Design of Smart Agricultural Systems Using MIT App and Firebase

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Abstrak

Penelitian dalam jurnal ini bertemakan rancang bangun sistem pertanian cerdas menggunakan web server yaitu firebase dan thingspeak yang berbasis mikrokontroler jenis NodeMCU Amica dan juga beberapa hardware pendukung seperti akuator dan lainnya. Dalam konsep sistem penelitian ini dapat dioperasikan menggunakan android dan web server yang dapat dilihat secara publik. Tujuan dilakukannya penelitian ini adalah untuk memberikan gambaran berupa konsep rancang bangun pertanian cerdas modern dan juga bagaimana konsep penelitian ini dapat dikembangkan dikemudian waktu sehingga menghasilkan sebuah produk yang efektif dalam menangani aktivitas di pertanian. Tahapan penelitian ini menggunakan jenis penelitian R&D model borg and gall namun dalam penelitian ini hanya sampai pada revisi tahap dua, hal ini dikarenakan tujuan dalam penulisan jurnal ini hanya memberikan konsep rancang bangun sistem untuk dikembangan dikemudian waktu oleh peneliti lainnya. Pengujian dalam penelitian ini dilakukan dengan uji coba software pada aplikasi yang telah jadi dibuat, kemudian pengujian web server, serta dilakukannya pengujian nilai set point dan ketiga pengujian itu telah berhasil dilakukan.

Kata kunci: Pertanian, Firebase, Thingspeak, R&D, IoT

Abstract

Research in this journal is the themed design of Smart agricultural systems using a web server, namely firebase and thingspeak, based on the NodeMCU Amica type microcontroller and some supporting hardware such as actuators and others. This research system can be operated using Android and a web server that can be viewed publicly. The purpose of this research is to provide an overview in the form of a modern smart agricultural design concept and how this research concept can be developed in the future to

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that is effective in handling activities in agriculture. The stages of this research used the type of R&D research, the borg and gall model, but in this study, it only reached the second revision. This is because the purpose of writing this journal is only to provide a system design concept to be developed in the future by other researchers. Testing in this study was carried out by testing the software on the application that had been made, then testing the web server and testing the set point value, and the three tests were successfully carried out.

Keywords: Agricultural, Firebase, Thingspeak, R&D, IoT

1. Introduction

The impact of technology on human life is increasing [1]. One of them is the existence of technology in the form of IoT. The Internet of Things, also known as the abbreviation IoT, is a concept that aims to expand the benefits of continuously connected internet connectivity [2]. One of the applications of IoT is in the field of smart agriculture [3]. Agriculture is one of the leading commodities in Indonesia. This is evidenced by the Indonesian government's reliance on the agricultural sector to boost gross domestic product (GDP) in 2021 [4]. Agriculture is a source of foreign exchange through exports, food and industrial raw material supply, poverty alleviation, employment providers and people's income [5]. According to BPS data, in the second quarter of 2022, the highest economic sector was found in the business fields of agriculture, forestry and fisheries at 13.15 percent [6].

In this research, we will create a smart farming system using Android based on IoT technology. It is also easier to develop Android-based applications with the presence of an App Inventor [7]. Besides that, it also uses Firebase to provide a real-time database and uses Thingspeak to accommodate sensor readings that will be obtained. Then for the microcontroller, use NodeMCU type Amica. The concept that will be given to this smart farming system is to control and monitor the target object using only Android. Using the Internet of things system can help farmers to produce the expected harvest [8].

The implementation of the design in this study is intended for agricultural systems such as monitoring temperature, humidity, and water content in the soil. There are also manual and automatic controls for dispensing water using the IoT-based App Inventor, and there are also additional system options for temperature and humidity control by providing an actuator in the form of a fan and exhaust. Adjusting the temperature and humidity for the actuator is automatically done by providing a sensor setpoint value in the Arduino.IDE program. The addition of the system is flexible depending on the implementation towards which type of agriculture will be applied.

Based on the background explained above, this research aims to describe a smart farming system that can be implemented into aspects of agricultural activity. Apart from that, this research also provides the concept of modern agriculture for the future, and of course, it is hoped that by providing technology-based monitoring controls, it can improve the quality of crop yields in the world of agriculture. This study combines real-time control and monitoring and contains sensor reading data obtained from Thingspeak. Combining these two concepts is expected in this study to have the advantage of being able to control and monitor in real-time and get sensor reading capture values in the form of files exported to excel. There is also an automatic watering time to provide water to the agricultural area. The smart referred to in this study is that there is an automatic system that works based on setting a setpoint value in this product. Of course, this paper is written for readers who want to know the concept of Smart Agricultural Systems described in this journal.

