ISSN 1816-6075 (Print), 1818-0523 (Online)
Journal of System and Management Sciences
Vol. 12 (2022) No. 3, pp. 104-116
DOI:10.33168/JSMS.2022.0306

Mobile Application For Agrotechnology Systems Using Internet of Things (IoT)

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Abstract. The purpose of this study is to propose an agrotechnology system using internet of things. It is Called Mobile IoT Farming Systems. Its can help the productivity of crop planting. The research methodology consists of several stages such as: requirement analysis, systems design, and development. First stage was conducted by collecting system requirements data through interviews. Second stage was conducted by implementing UML to design system. Third stage is develop the system using mobile technology. The results of this study are system design, features of systems, and systems implementation. It can be used for urban agricultural community . Besides that, we found the benefits of the systems such as can help users more easy to controlling plant maintenance, and it happened both during planting and harvesting, In order to support the productivity plant processes, users can find out the status of the plant and the room temperature to keep it stable. Its consists of features of systems that can supported planting growth. The systems can support the productivity planting growth, users can find out the status of the plant and the room temperature to keep it stable.

Keywords: internet of things, agrotechnology systems, mobile application

1. Introduction

Indonesia is an agricultural country that has a very wide agricultural land. Based on the BPS in 2016, the area of rice fields in Indonesia reached 8.19 million hectares (Vintarno et al., 2019). With these advantages, Indonesia has become an agricultural country that prioritizes the agricultural sector as a source of the nation's economy (Nurdiansyah et al., 2020). However, recently the development of the agricultural sector in Indonesia is faced with various challenges and problems (Nuraisah et al., 2019). With the process of urbanization and industrialization in big cities like Jakarta, agricultural land in big cities is decreasing (Prasetyawati 2019). The impact of this phenomenon is the shift in the function of land which was originally used as agricultural land into industrial land, economic activities, offices, housing, roads, and other public infrastructure facilities. The reduction in agricultural land in big cities will lead to several things, such as a drastic decline in the country's economy, malnutrition from quality vegetable products, and the need for high imports of crops (Furoidah 2020). Several social and economic problems also threaten the Indonesian agricultural sector, especially in big cities (Rivai et al., 2016). Problems such as policies, poorly functioning agricultural organizations, land ownership, information technology, and lack of capital threaten agricultural life in Indonesia. This is getting worse with the low interest of youth in agriculture which causes low regeneration of farmers (Ningtyas et al., 2020). To overcome these problems, a modernization process is needed in the form of appropriate engineering technology in agriculture (Prayoga et al., 2019). In the agricultural sector, the Internet of Things (IoT) can be used as a decision support system in controlling agricultural sensors and connecting them to cloud technology to support good plant growth (Data et al., 2019). Therefore, through this research, technological engineering was carried out to realize good automation of plant IoT micro-climate monitoring. First, the design of data collection technology for monitoring temperature, humidity, light, and CO2 based on IoT is carried out. Then, the development of software and databases that store and manage the monitoring data is carried out. Finally, an evaluation of the success of this technological device is carried out in monitoring the values of temperature, humidity, light, CO2, and pH that can produce productive and quality plants. Later, there will be several variations for plant cultivation methods, such as indoor plants, outdoor plants, and hydroponic plants. In each farming method, sensors will be tested so that we can find out the needs of each of their lives, such as how high the temperature is needed, how high the humidity level is, how much CO2 quantity is needed, and how bright the light is needed. Once fully known, the data will be entered into a database and the sensors can be run automatically through the IoT application and website that has been developed.

