OLED LCD display is used to display temperature, humidity, soil humidity, and light intensity data every 5 seconds.

All sensor data is sent serially to the raspberry pi device. For image data, the Pi Camera with a resolution of 5 MP is used. Raspberry pi is connected to the internet using a wifi modem. Data on temperature & air humidity, soil humidity, light intensity, and images with a resolution of 640x480 are sent to the MySQL database. Furthermore, a website was created to display the data stored in the MySQL database. Figure 1 is a block diagram of the system used in this study.

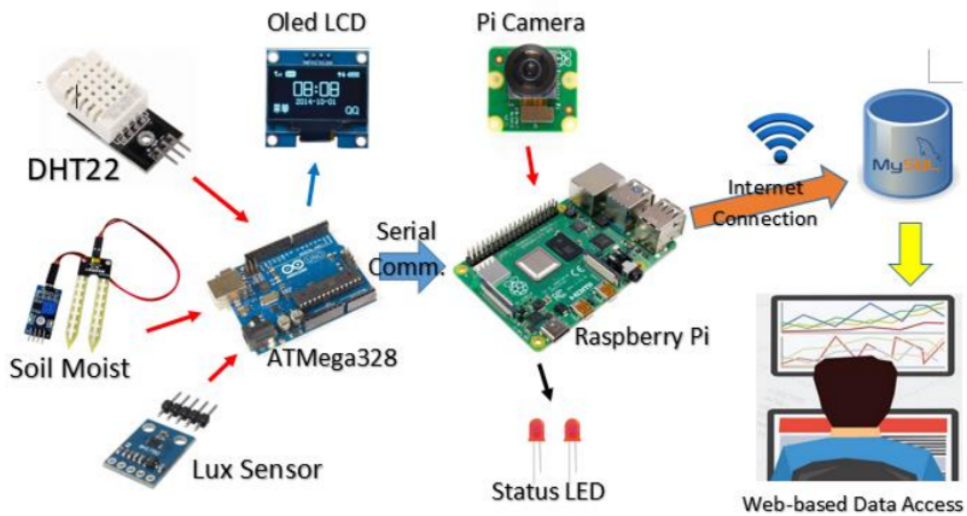

Figure 1. Block Diagram System

3.2 Software Design

In software design, there are 3 types of programming used, namely: microcontroller programming (using Arduino), raspberry programming (Python), and web programming (using PHP). Microcontroller is used to access DHT22 data, Lux sensor and soil sensor. DHT22 has 2 kinds of data, namely temperature and humidity. The 4 sensor data are then combined into one data package with the format "temperature; temperature; soil; lux;". The data packet is then sent to the raspberry using serial communication. The microcontroller programming flowchart is shown in Figure 2.

Raspberry pi will read the data sent by the microcontroller. The data is then split back into 4 sensor data. When connected to the internet, the sensor data is sent to the MySQL database every 10 minutes. Image data from pi cameras are sent to the database every 1 hour. The programming flowhart is shown in Figure 3. Next, the website will display data from the database in the form of the latest sensor values, images, and graphics.

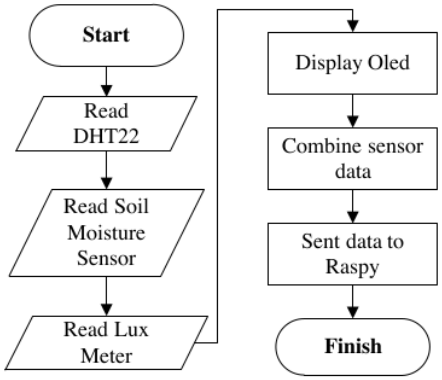

Figure 2 Flow Chart ATMega328

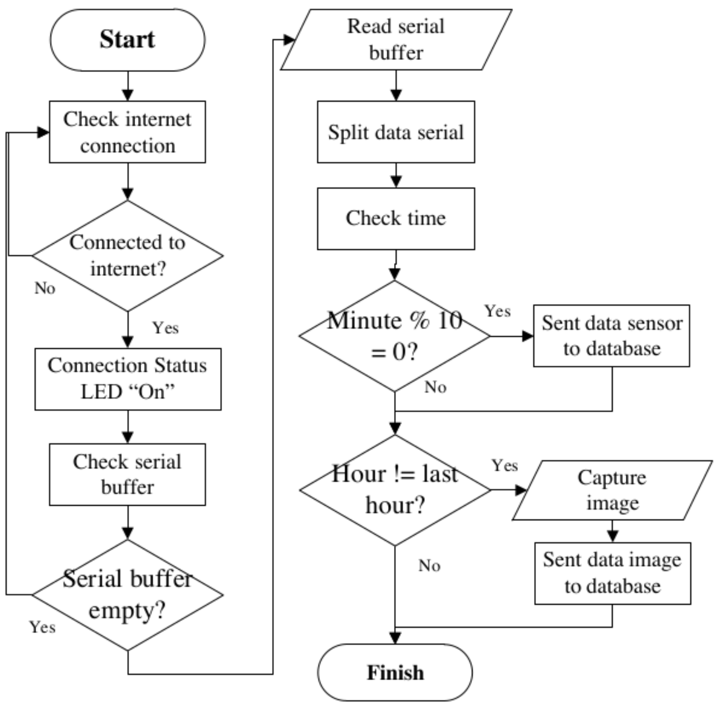

Figure 3 Flowchart Raspberry Pi

4. Result and Discussion

4.1. Hardware Realization

The power supply of the device is PLN electricity with a voltage of 220 V / 50 Hz. The voltage is further reduced to 5V Volt DC using an adapter. To protect against a blackout, the power supply for the Raspberry and microcontroller is equipped with a 5 Volt mini UPS. This mini UPS will back up the power so that the equipment can continue to work during the PLN electricity shutdown.