Then two previous studies are most relevant to this research. Of course, these two studies have technological innovations, which later in this research are also made to provide innovations for the future. The two studies are as follows. The research conducted by Anes Inda Rabbika et al. in 2023 is making a design for an IoT-based plant sprinkler control system. Some supporting software such as Blynk, which is used for remote control in this research, also uses system control using the web [9]. Then further research by Rahman Insani and Irawan Afrianto in 2023 explained in their study applying cloud computing technology in the agricultural sector, which is aimed at providing benefits and increasing farmer productivity; this is aimed at collecting and analyzing agrarian data, cloud computing is combined with the IoT concept, several Among those included in the research feature is to find out weather information, market conditions, pesticides, and groundwater quality information that is read by the sensor [10]. Previous research above each has innovativeness, so this study takes innovative steps as well, namely focusing more on the agricultural field sector, such as monitoring and storing data in the thingspeak database in real-time, then some applications are used to control and monitor the system, and there is a web database that is used from thingspeak, everything used in this research paper is open source so that other researchers in the future can also develop this research. The main contribution of this research is, of course, to advance Indonesian agriculture towards modern industry 4.0 and for future researchers to provide more innovative ideas.

2. Research Method

This research method uses Research and Development model Borg and Gall (1983). However, this study only reached the second revision stage, which only discussed the general concept of the results of this study to be implemented flexibly for agricultural systems following the system concept in this study. This study also looks at several previous studies which were carried out utilizing a literature study through articles that can be searched through Google Scholar. Then the literature study results get an additional feature in this study by adding a database and monitoring controls using the MIT App. Inventors. Choosing MIT App Inventor for monitoring control media because it is more practical. In this research, to look for literature studies as a reference, choose the most recent, where the research range is a maximum of the last five to ten years from the current year. The research flow based on the Borg and Gall model R&D method can be seen in Figure 1.

a) Research and collection preliminary
   It begins with a literature study following the research topic to be discussed, namely the central concept of IoT-based smart agriculture, which will then be developed through the Borg and Gall R&D method. Some literature studies have been given appropriate references to the background discussion.
b) Research planning
   It begins with formulating the problem and the objectives of the problem in research according to the topic to be discussed, namely IoT-based smart agriculture. The initial concept was to add a database to this study so that it would be easier to analyze the physical conditions of the environment around

agricultural land. The value contained in the database is a sensor reading value given in this study.

c) Early product development

The initial concept in the implementation of this research is to use IoT technology; then, it can be controlled and monitored using a smartphone, and there is a database to accommodate sensor reading values. The initial concept for the controlled media is to use the Telegram Bot.

d) Expert validation

The initial observation was to see how the system created could be related to the read value on the smartphone and the actual value in the Thingspeak database. Then an observation was also made of the characteristics of the moving actuator based on the determination of the sensor reading setpoint value.

e) Product revision

The initial observation was to see how the system created could be related to the real value on the smartphone and the actual value in the Thingspeak database. Then an observation was also made of the characteristics of the moving actuator based on the determination of the sensor reading setpoint value.

f) Early test

The initial trial was conducted by testing the entire system contained in this research feature. They started with database testing on Firebase and Thingspeak and testing on monitoring controls using the Android-based MIT App Inventor.

g) Product revision

The second phase of the revision was carried out by adding a soil moisture sensor, a Real-Time Clock (RTC) module, and several actuators for water sprinklers. The purpose of adding these three components is to provide additional features in the form of controls and automatic systems to provide sufficient water to the soil.

The research was only carried out until the second revision stage because this research only explains and describes an innovative smart farming system that is flexible so that it can be implemented into several agricultural activities that are suitable for this system.

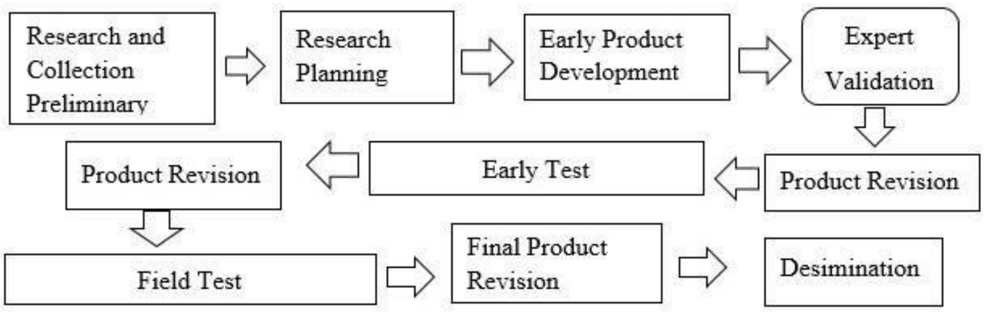

Figure 1. Research and Development (R&D) Model by Borg and Gall [11].