2. Related Works

IoT is a concept that connects multiple devices to the Internet and allows IoT devices to communicate with each other over the Internet. The IoT is a huge network of connected devices: they all collect and share data about device usage and the environment in which they operate. Like humans, each device learns from the experiences of other devices. IoT seeks to expand human independence, such as interacting, contributing, and collaborating on something. IoT (Internet of Thing) can be defined as the ability of various devices that can be connected and exchange data with each other through the internet network. IoT is a technology that allows for control, communication, collaboration with various hardware, data through the internet network According to Franklin (1955), Micro-climate is a set of climatic conditions measured in a localized area near the earth's surface. It is including temperature, light, wind speed, and humidity. Then it will provide meaningful indicators for habitat selection and other ecological activities. Besides that, related to Bramer et al (2018), Micro-climate is discuss about habitat and urgent for organisms at the micro scale. Today, hydroponics is growing fast, while Hydroponics is a planting technique using planting media other than soil. It can use spumic, gravel, sand, coconut fiber or foam and utilizes water flow to provide plant nutritional needs (Sharma et al., 2018). The impact of this condition is planting does not require large tracts of land (Roidah 2015). IoT technology allows data transmission without human intervention by using the internet as a transmission medium. This means that all controls can be carried out by people using their respective smartphones. IoT devices have programmable microcontroller chips that connect to smartphones via the Internet. Only need a smartphone connected to the Internet the user can control the IoT device remotely. Application Programming Interface or API is used to connect one application to another. The role of the API is to act as an intermediary that connects different applications, both from the same platform and across platforms. Besides that, deep learning in IOT has been proposed by Kim et al (2022). Then, IOT platform provider has been discussed by Wang et al (2022).

3. Research Methodology

In this study, we used interview technique to gather systems requirement. In order to analyzing and designing, we used UML diagram. It can modeling the systems. Then, we used Axure RP9, Visual Studio, and Visual Paradigm to construct prototyping. Related to sensors, ,we need an IoT plant monitoring technology in the form of a microcontroller board equipped with several sensors according to analysis needs. The NodeMCU is NodeMCU V3 which is equipped with an ESP8266 Wifi module and several pinouts for sensors on its surface.Later, the microcontroller board will be connected to several sensors related to the needs of plant life, such as CO2 sensors, temperature sensors, light sensors, and air humidity sensors. We will also add an OV7670 camera module to monitor the condition and development of the plant being analyzed. After everything is assembled, the circuit will be given a programming function with the Arduino IDE software according to the needs of the researcher. If the programming function is running, the application will be connected to the database using the cloud feature, then connected to the mobile application and website that we have designed The following are some of the sensors used in this study : DHT21 or AM2301 (Temperature and Humidity Sensor). This sensor can measure air humidity on a scale of 0-100% and temperature from -40° to 80°C. The sensor can be run with a voltage of 3.3-5V.MQ135 (CO_2 Sensor), This sensor can assess the level of carbon dioxide in the environment. This sensor can also be used to measure air quality values by detecting gases that are harmful to health such as ammonia, aromatic compounds, sulphur, benzene, smoke, etc. The sensor can be run with a voltage of 5V. BH1750 (Light Sensor). This sensor can measure the intensity of light which can be used to adjust the brightness of the display on the cell phone and LCD screen in lux units. This sensor has a wide reading and high resolution with small measurement variations. This sensor can also ignore the influence of infrared. The sensor can be run with a voltage of 2.4V-3.6V. Soil Moisture Hygrometer, This sensor can measure the level of soil moisture. The sensor can be run with a voltage of 3.3V-5V.

4. Results and Discussion

4.1. Analysis and design of mobile IoT farming systems

The IoT Based Crop Cultivation system architecture developed consists of 5 sensors, namely temperature sensors, humidity sensors, light sensors, CO_2 sensors, and Soil pH sensors. These five sensors will be connected in 1 NodeMCU microcontroller. It is used to capture data from each sensor with a certain time setting and then the data will be sent directly to cloud storage because this microcontroller already has a wifi module that is connected to the internet. The data that has been entered will be processed and visualized by the system and then displayed on the website and android pages for monitoring. At the very beginning, User can set their standard measurements data on each plant (3 plants). The system will save the plants' data on the cache (local). Afterwards, user can view the plants' measurement data details & delete the plants' data if the user felt that measurements data is no longer needed. The Information System in the application of IoT Farming apps is to combine all measurement data that has been received by the IoT Farming Sensor into a database on the cloud server. The data will be needed by the IoT Farming application to be retrieved & sent to the user so that the user can see each measurement data (one by one). Users can also monitor all summary data results from each measurement in tabular form. Use case Diagram for Mobile IoT Farming Systems will be explained in the figure below.