The power supply, raspberry, microcontroller, and modem are placed in a plastic box measuring 20cm x 30 cm x 15cm. A 5 volt DC fan was installed on the inside of the box to keep the raspberry temperature low. It helps the Raspberry Pi to work with maximum performance. The Raspberry device is connected to a 4G wireless modem. The modem is equipped with an internal battery so that it can also work when the PLN electricity goes out. The overall placement of the devices is shown in figure 5.

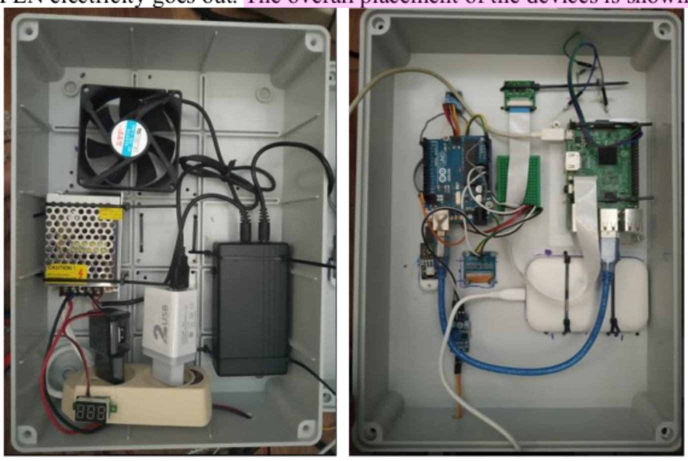

Figure 4. Hardware

The wiring on the microcontroller and raspberry device is shown in table 3. The pin placement is made based on the communication features used on the sensor and display. Furthermore, the monitoring device is placed at the side of the entrance to the Green House. In this position, the Chrysanthemum plant is fully visible on the camera. To measure soil moisture, sensors are installed at the location where the plants are growing. It is intended that the moisture content can be monitored by the device. The soill moisture sensor is connected by wire 3 meters long. The placement of the monitoring equipment at the Greenhouse is shown in Figure 5.

Figure 5. placement of sensors in the greenhouse

Table 1. Pin Mapping

Controller	PIN	Device
ATMega328	A4, A5 (I2C)	Lux Sensor
	2	DHT22
	A1 (analog In)	Soil Moisture
	A4, A5 (I2C	OLed LCD
Raspberry Pi	2,3	Led Status
	Aux pin	Pi Camera

4.2. Testing result

After the device has been mounted in the Greenhouse, the device runs for 24 hours non-stop. The database is designed to be able to store data per hour in 1 week. This is approximately 168 data per sensor (672 data total, excluding image data). Figure 4 is the database setting that was used in this study. At the top of the web, the DHT 11-lux-soil sensors were displayed every 10 minutes. In part 2, there is a column for displaying image data. There are 2 image data displayed on the web, namely the latest image, and image data for the previous hour. Both images are used to observe conditions change in the greenhouse. In part 3, there is a graph plotting for each sensor. Users can view data trends from environmental conditions for the last 7 days. The entire web interface can be seen in Figure 7. Data can be accessed in address http://bungakrisan.iot24hours.com via a standard web browser.

Based on observations of data for 7 days, sometimes there are miss data at certain hours, especially at 10 pm (GMT +7). This may be due to heavy traffic on hosting, which interferes with data storage in the cloud database. However, as a whole system, this does not interfere with the overall data observation, because the percentage of miss data is only around 1.2%. The results of the data storage observations are shown in table 2. For internet usage, based on the observation for a month it only consumed less than 2GB of data. Efficient data use is based on data transmission settings, including medium resolution of image data.

Table 2. Data Test

Day	Missed data				Error
	Temperature	Humidity	Lux	Soil	
1	10pm	10pm	10pm	10pm	4,2%
2	Full	Full	Full	Full	0%
3	Full	Full	Full	Full	0%
4	11pm	11pm	11pm	11pm	4,2%
5	Full	Full	Full	Full	0%
6	Full	Full	Full	Full	0%
7	Full	Full	Full	Full	0%
				Ave	1,2%

Figure 6. display of monitoring system

5. Conclusion

As long as the device works in 24 hours, the database can store data per hour in 1 week, reaching 168 data per sensor with a total of 672 data excluding image data. Observation of data as a whole experiences a percentage of data that is missed or error is around 1.2%, with the causative factor being the density of data storage traffic on the cloud system. The effectiveness of the management of chrysanthemum cultivation to increase the productivity of chrysanthemum cultivation results can be attempted by monitoring the greenhouse conditions in real time by sensors on 4 parameters including humidity, temperature, light intensity and soil water content. Recording is done every 2 hours per day and displayed in graphical form that can be monitored by the manager in real time. The database of observations is stored on a cloud system and displayed on the website http://bungakrisan.iot24hours.com.

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