System Architecture for Urban Farming Using Internet of Things and Microservices

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Abstract

Urban farming is growing rapidly currently. This has an impact on the use of systems and technologies that support urban farming. Problems faced by urban farming managers include difficulties in checking, extreme natural conditions, and limited knowledge related to plant management. The use of IoT in supporting Urban Farming has been done by many other researchers. However, so far there has been no research that synergizes IoT and Microservices in supporting Urban Farming. Synergy of IoT and Microservices can optimize Urban Farming's productivity and efficiency. In this study, we used system development approach to construct the system. We divided into three stages, such as requirement analysis, design and implementation. The result in this study are system architecture and prototype system, which is include system architecture design, and list of microservices in system architecture. Then, we provided some features in system architecture.

Keyword
Internet of Things, Microservices, Urban Farming, System Architecture.

1. Introduction
Agricultural commodities are one of the important aspects in meeting the needs of food supply (Naik et al. 2018) Urban farming is increasingly in demand by people who live in big cities (Buehler et al. 2016) Urban agriculture is oriented towards realizing the ease of fulfilling daily food needs and creating additional urban green open spaces (Horst et al. 2017). However, there are several challenges currently being faced by many farmers and owners of urban gardens or urban farming. Manually caring plant tends to take time in the process and there can be human error from the results obtained (Rajalakshmi et al .2018)

In the agricultural and plantation industries, temperature and weather greatly affect the process of plant development and the results obtained (Weng et al However, with weather conditions that are currently uncertain and often change (B. Parkes et al), there are temperature conditions that can change for plants and can hamper crop yields and others. Third, limited knowledge on how to check and determine the pH of water, soil moisture, and plant conditions can also have an unfavourable impact and results are not optimal (Higgins et al. 2017), Irregular plant caring and watering schedules damage plant development (Katsoulas et al. 2006). These conditions result in frequent damage to crops, crop failures and a decrease in the quantity and quality of crop yields. Therefore, the development of a system that can help industrialization and modernization of urban farming. One technique that can be applied to overcome this problem is to develop a smart system for urban farming cultivation using IoT and Microservices.

1.1 Objectives
The research objectives in this study are to analyzing systems requirement, to design systems architecture and design prototyping systems for urban farming. The systems would be developed based on Internet of Things and Microservices Architecture. We combined Internet of Things and Microservices Architecture (MSA) to implement systems requirement and systems design.

2. Literature Review

According to (T. B. Franklin et al), 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 et al. 2015).

On the other hand, produce an optimal monitoring system using the concept of IoT has been conducted by (Harun et al. 2019) and (Colezea et al.2018). They proposed the integration of IoT into an agricultural. Meanwhile, related to (Khanna et al 2019), the using of IoT can make the agricultural process more efficient, and Farmers use IoT to control agricultural activities in a more effective way. Microservices can be seen as a technique for developing software applications that inherit the principles and concepts of the Service Oriented Architecture (SOA) style. it is possible to structure a service-based application as a very small, loosely coupled collection of software services.

Microservices architecture can be seen as a new paradigm for programming applications through a composition of small services, each running its own process and communicating through lightweight mechanisms (Rademacher et al. 2018). Microservices is a software architecture concept where the system consists of small services that work together and are autonomous, deployable, scalable, modeled on a bounded context. According to (Fauziah 2014), An API Gateway is a server that is the single entry point into the system. This is similar to the outward side view pattern of object-oriented design. Its encapsulates the internal system architecture and provides a customized API for each client. Besides that, an API Gateway may have other responsibilities such as authentication, monitoring, load balancing, caching, request shaping and request management, and static response handling. The API Gateway will often handle requests by implementing multiple microservices and aggregating the results. It can translate between web protocols like HTTP and WebSocket and web protocols that are not commonly used internally (Fauziah 2014).