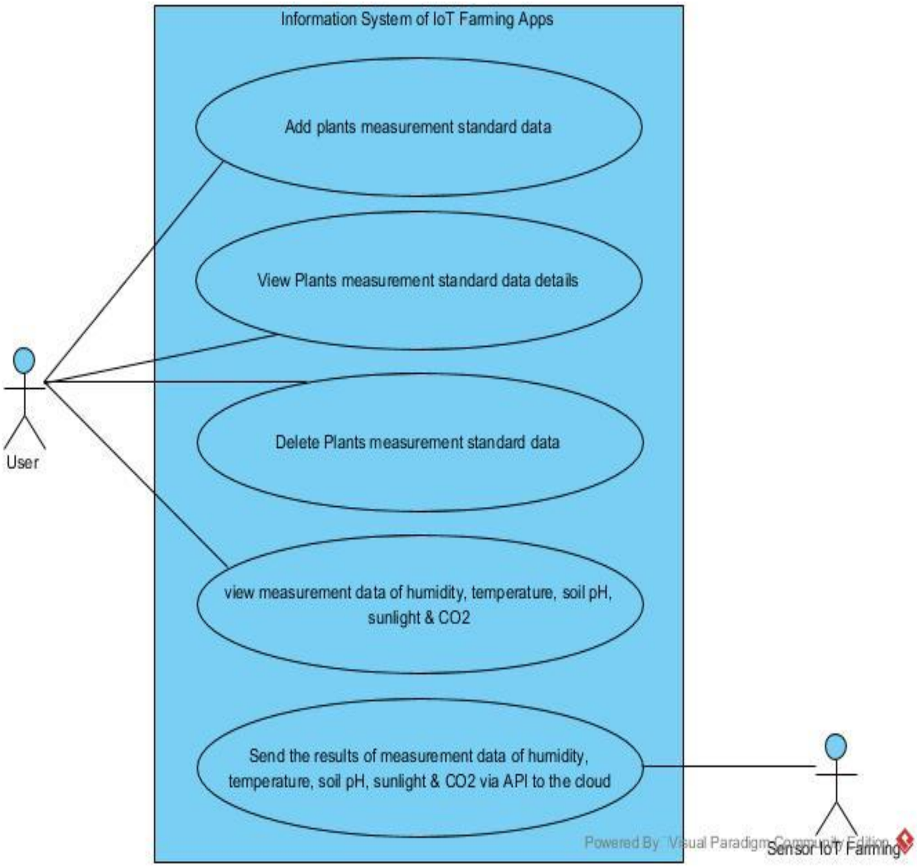

Fig. 1: Use case diagram mobile IoT farming systems

Use case diagram in Figure 1 above shown five use case to describe the functionality in Mobile IoT Farming systems. The use case are

1. add plants measurement data
2. view plant measurements standard data details
3. delete plant measurements standard data details
4. View measurements data of humidity, temperature, soil ph,sunlight & CO2
5. Send the results of measurement data humidity\, temperature, soil ph,sunlight & CO2 via API to cloud

4.2. Implementation of mobile IoT farming systems

We construct Mobile IOT Farming Systems using mobile technology based on Android. Figure below shows the available features in Mobile IOT Farming Systems.

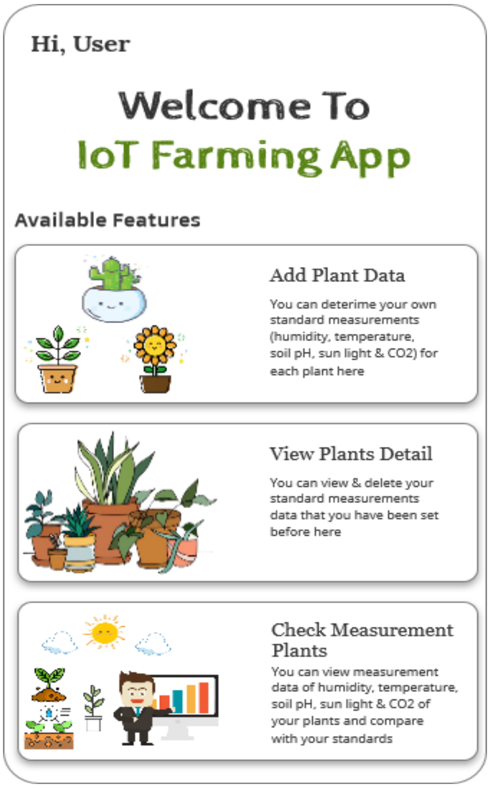

Fig. 4: Home page mobile IoT farming systems

The figure above is the Main Menu or Home Page of the Mobile IOT Farming Systems. The Home Page display displays several features that are available & can be used by the user. The available features are "Add Plant Data", "View Plants Detail" & "Check Measurement Plants". Each feature is accompanied by a brief explanation of the use of the feature & menu.