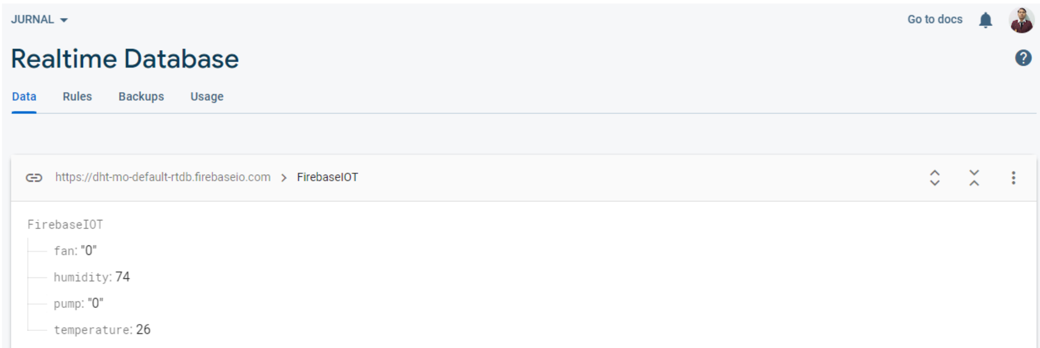

Figure 2. Firebase Realtime Configuration.

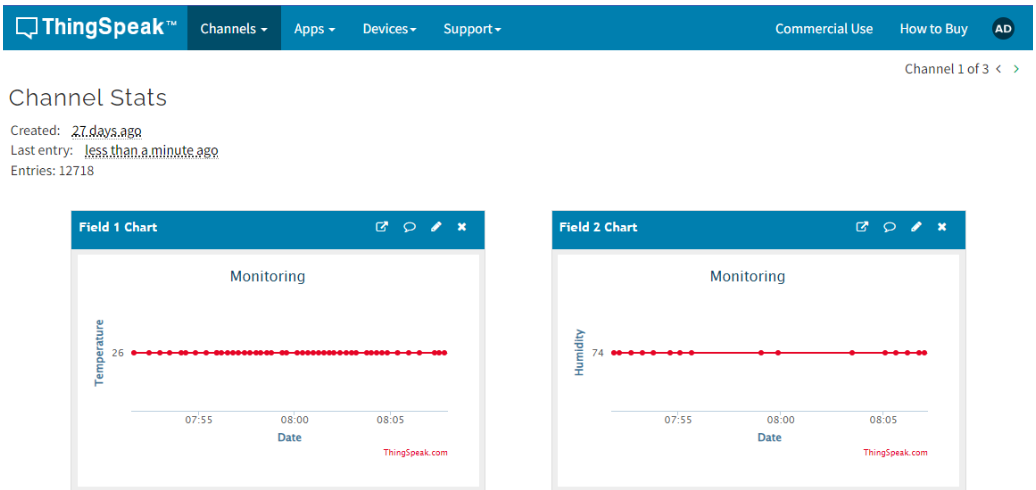

Figure 3. Thingspeak Configuration.

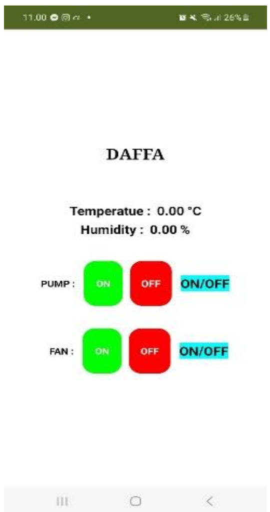

Figure 4. Application design that has been created using the MIT App Inventor.

2.1. Tools and Materials

a) DHT22

DHT22 is a single chip detector with multiple sensors for temperature and relative humidity [12]. DHT22 is a digital compound temperature and humidity sensor that outputs calibrated digital signals [13]. DHT22 is used in this study as a temperature and humidity sensor. To buy this sensor, there are many online shops in Indonesia. This study utilises the DHT22 sensor, where from several research results, the DHT22 sensor is claimed to have a better result accuracy value compared to a similar sensor, namely DHT11 [14].

b) Soil Moisture Sensor

In this design, the Soil Moisture sensor detects soil moisture in dry, humid or wet conditions [15]. The purpose of implementing a soil moisture sensor is to provide a sensor reading data trigger which then when it reaches the setpoint value, will affect the water that comes out that wets the soil so that when the soil is wet, the water that comes out of the DC motor will stop, this is of course greatly influenced by the value read this sensor for conditions in the ground.

c) Real-Time Clock (RTC)

RTC in this concept is RTC which is implemented in the form of an RTC module which can then be connected to the Arduino.IDE programming. The main function of the RTC here is to provide real-time time. The implementation of the RTC in this study is to provide a real-time set value for the time of soil irrigation in agricultural activities.

