

# Applications of temperature and humidity monitoring system at aeroponic plants based on IoT

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**Abstract.** Indonesian agricultural system has improved significantly along with technological developments. However, as a result of technological developments, agricultural land becomes narrow. To overcome the increasingly narrow farming land, start developing systems suitable for planting with aeroponic system. Unpredictable environmental climate changes can disrupt productivity growth and create low quality crops. To solve this problem, monitoring system based on Android needed. This system is used to monitor in parameters change, the parameters include temperature and humidity. Android-based monitoring system uses java programming and is open source, besides the user can monitor the development of spinach plants, by looking at data that has been stored into the database so that users can know the development of the plant. This application can be accessed via smartphone with android operating system as a client server.

## 1 Introduction

Indonesia's agricultural system has begun to develop cultivation systems with various systems. One example of a system that began to be developed is the aeroponic system, using the air media by hanging plants on the air and then the nutrients sprayed on the roots of plants [1]. Plants suitable for aeroponic systems are vegetables [2]. The object used in this study is spinach, because spinach requires a relatively short cultivation time of 25-35 days after planting [3]. Spinach plants require temperature, humidity, carbon dioxide levels and sufficient lighting to grow well. If one of these parameters is not met or excessive then the crop is not maximal and cause the spinach plants to dry will not even grow [4].

The effects of climate change in agriculture are characterized by floods, droughts and rainy seasons. Climate change leads to reduced productivity growth and low quality crops [5]. It requires a continuous monitoring system from seed planting to harvest time. Manual monitoring of plant growth has limitations caused by human physical factors including

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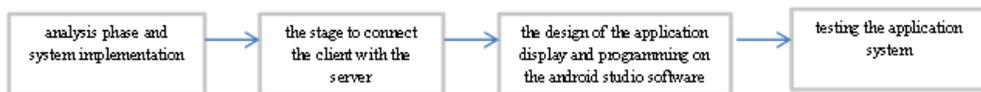
fatigue, non-continuity, uniformity and inaccuracy. The solution of the problem is by applying technology in the form of remote monitoring. Remote monitoring is very effective because the results of direct monitoring data are stored in the database [6].

The monitoring system research on spinach plant is focused on monitoring system only with parameters of temperature, humidity, light intensity and carbon dioxide levels. The differentiator of this study with previous research [8-10] is to use android application for remote monitoring on spinach plants with aeroponic system. Android is one of the operating systems for linux-based mobile devices that include operating systems, middleware, and applications. Android is made by using Java programming and is open source so it can grow quickly and also provide an open platform [7]. Application of aeromosis can monitor the development of spinach plants, by looking at data that has been stored into the database so that users can know the development of the spinach plant. This application is accessed via smartphone with Android operating system and is client server.

## 2 Research methods

### 2.1 Research methods

The design of research monitoring system (aeromosis) is divided into 4 stages namely, system design, architecture design (linking between the database with android), designing the application and programming view on android studio, and testing applications against multiple smartphones. Flow diagram design research can be seen in Figure 1.

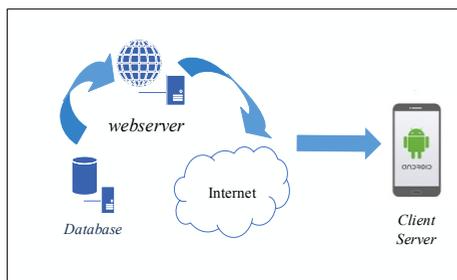


**Fig. 1.** Diagram block of designing research

Figure 1 describes the steps to be used in this study. The first phase begins with the analysis phase and system implementation. The second stage is the stage to connect the client with the server. In the process of connecting the database to the application monitoring system using JSON (JavaScript Object Notation) format. The third stage discusses the design of the application display and programming on the android studio software. The fourth stage is the last stage of testing the application system, whether the system runs according to the design or not as well as on a variety of smartphones.

### 2.2 Design Architecture

The architecture design of the monitoring system application research aims to connect the client with the server via the internet. Client will request server to get information about the last condition parameter. The depiction of the architectural design flow can be seen in Figure 2.