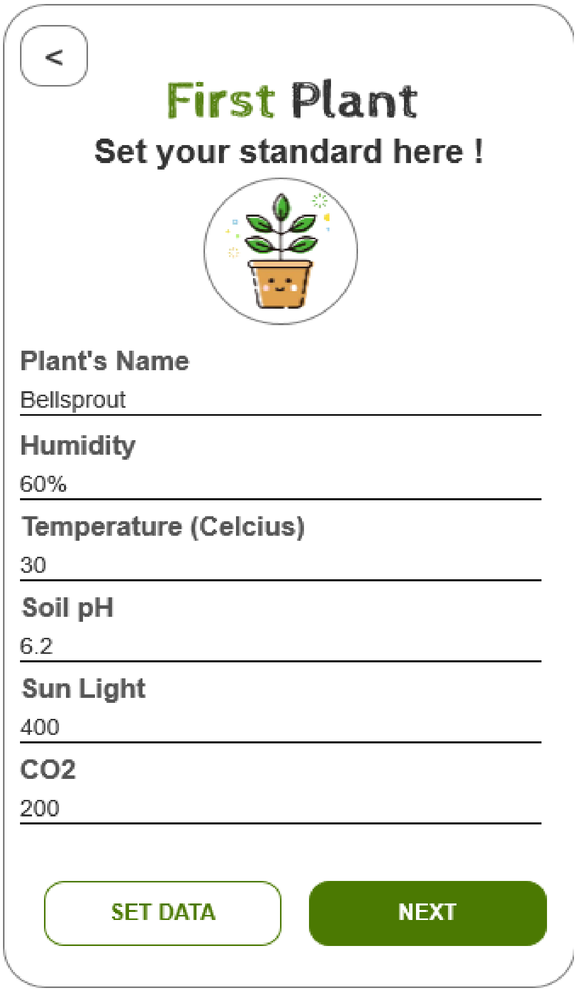

Fig. 5: First plant features mobile IoT farming systems

The display above is the display after the user opens the "Add Plant" menu, and is the display when the user wants to set the measurement standard for the first plant. There is a back menu on the top left of the display to direct the user back to the Home Page. The user must fill in the Plant's Name, Humidity, Temperature, soil pH, Sun Light, CO_2 as the standard size that the user wants to store in the first plant. If so, the user must click the "SET DATA" button to save the data, then click the "NEXT" button to go to the second plant menu.