2.2. Theoritical Basis

a) App Inventor

An open-source-based web application platform is used to create a simple application. App Inventor was developed by Google and maintained by the Massachusetts Institute of Technology (MIT). App Inventor is also an app creation tool that supports Android devices [16]. Using this platform makes it easier to create simple applications without using various programming languages, and the platform features only use a kind of block logic. Of course, the existence of App Inventor can make it easier when creating simple Android-based applications.

b) Firebase

Firebase is a Not Only SQL (NoSQL) database. Using Firebase can store and sync data between users in real-time so that Firebase can make it easier to develop an application with a real-time background. Data on the firebase database is stored as JSON tree objects [17]. The advantage of Firebase is that it can store data locally when the device is unavailable or not connected to internet access, it can be synchronized immediately after the device has got internet access [18]. Of course, with Firebase, we can provide services in developing applications, one of which is an Android-based application. Firebase is also an excellent service to assist users in developing applications, especially Android-based applications.

c) Setpoint

Setpoint is a value that is set to provide logic to the sensor reading value. Setpoints can be given in programming algorithms, for example, in this study using the C programming language on the Arduino IDE software. Setpoints are given in writing the if and else if syntax, which is intended to read the logical conditions in the if and else against the absolute value of the system input (e.g. the read value of the sensor). The set point can also be connected from the reading value of the sensor to the actuator so that an automatic system is made based on the reading value of the sensor and will then give the command on or off to the actuator based on the value read by the sensor against the setpoint value given. Of course, the implementation of setpoints, it is constructive in making modern automated systems. According to merriam-webster.com accessed on March 5 2023, the meaning of set point is a situation (as in tennis) in which one player will win the set by winning the next point. The point is that if it is adjusted to the context of this study, the setpoint is a value assigned to the variable you want to measure.

d) Thingspeak

Using Thingspeak is used for cloud data storage for free. ThingSpeak is an open-source platform in the form of a website that provides services for IoT needs and can receive data using the HTTP protocol over the internet network [19]. ThingSpeak enables the creation of logging applications, location-tracking applications, and social networks of things with status updates [20]. In Thingspeak, there is also an export file data feature that can be stored in excel, so using Thingspeak is very helpful. So with these features, using Thingspeak, the analysis process can be carried out efficiently. In essence, Thingspeak is an IoT-based web server which is very helpful for making a project because it is open source and free.

e) Application Programming Interface (API)

The API acts as an interface that connects one system to another or between a client and a server. Having an API helps communicate services with other services, which is very efficient and easy. In this research, the API was carried out to connect Thingspeak and Firebase so that they can be connected, and all of this is accommodated by the NodeMCU-type Amica microcontroller. APIs working at the operating system level help applications communicate with the base layer and each other, following a customized set of protocols and specifications [21]. API is also commonly considered a clear set of communication techniques between different software components [22].

3. Results and Discussion

The discussion will describe the concept of the tool and some validation that the research carried out was successful and can be flexible when applied to agricultural aspects related to system control and monitoring.

The system control features in this study use the MIT App Inventor which is connected via Firebase on the URL and Token (Figure 5). The control system that was applied to this study so that it can be reviewed in Table 1.

Table 1. Description of system control features.

No	Control Button	Description	Result
1	Pump	In this feature you can turn on and turn off the pump. This pump can provide a flow of water to provide sufficient irrigation for agricultural crops.	Success
2	Fan/Exhaust	This feature serves to minimize moisture in the intended area. In this feature, on and off are given to turn on and turn off the control feature.	Success

Please note that this feature can still be added and adjusted as needed. This can be done simply by adding features to the MIT App Inventor and a little program to the void loop in Arduino.IDE (Figure 5). Then the system control flow chart in this study can be seen in Figure 6. It should also be noted that all actuators are connected to a 5-volt relay with the Normally Open (NO) initial position. Because this type of feature is based on IoT, good internet quality is needed to operate the system so there are no delays.