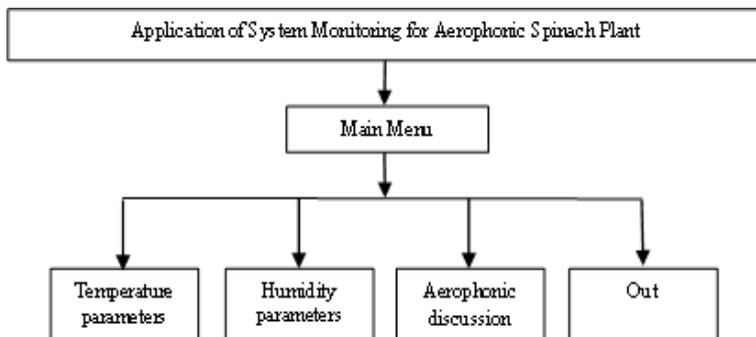


**Fig. 2.** The architecture design of the monitoring system application

Figure 2 is an architectural design of aeroponic plant monitoring system applications. Which consists of database, web server, internet and client server ie smartphone. The database is created using MySQL, which connects to the webserver. In order to connect between database, web server, and smartphone required internet network.

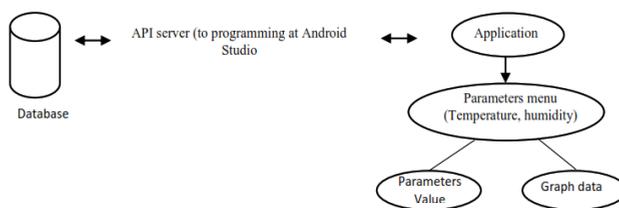
### 2.3 Application and Programming Display Design on Android Studio

This design begins by creating a block diagram of the display sketch of the application content (description of the application content). The block diagram can be seen in Figure 3.



**Fig. 3.** Diagram Block of Application System Monitoring

Figure 3 illustrates the description of the contents of aeroponic monitoring system application (aeromosis) consisting of a main menu containing temperature and humidity content, aeroponic discussion (containing questions and answers about aeroponics), and exit application). Figure 3 can run with any programming on the android studio software. The programming stage of android studio is very important in making the application of aeromic monitoring system (aerophonic monitoring system). In android studio there are two programming languages that is xml to make the application and java display to run the application display in order to run in accordance with the design.



**Fig. 4.** How to Get Data of Application System Monitoring

Figure 4 describes the steps in data retrieval for the application of this monitoring system (aeromosis). Data stored on the database, connected with php files that have been uploaded on the web server. Connecting data from the database into this aeromosis application by calling the database url in the java file in android studio. Once the url is entered into java programming, the application can access the data with the internet connection.

## 3 Results and discussion

All menus can run because of coding. Coding is a process of translation of design or application design from the main menu to the existing menu in it into the java programming

language to be a unity in order to become a medium that can be used in accordance with the design. Testing is very important because at this stage aims to determine whether the menu in the application can run correctly and to determine the shortcomings or errors that must be corrected. Testing the application is done using a smartphone.

### 3.1 Running application

The most important stage for aeromosis applications to be used is the stage of running the application. At this stage the application is run using a smartphone (USB Debugging), this stage is also a stage to test the application can run in accordance with the design or not. The application runs on Lenovo brand A6600d40 smartphone with android 6.0 operating system, API 23 and 5-inch screen size. Here are the steps in running the application using a smartphone:

1. Preparing smartphones as well as Micro USB to USB cable. Then open Developer Mode (Smartphone Mode) on your smartphone. If Developer Mode does not appear on the smartphone, enter the settings first, then enter the about phone menu, select the build number (press 5 times) until the message appears if the smartphone has become a developer.
2. Enable USB debugging on smartphone by connecting smartphone with PC using USB cable. Enable developer mode through the settings menu, by searching for USB debugging.
3. Run the application by Run on the android studio software, and search auto smartphone will become emulator and appear on the screen android studio software. Once the smartphone that we use appears then click OK, and wait until the compile process is complete. The application will appear on the smartphone screen.

### 3.2 Monitoring system application view

The aeromosis application displays the values of those parameters, the graph data that serves to see the values of the parameters that have been stored into the database in the form of line graphs, some questions and answers about aeroponics. Interface testing is done on the main menu to make sure the menus in the main menu interface can run according to the design. Display applications in accordance with the design using a smartphone with 5-inch screen size, operating system android 5.0.0 as the brand Lenovo A6600d40 hp.

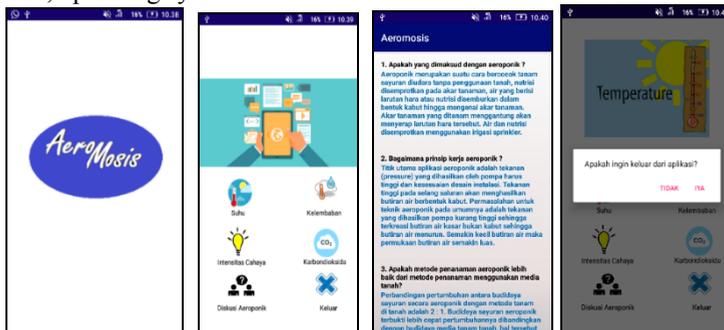


Fig. 5. Display of Aeromosis

Figure 5 is an aeromosis display, a splashscreen menu, a main menu, an aeroponic discussion menu and an exit menu. In the splashscreen display contains a logo that describes the application with aeroponic writing (in aeroponic monitoring system).