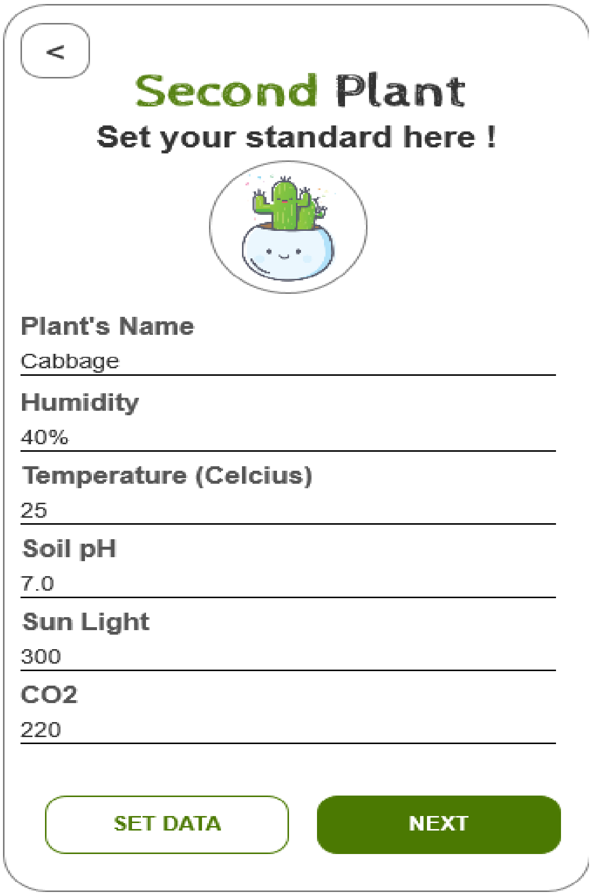

Fig 6: Second plant features mobile IOT farming systems

The display above is the display after the user has completed the "First Plant" display, and is the display when the user wants to set the measurement standard for the second plant. There is a back menu on the top left of the display to direct the user back to the "First Plant" menu. The user must fill in the Plant's Name, Humidity, Temperature, soil pH, Sun Light, CO_2 as the standard size that the user wants to store in the second plant. If so, the user must click the "SET DATA" button to save the data, then click the "NEXT" button to go to the third plant view.

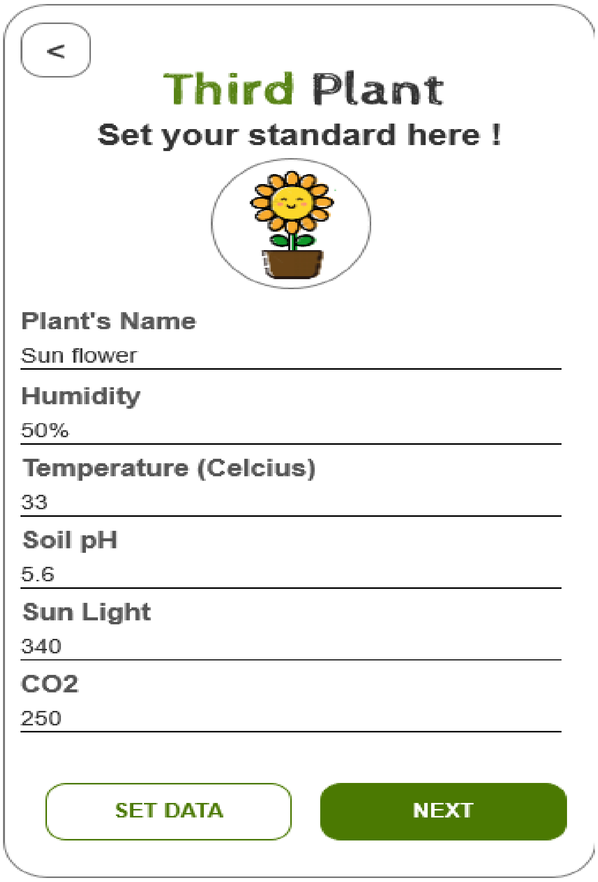

Fig. 5: Third plant features mobile IoT farming systems

The display above is the display after the user has completed the “Second Plant” display, and is the display when the user wants to set the measurement standard for the third plant. There is a back menu on the top left of the display to direct the user back to the “Second Plant” view. The user must fill in the Plant's Name, Humidity, Temperature, soil pH, Sun Light, CO2 as the standard size that the user wants to store in the third plant. If so, the user must click the "SET DATA" button to save the data, then click the "NEXT" button to go to the Home Page display because all plant data has been saved.

