DEVELOPMENT OF AUTOMATIC PLANTS CULTIVATION AND PEST CONTROL SYSTEM BASED INTERNET OF THINGS

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ABSTRACT

The system cultivation plants of conventional agriculture modern automatic in the screen house based IoT is taking care of the plants included giving some water, nutrition, and pesticide which integrated to the internet using soil moisture sensor as the point of reference for giving some water automatically in the land based on the value which obtained from the soil moisture sensor with 3 criteria of the soil, dry, clammy and very clammy. The erection of system cultivation plants aims to minimize the wastage of water, giving nutrition will be more directed and maximize of controlling OPT. The erection of system cultivation plants is using Raspberry Pi as mini PC and Arduino as the mini controller, and the application based web as an interface for the farmer. The steps of the processing start with developing web service RESTful API with data exchange based JSON. This web service will be connected to a database. The web service will receive data from the application system cultivation plants web on Raspberry Pi and the application client farmer web as an interface for the farmer. Next, the data will save on the database and if the application needs the data then web service will send the data in accordance with its need. Next, the data will save on the database and if the application needs the data then web service will send the data in accordance with the requirement. Raspberry Pi usability for farmers interface an Arduino to control sensors which are used. This prototype can simplify the farmer's task which is in Balai Penelitian Tanaman Sayuran (balsa), and this research is already with the expected goal.

Keywords: Arduino, Sistem Pemeliharaan Tanaman, Internet of Things, Raspberry Pi, Web

1. Introduction

Vegetable Crops Research Hall (Balitsa) is one of the Technical Implementing (UPT) Agricultural Research and Development Agency under coordination and is responsible directly to the Horticulture Research and Development Centre. Located at JL. Tangkuban Perahu Raya No. 517, Cikole, Lembang, West Bandung Regency, West Java 40391.

Conventional agriculture is one of the farming systems with soil planting media, conventional agriculture is divided into two types, namely the traditional conventional agriculture and modern conventional agriculture. The traditional conventional agriculture i.e. conventional agriculture that still uses traditional farming tools so that all stages of the process of cultivation is still manual and requires a lot of labor. The hallmark of traditional is the use of conventional agricultural hoe as a tool for processing the ground, pumped hand sprayer manual by hand for spraying pesticides, as well as hoses or sprinklers as embrat plants. While the modern conventional agriculture i.e. conventional agriculture which has already implemented a wide range of technological innovation to provide convenience for farmers in cultivating the plant. The hallmark of the modern conventional agriculture is the use of greenhouses as a simple climate engineering, the use of tractors for tilling the land in a non greenhouse, as well as sprinklers sprinkler plants.

Based on interviews conducted with research services section in the Vegetable Crops Research Hall named Andi Supriadi S.T. obtained information that most types of cultivation are applied here is to use the system conventional agriculture which is still traditional, and only a few that have already switched to a modern conventional agriculture. Because conventional agriculture which is still cheaper then the traditional in Indonesia in particular areas of the Valley and all the types of plants can be cultivated in this way. Despite the many shortcomings in conventional agriculture which is still traditional, however, this type of farming is still one of the cultivation ways most often used by farmers.

Process on the stages of land preparation begins with the sanitation of the land, the tools used in this process is a hoe. Then after sanitizing is completed, the land then was undertaken the process of pembalikkan the soil so nutrient elements and the content of organic matter in the soil can be well blended. Basic fertilization it contains one of the stages of the process of land preparation, fertilizing basis using organic fertilizer. After being left on for approximately 2 weeks, the soil is ready for planting seeds or seeds of plants that have been sown before. The next step is the process of plant maintenance. Plant maintenance activities are to do weeding,

watering, pembumbunan, control OPT (Plant Pest Organisms), delivery of nutrients in plants and fertilizing the soil further. But why still many growing plants is not uniform, it turns out that these problems are not only derived from the genes of plants that alone, the treatment of human beings on the plant cultivation of any influence. Watering which is not in accordance with the needs of water in plants, the gift of nutrition and the uneven spraying pesticides included in the supporting factors of occurrence of varicosity of the growth of a plant population in the land. Farmers usually do Rego by using embrat and perform manual pruning, sowing or by way of burying the fertilizer around the plant. Whereas for the grant of the fertilizer and pesticide spraying, farmers use a tool named handsprayer. How to use manual handsprayer is by pumping the tool so that a fertilizer and pesticide solution liquid leaf will come out through a nozzle which is at the other end of the hose handsprayer. In this case, the granting of water and fertilizer is usually uneven from one plant with another crop, farmers would only estimate the discharge water is sprayed and doses of fertilizer given to plants when the plant pest organisms attack have high survival power, of course, his way will be more difficult. That's the reason why the manual way more flaws and cause more losses.

The greenhouse is starting digalakan in Balitsa as the initial step in the transfer of conventional farming system of traditional modern conventional agriculture. The goal is to reduce the risk of the spread of pests and diseases in plants cultivation. The most greenhouse can also reverse engineer the climate inside. By implementing automated plant maintenance system on plant cultivation in greenhouses is expected to progressively suppress the spread of pests and diseases and enlarge your chances of success by cultivating plants harvest the optimal growth.