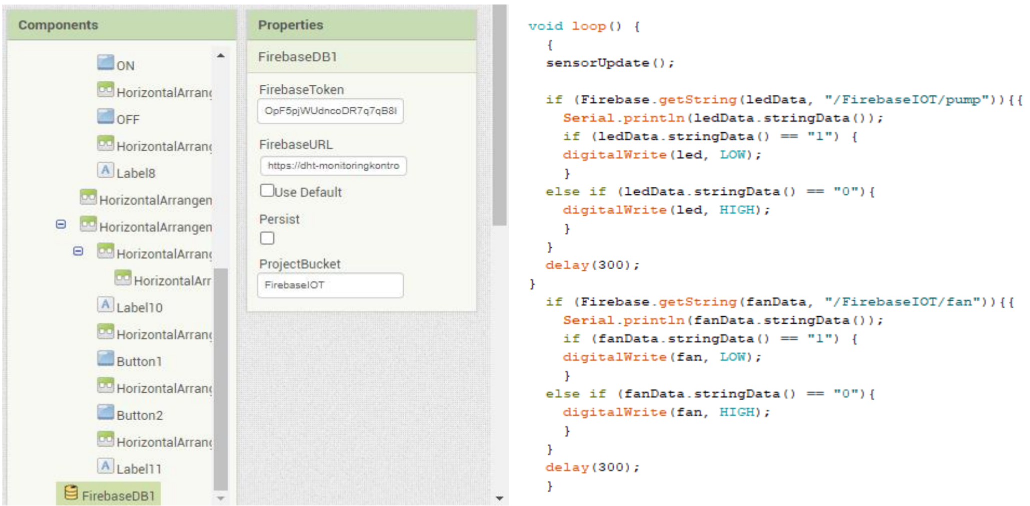

Figure 5. (Top) Firebase Implementation on the MIT App. (Bottom) Void loop in the Arduino.IDE program.

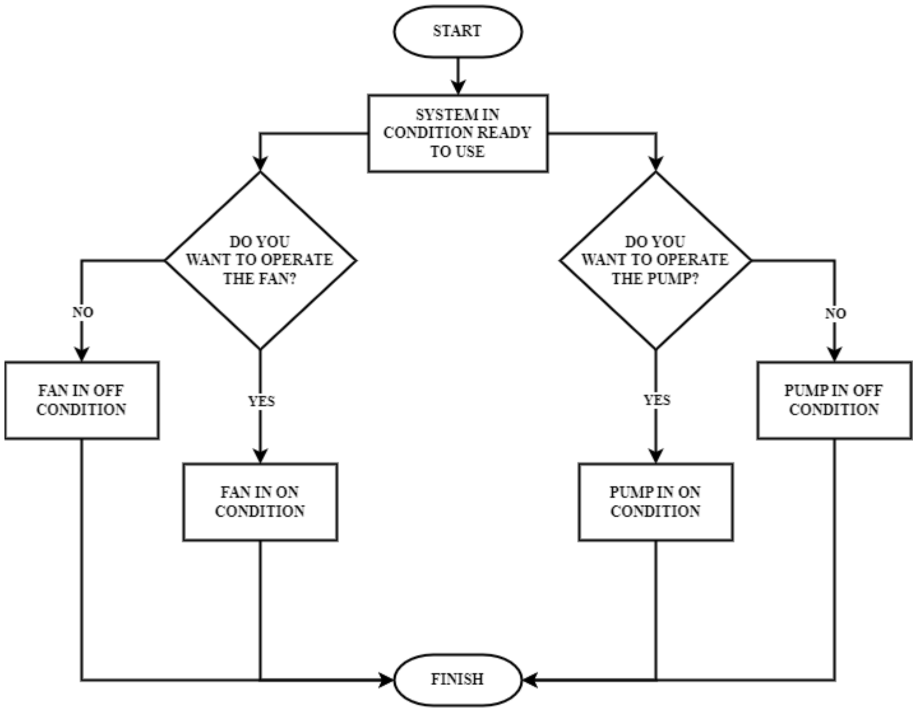

Figure 6. System control flow chart.

System monitoring is separated into two: real-time monitoring using the MIT App Inventor and real-time monitoring using Thingspeak in tables and data. Using the MIT App Inventor aims to make it easier when monitoring the system at a glance, and using Thingspeak aims to save sensor reading data into a database that can be exported to CSV and then accessible using excel to make it easier to analyze it, if data analysis is needed in the system. Further explanation can be seen in the following:

3.1. Monitoring with MIT App Inventor

It is done using Android, and it can be installed on all Android. The display in the monitoring is the magnitude of the reading value of the DHT22 sensor at temperature (°C) and humidity (%RH), as shown in Figure 7. Access for monitoring is sufficient to use the internet, so that this feature can be used. Testing was carried out using cellular data quota. For systems that were in NodeMCU connected via WiFi at the research site, then the results of testing this feature were successful (Figure 7). This feature can be connected continuously because this feature is connected to a real-time database on Firebase.