REST is a type of web service that applies the concept of switching between states. State here can be described as if the browser requests a web page, then the server will send the current state of the web page to the browser. Navigating through the links provided is the same as changing the state of the web page. Similarly, REST works, by navigating through HTTP links to perform certain activities, as if they were switching states from one another (Fauziah 2014). REST Webservices builds integrations in a lighter and simpler way, and focuses on resources (Rettig et al. 2015). The main idea of REST is the concept of resources as components of the application that need to be used or addressed (Rettig et al. 2015)

3. Methods

In this study, we used system development approach. It consists of several stages, such as requirement analysis, design, and implementation. In requirement analysis stages, we are going to gather the user requirement and user need. In this stage we analyze and mapping the system processes existing. We use UML diagram to visualize what is the system requirement. After that, we continued to design stage. In this stage, we design the systems included system architecture, features in system architecture, and hardware also. In this stage we used UML diagram for described the system design. Then, we continued to implementation stage. In this stage, we implement the system based on requirement and system design that has been created. In this stage, we used prototyping and mockup approach. We used JSON, Rest API, mobile application, and Arduino for supported the implementation stages.

4. Data Collection

We collect the data using interview technique. In this study, we used in depth interview, besides that in order to gathering requirements, focus group discussion are needed. We used several references from related documents.

5. Results and Discussion

5.1 Proposed Systems Architecture

The process used for recorded the development of plants that are being checked periodically will cause difficulties in finding files. The recording plants also includes recording the progress of plant status that has been monitored. It will certainly take time due to the large number of areas which must also be thoroughly monitored and recorded. In order to accommodate these condition, we proposed system architecture which has several functionality to solve the problem that we can see in the Table 1 below:

Table 1. Functionality in System Architecture Proposed

Problem	Functionality in System Architecture Proposed
Checking Periodically	each user or user can easily check periodically using only a smartphone, data from information on plant development status can also be monitored through cctv media provided one of these features, the sensor will also automatically provide status to the server which will be sent directly to the user .
The weather conditions in Indonesia are very uncertain for planting. It can affect the quality and process of plant development which is found to be inappropriate	each plant will be given a sensor along with a temperature controller that will automatically provide information on the status of existing plants, the other process is that the status of the plant can be received by the user transparently and quickly so that the user can find out which plants need special care and several other things that have a good effect in the process of plant care.
This is a limitation of knowledge about how to check and determine water pH, soil moisture, and certain plant conditions	With the application of a system designed automatically the sensor will provide information related to the description of water pH, soil moisture, and other information based on indicators that are easy to understand, where certain indicators can easily be understood so that users can use the designed system easily. In addition to the status that is easy to read and understand, other processes such as scheduling watering and planting can be easily managed using the system created.

The System Architecture Proposed has three actor or role, such as manager/admin, engineer, and assistant. Table 2. below described the activity for each actor or role in system architecture proposed.

Table 2. Actor in System Architecture Proposed

Actor	Activity
Manager/Admin	manager or admin who will monitor managing every process of the entire system activity
Engineer	engineer in charge of adding sensors, checking the function of each running system and updating the system as needed
Assistant	assistant who functions as a gardener or plant being planted by monitoring and also providing information related to the development of plant status

According to three actors above, all users will initially become managers, then want to add accounts or other users can add them in add account. It can be implemented where indirectly the manager will choose and invite other managers but can be made as assistant or engineer depending on the agreement. Even the manager actor can also be an assistant or engineer in other plantations to help and establish relationships between garden owners. An additional feature that each role has is the presence of a button Smart Farming. A button smart farming will provide a function of system automation that can carry out monitoring automatically using sensors assisted by tools (actuators) from lowering the temperature with a fan, doing watering automatically and arranging scheduling without having to be monitored or monitored by the administrator. The following is an overview of the architectural system design used in describing the systematics of the architectural process, here the user will get information and update through the use of the API which will later be processed into data that can be read by the cloud server media and will be sent to the database and sent to the sensor system. , the following is an example of an architectural system description of urban farming design (Figure 1).

