Application of Open Garden Sensor on Hydroponic Maintenance Management

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Abstract. Hydroponic farming system is an agricultural system that uses direct water as a nutrient without using soil as a planting medium. This system allows smallholder farmers to have the opportunity to develop their crop production with less capital. In addition, hydroponic planting has also been widely adapted by individuals as a personal hobby. Application of technology has penetrated various fields including agricultural fields. One of the technologies that can be applied in a hydroponic farming system is the sensor. Sensors are devices that used to convert a physical quantity into a quantity of electricity so that it can be analyse with a certain electrical circuit. In this study, the technology to be applied is wireless sensor technology applied in human life to help get information quickly and accurately. Sensors to be used in this study are pH sensors, conductivity sensors, temperature sensors and humidity. In addition to sensors, the study also involved Arduino technology. Arduino is a microcontroller board that is used to interact with the environment based on programs that have been made. The final results of the application testing show that the system success to display diagram in real-time in an environment from Arduino board to database and web server.

1. Introduction

The role of wireless sensor technology can be applied in human life to help get information quickly and accurately. Open Garden consists of three different kits, each for a specific type of indoor growing plants (house and greenhouse), outside (gardens and fields) and hydroponics (plants in water installations). Open Garden has been designed to assist in caring for gardens by automating controls and organizing work that takes place in hydroponic pots. This platform allows to control the state of the plant by sensing some parameters such as soil moisture, temperature, humidity, light consisting of water sensors: pH, conductivity, and temperature. Hydroponic farming system is an agricultural system that uses direct water as a nutrient without using soil as a planting medium. The use of soil as a growing medium can be replaced with other growing media such as sand, broken bricks, coconut husk, foam, Rockwool, etc. [1]. The use of hydroponic farming systems in developed countries especially in countries with high population levels has been done by individuals as a hobby and also on a large scale for commercial purposes [2]. By looking at the above background, the authors lifted the title of this study as, “Application of Open Garden Sensor on Hydroponic Maintenance Management”
2. Problem Identification
Technology that can help the management of the treatment is an open garden sensor that can monitor the state of the plant at any time but it takes the system to organize information from open sensors to be displayed to the user especially when the user is away from the plant.

3. Previous Research
In 2014, Saputri undertook research for the manufacture of Voice Recognition Application System as the Arduino UNO Electrical Equipment Controller. Created a smart home control that allows humans to control home electrical devices using EasyVR as voice recognition [3]. In 2013, Saenz, et al conducted a study entitled Strawberries Collecting Robot Prototype in the Greenhouse Hydroponic System. In this study Saenz undertook the development of collecting robot strawberry prototypes in a greenhouse hydroponic system, using artificial vision in identifying the maturity and redness of strawberries [4]. By 2015, Ali, M, et al conducted a study on the title of Automated pH Controller System for Hydroponic Cultivation. In this study Ali automated pH levels in aqueous solutions administered by microcontrollers and measured by sensors [5]. In 2016, Siregar, et al. [6] publish research that using Wireless Sensor Network to monitor plant growing. Plant growth is highly depending on the sunlight, if the consumption of sunlight is enough, it will grow well. The plant will be green because of its chlorophyll and it can perform photosynthesis at maximum; but if the plants get less sunlight, it will make the plants be yellowing. In the same year, Siregar, et al. also publish research about air pollution [7], one of the indicators is the measurement of the level of environmental air humidity in a city where the study was conducted. This research also uses Wireless Sensor Network technology.

4. Methodology
In this study consists of several steps, which begins with the general architecture of the use of sensors and tools used and work processes of the built system can be seen in Figure 1.
4.1. Hardware and Sensor Monitoring System Design

The elaboration of the stages of the system's general architecture is as follows: At hardware stage shows the process of taking data with the sensor to be sent to Arduino. Submission of data by Arduino to the monitoring application system using SIM module 800L GPRS GSM Module. This process starts from the pH sensor, conductivity, water level and temperature placed on the plant. The sensor will collect data from the plant and sent to the Arduino. Sensors will transmit data via digital pins. The Arduino then calculates the data received from the sensors placed in the plant. Data obtained from the pH sensor, conductivity, water level, air temperature, air humidity, and light level are sent to the database where data collection through the server to be carried out into a real-time monitoring system. Delivery of data to server using SIM800L GPRS GSM Module and connected to server. Hydroponic monitoring application system built using a web-based application system using PHP.