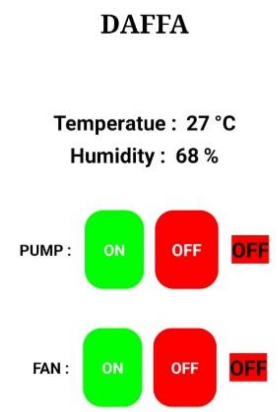

Figure 7. Applications created using MIT App Inventor.

3.2. Monitoring with Thingspeak

Monitoring Thingspeak is carried out in real-time and continuously, then sensor reading values are stored in a database which can be exported into a Comma Separated Values (CSV) file which can then be opened in excel if you want to analyze sensor data.

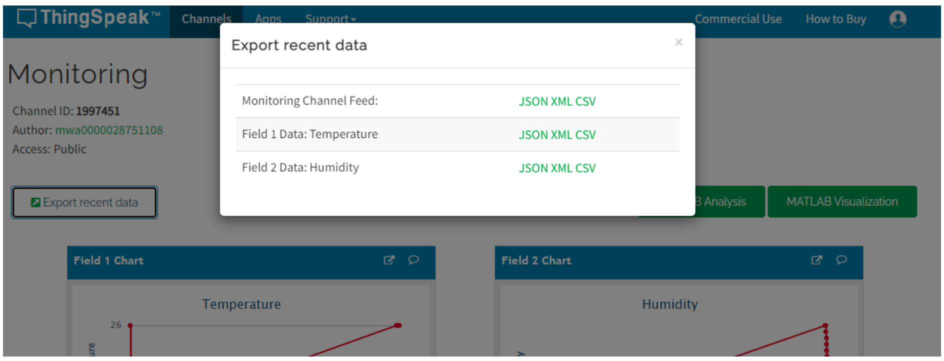

Figure 8. Monitoring with Thingspeak.

The advantage of using Thingspeak is that data can be sent to the database in real-time and automatically. In Thingspeak you can also add it to the Channel Settings menu then add the latest Field and if you have Save Channel, then if you want to add a reading of the sensor reading value then the programming will be slightly changed in the void loop, namely in the myChannelNumber syntax added to the latest number sequence and entering the sensor reading value that is contained in the sensor data reading syntax. For example, in Figure 9 there are the variables t and h which are the DHT22 sensor reading value variables where the t variable is the temperature reading value variable and the h variable is the humidity reading value.

```
}
float t = dht.readTemperature();
float h = dht.readTemperature();
if(isnan (h) || isnan(t)){
  Serial.println("Sensor Tidak Terdeteksi");
  return;
}
ThingSpeak.writeField(myChannelNumber, 1, t, myWriteAPIKey);
ThingSpeak.writeField(myChannelNumber, 2, h, myWriteAPIKey);
delay(10);
```

Figure 9. The sensor reading variable and display order placement in the Thingspeak field.

Further discussion in this research system there is a system that works based on the provision of set point values, namely the set point values of time and sensors. At the time set point value using the Real-Time Clock (RTC) module to provide a set point value in real-time. Then the sensor set point value can be adjusted as needed. For example, in closed agricultural land, there are humidity limits and soil wetness limits, in these conditions a set point system can be implemented.

```
#define PenyiramanPertama DateTime(0, 1, 1,  7, 0, 0, 0)
#define PenyiramanKedua DateTime(0, 1, 1,  15, 0, 0, 0)

#include <Wire.h>
#include <LiquidCrystal.h>
#include "RTC_DS3231_RP.h"
#include <Servo.h>
```

Figure 10. Set point configuration.

The picture above is an example of applying the watering time set point, which is done twice, namely at seven in the morning and three in the afternoon. Of course, the amount of watering time can also be adjusted. These two set points are intended to overcome dry soil in agricultural land areas. This system works continuously based on determining the set point value, which is always continuous when the system is on. Then, the set point on the moisture sensor will be explained using Table 2 because if it is displayed using a screenshot, it will be too long.

All systems based on set points have been successfully tested. This is seen from the characteristics when the set value reaches the set point value, and then the actuator will work. For example, when the time shows seven in the morning, the pump as the actuator will work to water the plants, or even when the soil sensor reaches the set point value, the soil sensor will provide information to the microcontroller, which will then be forwarded to the actuator, the set point value on the soil sensor will be given to manipulate when the soil conditions are dry and wet always with the desired conditions.