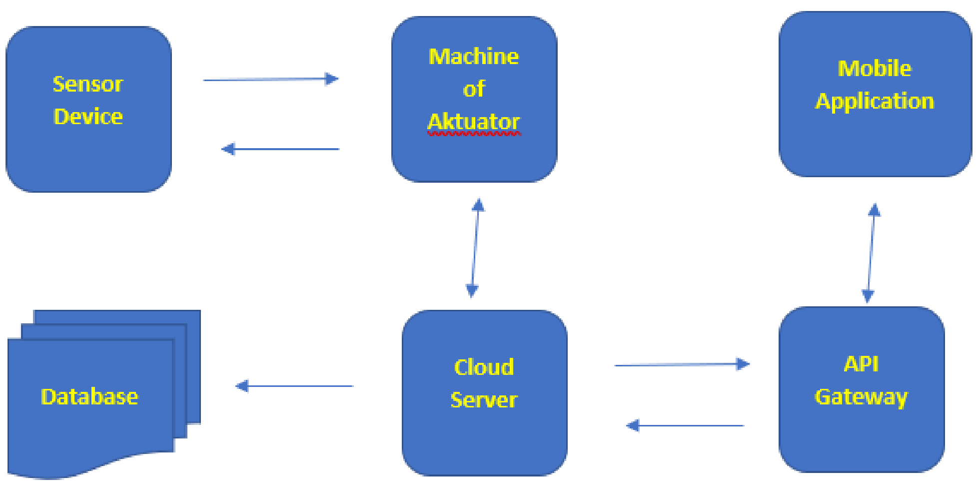

Figure 1. Design of System Architecture Proposed

Then, the microservices in system proposed will be explained in Figure 2.

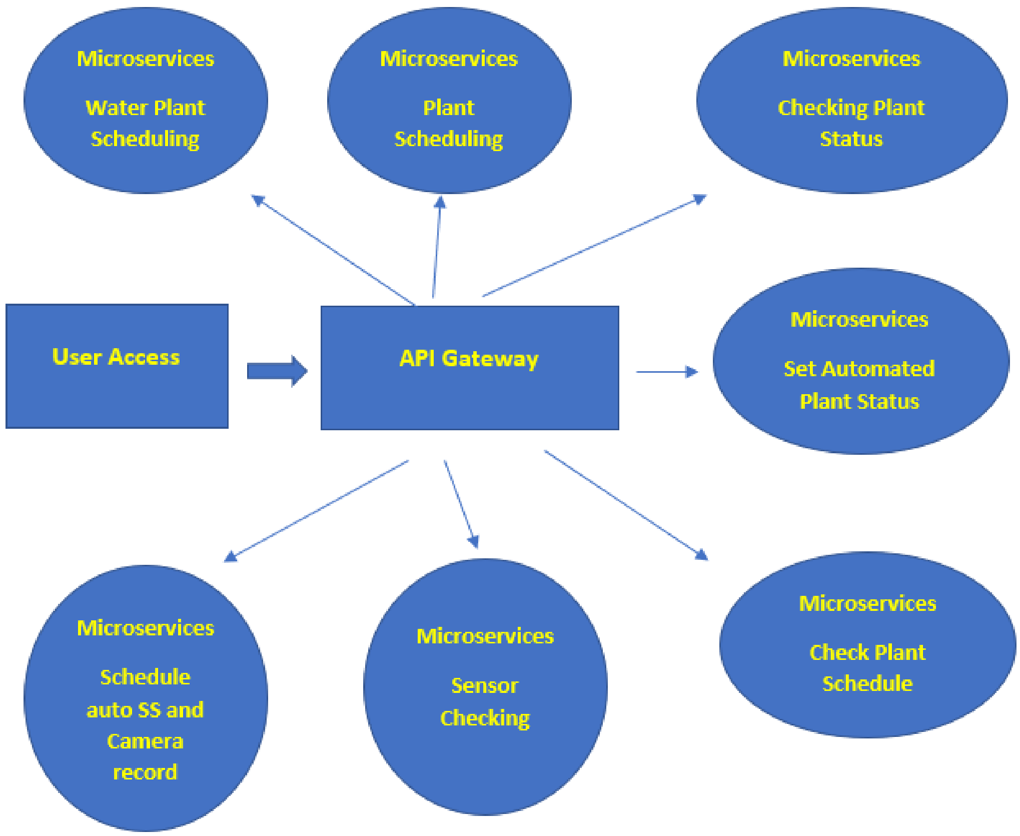

Figure 2. Microservices in System Architecture Proposed

5.2 Features in Systems Architecture Proposed

A feature that provides a picture status of the plant in real time and updates from the system, besides that information made from the manager section will also enter the plant status view menu so that the status at the bottom will be seen whether the system has been updated and the status will automatically be displayed. integrated into the server. Figure 3 will be explained below