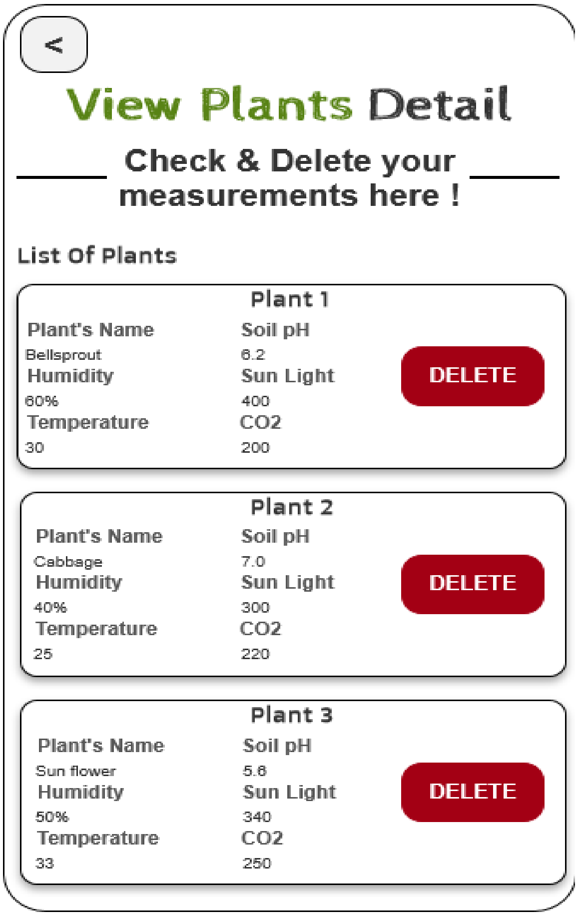

Fig. 6: View plants detail features mobile IoT farming systems

The display above is the menu when the user opens the "View Plants Detail" menu. There is a back menu on the top left of the display to direct the user back to the Home Page. In this view, the User can see a list of available plants (Plant 1, 2 & 3), and display plant data according to the data set by the User on the "Add Plant" menu. In addition, if there is an incorrect data input, the user can click the "DELETE" button to delete the plant data.

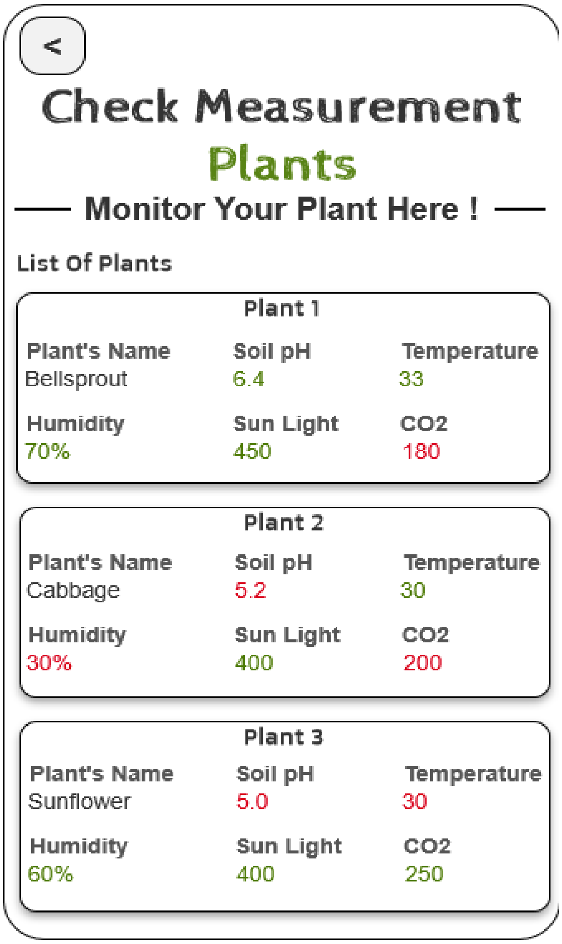

Fig. 7: Check Measurements features mobile IoT farming systems

The display above is the menu after the User opens the "Check Measurement Plants" menu. There is a back menu on the top left of the display to direct the user back to the Home Page. In this view, the user can see 3 lists of available plants (Plant 1, 2 & 3), and the user can view the original measurement data received by the sensor in real time, and compare it with the data that has been previously set by the user on the “Add Plant" menu on each plant. In plant’s box 1, 2 & 3 each has data regarding "Plant's Name, Humidity, Temperature, soil pH, Sun Light, CO2". Green data means that the measurement results have passed the minimum standard set by the User on the "Add Plant" menu. Meanwhile, if the data is red, it means that the measurement results have not passed the minimum standard set by the User.

5. Conclusions

Mobile IOT Farming Systems has been constructed and implemented in this study. The systems consists of software features that can support in planting growth. The implication of the systems is can support the productivity planting growth processes. Besides that, users can find out the status of the plant and the room temperature to keep it stable. Its can be expanded and developed into a product that can be used for urban agricultural community

Acknowledgment

The authors acknowledge contribution of the other research team members and RTTO Binus University. This work supported by Research Grant from DIKTI (Directorate General of Higher Education) Republic of Indonesia with entitle "Development of Internet-Of-Things . Intelligent Micro-Climate Observation and Control System Development To Increase Horticultural Production"

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