Table 2. Description of the explanation of the set point on the moisture sensor.

No	Set point	Description
1	value < 700	The soil condition is wet, so the relay is inactive and does not allow the pump to turn on.
2	The sensor reading value is between 700 and 350	The soil is under normal conditions, so the relay is inactive and does not allow the pump to turn on.
3	The sensor reads below 350	The soil is dry, so the relay turns on and activates the pump, which will turn on and water the soil and plants.

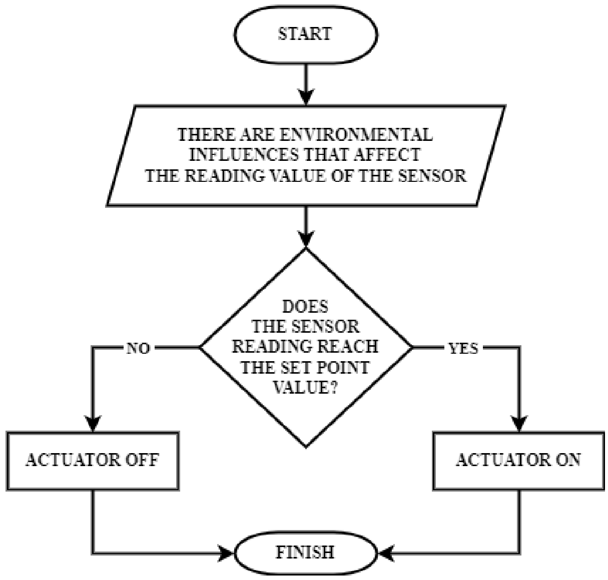

Figure 11. Flowchart of the concept of set point logic in this research.

4. Conclusion

Some of the conclusions based on the discussion of the research above can be explained into several points including:

a. The system concept created in this study includes Android-based smart agricultural monitoring controls and a web server, so that observations and analysis can be carried out easily. Then there is also an automated system that has been defined using set point sensors and supporting modules.
b. Implementation of research systems using MIT App Inventor, Firebase, and Thingspeak because it's easier to develop and of course it's all free. With free service providers such as MIT App Inventor, Firebase, and Thingspeak, it can facilitate the conduct of research, for example in this study.
c. In this study, there are already available temperature and humidity monitoring control features, several on and off controls on the actuator, as well as an automatic soil watering system. Of course, these available features can still be added according to the needs of agricultural activities.

References

[1] B. L. Trengginas, H. H. Handayani, & A. R. Juwita, "Rancang Bangun Sistem Parkir Otomatis Pada Kampus UBPBerbasis IoT," Scientific Student Journal for Information, Technology and Science, vol. 3, no. 2, pp. 268-283, 2022.

[2] H. E. Putra, M. Jamil, and S. Lutfi, "SMART AKUARIUM BERBASIS IoT MENGGUNAKAN RASPBERRY PI 3," JIKO (Jurnal Informatika dan Komputer), vol. 2, no. 2, pp. 60-66, 2019.

[3] A. A. R. Madushanki, M. N. Halgamuge, W. A. H. S. Wirasagoda, & A. Syed, "Adoption of the Internet of Things (IoT) in agriculture and smart farming towards urban greening: A review," (IJACSA) International Journal of Advanced Computer Science and Applications, vol. 10, no. 4, pp. 11-28, 2019.

[4] B. E. Sibarani, "Smart Farmer Sebagai Optimalisasi Digital Platform Dalam Pemasaran Produk Pertanian Pada Masa Pandemi Covid-19," Technomedia Journal (TMJ), vol. 6, no. 1, pp. 43-55, 2021.

[5] M. Faradise, M. Hefni, T. Rahman, A. Naufal, M. T. Ali, and A. Ferdiansyah, "Pelatihan Dan Pembuatan Pestisida Nabati Untuk Pengendalian Hama Penyakit Pada Tanaman Pertanian," Jurnal PkM ABDHINAH, vol. 1, no. 1, pp. 29-36, 2023.

[6] Badan Pusat Statistik, "Pertumbuhan Ekonomi Indonesia Triwulan II -2022," Www.Bps.Go.Id, no. 13, hal. 12, 2022.

[7] Puspabhuana and P. Y. D. Arliyanto, "Rancang Bangun Purwarupa Aplikasi Kendali Lampu Rumah (Smart Home) Berbasis Iot Dan Androidyang Terkoneksi Dengan Firebase," Jurnal Inkofar, vol. 5, no. 2, pp. 25-35, 2021.

[8] M. B. Maharani, "Pertanian Cerdas Internet of Things aktif ZigBee: Tinjauan Sistematis," Jurnal Portal Data, vol. 2, no. 4, pp. 1-8, 2022.