4.1.1. Web Server

Web Server serves as a storage and processing data between Arduino, database, and client. The data received by the sensor is sent to the Arduino for processing and sent to the server where the data is collected. The data obtained will be stored into the database and ready to be displayed to the client in graphical form. Graphs are displayed in time with a certain interval and will always move updated automatically every second as long as the Arduino sends data to the server.

4.1.2. Client

The system is made based on the web to perform monitoring. Client dealing with a page containing the display of sensor data presented in the form of graphs. The data displayed are pH sensors, conductivity, water level, water temperature, air humidity, air temperature, and light level.

4.2. System Design

In designing the system will be designed how the application will display data from the existing sensors in hydroponics plants.

4.2.1. Use Case Diagram

Use case describes a typical interaction between the user and the system itself with a member of a narrative about how the system is used [6]. System use case diagram to be viewed in the Figure 2.

![Figure 2. Use Case Diagram.](image)

4.2.2. Use Case Specification

Use case specification is a description of the use case diagram, explaining how a use case it works. Specification of use case to display sensor data.
Table 1. Use Case Specification for Main Page.

| Use Case Name      | Specification                                                                 |
|--------------------|-------------------------------------------------------------------------------|
| Actor              | Computer user.                                                                |
| Description        | Used by user to view sensor data.                                             |
| Pre-Condition      | System turned-on.                                                             |
| Characteristic of activation | Could be done by anyone who has given authorization.                  |
| Basic flow         | User sees sensor data at main page.                                           |
| Post condition     | User can view sensor data condition of the plant with periods of 15 seconds. |
| Limitations        | User can only monitor phenomena that captured by appropriate sensors function.|

4.2.3. Web Application Page Layout

After the user successfully login, then the user directly into the main page. On the main page there are buttons labeled Home, Tanaman, Log Sensor, and Log Out. In the middle of the page is a description of the sensor graph for each sensor and indicator lights as a notification whether the value captured by the sensor reaches a low, medium, or high threshold. The design of this main page can be seen in Figure 3.

Figure 3. Main Page Design View Layout

5. Study and Result

Implementation of interface design that has been done previously on the system is the web dashboard that shown running graph periodically can be seen in Figure 4.
Figure 4. Web Dashboard that Shows Running Graph.

In this dashboard page users can see the value of the sensor in the form of a diagram of each sensor. On this page there is also a display of 7 diagrams, the first diagram is an air temperature diagram.
showing data from the surrounding air. The second is the air humidity diagram showing the high humidity. The third is a water temperature diagram showing the water temperature. The fourth is a pH sensor diagram showing the water in an acid or base pot. The fifth is the sensor conductivity diagram showing the value of electrical conductivity in the solution. The sixth is a light level diagram that shows the darkness of a room. The seventh is a water level diagram showing the dose of water in a pot. On the next page, as shown in Figure 5, the value of numbers obtained from sensors attached to the plant is tabulated. The views on the page will be updated every 15 seconds.

![Graph showing data from sensors attached to the plant](image)

**Figure 5. Sensor Log Page**

Testing of integrity is done to ensure that the phenomenon captured by the plant is successfully delivered and received into the database without any data being changed or corrupt. The test results can be seen in Table 2.

**Table 2. Data Sensing Integrity**

| Data Integrity of Sensing Results Received by Database Periodically | States |
|---------------------------------------------------------------|--------|
| Air Temperature                                              | Whole  |
| Air Humidity                                                  | Whole  |
| Water Temperature                                             | Whole  |
| pH                                                            | Whole  |
| Conductivity                                                  | Whole  |
| Light Level                                                   | Whole  |
| Water Level                                                   | Whole  |

Some points on the graph can be highlighted to more details about the captured data of a particular sensor. As the example can be seen in Figure 6, which is more detailed information about the water level in the hydroponic plant container at certain times. For hydroponic plants, water level conditions...
in the container are necessary to get special attention. Plants in containers should not suffer from shortages or excess water.

![Figure 6. Water Level Indicator: (a) Not Full, (b) Full](image)

6. Conclusion
The results of the application testing show that data from sensor readings success put into database and then shown in web dashboard in real time. The time range for data updates is 15 seconds, so the user can do a comparison to study the condition of the plant.

References

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