Splashscreen duration of about 5 seconds, then after automatically going to the main menu view.

The main menu consists of imageslider and some menu options. Imageslider on this main menu contains some animations that can shift automatically with delay every two to three to move from one image to another. After the three image will automatically move to the first image. In addition to the main menu imageslider also displays some menu options are: temperature menu, and humidity menu aeroponic discussion menu and exit menu.

### 3.2.1 Menu of temperature

Aeromosis is an aeroponic plant monitoring application that focuses on spinach. In aeromosis applications, this temperature menu displays values in real time graphs and lines. Display the menu menu temperature can be seen in Figure 6.



Fig. 6. Display of Temperature Menu in Smartphone

### 3.2.2 Menu of humidity

The humidity parameter menu display does not vary much with the temperature menu menu view. The humidity parameter menu display can be seen in Figure 7.

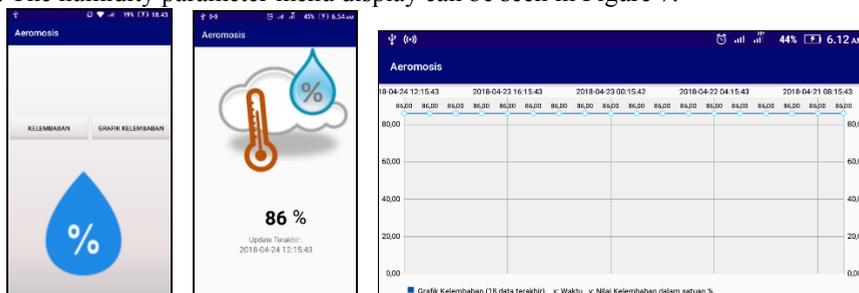


Fig. 7. Display of Humidity Menu in Smartphone

## 3.3 Testing of Device Screens

Tests on various screen devices done to check the system can work well or not on other smartphones. In this study using 10 kinds of smartphones with different types and specifications like can be seen in Table 1.

Test results from various screen device sizes in Table 1, obtained successful measurements 9 and 1 failed on the smartphone. Failure on this test is caused by screen display that is not in accordance with the design. This failure occurs because the application is run on a smartphone with a screen size of the device under 4 inches and the operating

system on the smartphone 4.1.2. The size of the screen and operating system on the smartphone is very influential in the application of this monitoring system

**Tabel 1.** List Of Various Devices Used

No.	Devices Name	Screen Size	Operation System	API	Result
1.	Lenovo A6600d40	5 inci (720x1280 piksel)	Android 6.0	23	Succes
2.	Samsung GT-S6310	3.27 inci (320x480 piksel)	Android 4.1.2	16	Failed
3.	Xiaomi Redmi 4A	5 inci (720x1280 piksel)	Android 6.0.1	23	Succes
4.	Xiaomi Mi A1	5.5 inci (1920x1080 piksel)	Android 8.0	26	Succes
5.	Asus Z00RD	5 inci (720x1280 piksel)	Android 5.0.2	23	Succes
6.	Lenovo A7010a48	5 inci (720x1280 piksel)	Android 6.0	23	Succes
7.	Xiaomi Mi Max	6.44 inci (1920x1080 piksel)	Android 6.0.1	23	Succes
8.	Xiaomi Redmi Note 4	5.5 inci (1920x1080 piksel)	Android 6.0	23	Succes
9.	ASUS-X0011D	5.5 inci (1920x1080 piksel)	Android 7.1.1	25	Succes
10.	Freetel FTJ161A	4 inci (480x800 piksel)	Android 5.1	22	Succes

## 4 Conclusion

Based on the results of the application of temperature monitoring systems, humidity, light content and carbon dioxide in aeroponic system can be explained as follows:

- Application of aeroponic spinach system monitoring system has been completed in accordance with the design. All functions are used on phones with minimal size on 4-inch smartphones and 5.0.0 Android operating system and the system already meets the needs of the plant.
- Application of remote monitoring system can display parameter value; temperature and humidity content by displaying value and time. In addition, this application can also display graph data in the form of line graph display as much as 18 data obtained from the database. This application is very useful to develop aeroponic spinach plants.

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