[9] A. I. Rabbika, M. H. Nugraha, A. Rohman, Widyantoro, Tatakostaman, W. M. Fauzi, A. Mustofa, and T. J. Widagdo, "Rancang Bangun Sistem Controlling Penyiraman Tanaman Kangkung Berbasis Internet of Things," Jurnal Indonesia: Manajemen Informatika dan Komunikasi, vol. 4, no. 1, pp. 373-380, 2023.

[10]R. Insani and I. Afrianto, "Transformasi Pertanian Berbasis Teknologi Cloud Computing untuk Meningkatkan Produktivitas Usaha Tani," DOI: 10.13140/RG.2.2.13908.27529.

[11]P. Hendarto, Maridi, and B. A. Prayitno, "Validity of guided inquiry-based modules on digestive system to improve argumentation skill," JPBI (Jurnal Pendidikan Biologi Indonesia), vol. 5, no. 1, pp. 127-140, 2019.

[12]M. W. R. Syawal, A. A. Muayyadi, and A. Mulyana, "Implementasi Pengendalian Hama dan Monitoring Pada Tanaman Terong Berbasis Internet of Things," eProceedings of Engineering, vol. 8, no. 6, pp. 1-5, 2022.

[13]F. B. Awi, A. Rabi, and W. Dirgantara, "Pengimplementasian Metode Fuzzy Logic pada Kontrol Rumah Jamur Otomatis Berbasis NodeRED," Jurnal Teknik Elektro dan Komputer TRIAC, vol. 9, no. 3, pp. 24-28, 2022.

[14]F. Puspasari, T. P. Satya, U. Y. Oktiawati, I. Fahrurrozi, and H. Prisyanti, "Analisis Akurasi Sistem Sensor DHT22 berbasis Arduino terhadap Thermohygrometer Standar," JURNAL FISIKA DAN APLIKASINYA, vol. 16, no. 1, pp. 40-45, 2020.

[15]B. Pardosi, Ardianto, and D. Suherdi, "Penyiraman Otomatis Pada Bibit Kopi Ateng Menggunakan Sensor Kelembaban Tanah Berbasis Arduino Uno," Jurnal CyberTech, vol. 3, no. 2, p. 300~306, 2020.

[16]B. Juniagoro and R. Rahmadewi, "Aplikasi Pengendali Perangkap Tikus Berbasis Android Menggunakan Mit App Inventor," Jurnal Ilmiah Elektronika Dan Komputer, vol. 15, no. 1, p. 189–198, 2022.

[17]R. Andrianto and M. H. Munandar, "Aplikasi E-Commerce Penjualan Pakaian Berbasis Android Menggunakan Firebase Realtime Database," Journal Computer Science and Information Technology (JCoInT), vol. 3, no. 1, pp. 20-29, 2022.

[18]I. Humaini, "Aplikasi Mobile Pemesanan Jasa Barbershop Menggunakan Firebase Realtime Database," Jurnal ADIPATI, vol. 1, no. 2, pp. 1-8, 2022.

[19]U. A. Saputro and A. Tuslam, "Sistem Deteksi Kebakaran Berbasis Internet of Things Dengan Pesan Peringatan Menggunakan NodeMCU ESP8266 Dan Platform ThingSpeak," Jurnal Infomedia: Teknik Informatika, Multimedia & Jaringan, vol. 7, no. 1, pp. 24-30, 2022.

[20] A. Marina, H. K. Ilman, F. Febi, A. E. Muhammad, and I. Muhammad, "Studi Perbandingan Platform Internet of Things (IoT) untuk Smart Home Kontrol Lampu Menggunakan NodeMCU dengan Aplikasi Web ThingSpeak dan Blynk," J. Fidel, vol. 2, no. 1, pp. 59-78, 2020.

[21] Hasanuddin, H. Asgar, and B. Hartono, "Rancang Bangun Rest Api Aplikasi Weshare Sebagai Upaya Mempermudah Pelayanan Donasi Kemanusiaan," JINTEKS (Jurnal Informatika Teknologi dan Sains), vol. 4, no. 1, pp. 8-14, 2022.

[22] N. K. Akmal and M. N. Dasaprawira, "Rancang Bangun Application Programming Interface (Api) Menggunakan Gaya Arsitektur Graphql Untuk Pembuatan Sistem Informasi Pendataan Anggota Unit Kegiatan Mahasiswa (Ukm) Studi Kasus Ukm Starlabs," Jurnal Sistem Informasi Dan Tenologi, vol. 5, no. 1, pp. 37-40, 2022.

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