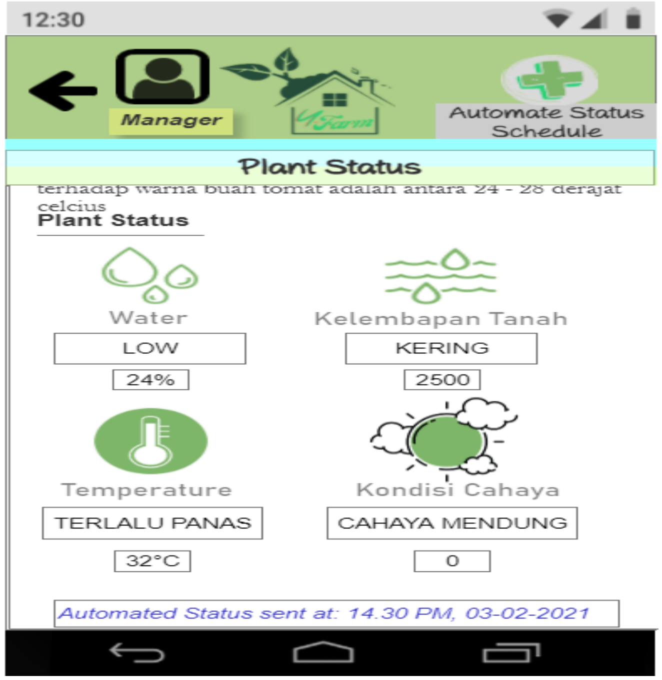

Figure 3. View Plant Status detail

A feature that describes the smart farming feature where this process allows users to be assisted by the system in running and supervising plants, both in the process of scheduling automatic watering, reducing temperatures, turning on fans and recording on the camera which later all data will be provided via user notifications can be see in Figure 4. To avoid system failure when internet connection lost. All of automated scheduling are delegated from the central computation to the microcontroller as an edge of computation.

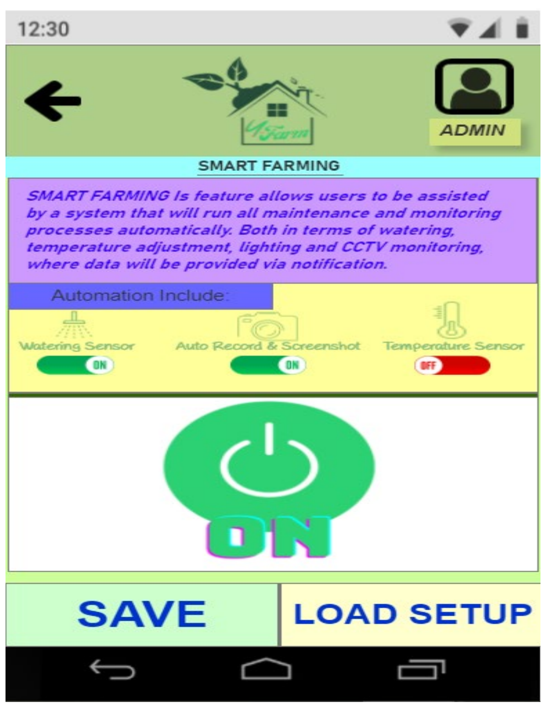

Figure 4. Smart Farming

5.3. Interpretation of Data Results

In this study we compare the traditional farming and Smart Farming. The results of data comparation can be shown in Table 1 below:

Table 1. Data comparation

Indicator	Traditional Farming	Smart Farming
Time Checking Periodically	12 hours	0,1 second
Time Temperature information	24 hours	1 second
Time water pH, soil moisture Information	24 hours	1,5 second

According to Table 1 above, we compare the time based on data analysis and focus group discussion with stakeholder in farming ecosystem.

6. Conclusion

The system Architecture for urban farming based on IoT and Microservices can be Implemented using mobile apps media. It would be easier for users to manage and monitor in real time. The system can be used effectively to improve the information obtained and utilization in using water resources. Microservices Architecture can be choose for implement urban farming Internet of Things Platform

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