From the statement then it needs a system that can do the spraying plants automatically, the automatic plant nutrients as well as granting control organisms bullies plants automatically.

Based on the above issue, then the solution that can be done is by "Architecture Prototype plant maintenance System On Modern Auto in Conventional Agricultural Greenhouse Based Internet Of Things".

As for the research objectives that will be achieved from the construction of this system are as follows:

1 minimizing the waste of water in the land by way of calculating water needs prior to watering.

2 granting of more plant nutrients was routed by calculating the nutrient needs by following the suggestion allotment process usage and dosage of nutrients that is assisted by auto plant maintenance tool.

3 Maximize control OPT chemically by the calculation of the content of pesticides and observe a large number of attacks of pests and diseases that attack plants cultivation.

2. CONTENT of the STUDY

2.1 Grounding Theory

The cornerstone of the theory of the construction of this system outlines the basic theories to the analysis process system and supports the process architecture prototype plant maintenance system on modern conventional agriculture in greenhouses in the cloud of things (IoT) with case studies on Vegetable Research Hall (Balitsa).

2.1.1 plant maintenance

Plant maintenance generally includes activities related to maintaining the viability of the plant so that plant grows optimally. Plant maintenance is important because it is one of the deciding factor in the productivity of the plant, the better the plant maintenance process then the level of crop productivity will be higher. Plant maintenance it is a human action that aims to give environmental conditions in accordance with the terms of growing plants so that the plant can grow optimally.

2.1.2 Internet of Things

Internet of Things or the IoT, known by the acronym is a basic concept that aims to extend the benefits of internet connectivity that connect on an ongoing basis. As for capabilities such as data sharing, remote control, and so on, including on objects in the real world. For example, electronics, foodstuffs, tools, and collections including living things that everything connected to local and global networks through sensors that are embedded and are always active [1].

In the words of the Internet of Things, there is the word "with Things" is as a subject, for example, people with monitors heart implants. Animal farm with transponder biochip, a car is equipped with built-in sensors to warn the driver when tire pressure is low. Internet of Things is most closely related to the communication of machine-to-machine (M2M) in manufacturing and electricity, gas, and petroleum. Products built with M2M communication skill that is often referred to as an intelligent system or "smart ". (example: smart labels, smart meters, smart grid sensor) [1].

2.1.3 Raspberry Raspberry Pi Pi is a mini pc

single Board (single-board circuit) design features a digital input output port composed as many as 40 pins. The size of this phi only raspberry of a credit card but can run programs Office, games, as well as run media like video with high resolution. Non-profit, Raspberry Pi Foundation is a foundation that developed the Raspberry where there is a computer expert from the University of Cambridge, United Kingdom [2].

In Raspberry Pi already equipped with processors ARM1176JZF-S 700 MHz, 256 MB of

RAM and also a GPU VideoCore IV. On data storage, Raspberry Pi does not use the Hard Disk but the Raspberry Pi can use SD cards to store data, be it data or Operating System for long-term data storage media [2].

2.1.4 the Arduino

Arduino is a microcontroller board which is open source, which the design schematic and PCB are open sources, so we can use it or modify it. Hardware and software are easy to use, this device is intended for anyone who is interested/utilizing microcontroller practically and easily. For a beginner using this board will easily learn control with a microcontroller, for Designer controllers become easier in making prototypes or implementation. Arduino can be used to detect the environment by receiving inputs from various sensors (e.g. light, temperature, infrared, ultrasonic, distance, pressure, humidity) and can control the surrounding equipment (e.g.: lamps, various types of motor and other actuators) [3].

Arduino uno is a Board that can be used by beginners because of the source code and documentation contained on the average internet use arduino uno as the main Board. Arduino uno is a microcontroller based on the ATmega 328P. the microcontroller has 14 digital input/output, analog input, 16 6 MHz Crystal USB slot, Q1, ICSP, electric jacks, and the reset button [3].

2.1.5 SKU: Soil Humidity Sensor SEN0114

Soil moisture sensors can read the amount of moisture that is in the ground and surrounding areas.

Arduino sensors humidity this land use 2 examinations to pass current through the ground and then read that resilience to get the level of humidity [4].

2.1.6 Ultrasonic Sensors SR04-HC

The ultrasonic sensor works by emitting a wave and then calculate the wave reflection time. ultrasonic wave's work on a frequency range from 20 KHz to 20 MHz [3].

2.1.7 temperature sensors DHT11

DHT 11 sensor outputs are two environmental parameters at once, namely temperature and humidity (humidity). In this, there is a thermistor sensor type NTC (Negative Temperature's) to measure the temperature, an 8-bit mikrokontroller that cultivate both the sensors and send the results to the output format is pin single-wire cables (bi-directional two-way single) [3].

2.2 system analysis

System analysis can be defined as the unraveling of an intact system into parts of its components with a view to identifying and evaluating existing problems, barriers, and the expected needs.

2.2.1 Problem Analysis

Construction of the plant maintenance system on the conventional agriculture-based automated Internet of Things using Raspberry Pi and the Arduino microcontroller, as well as a web-based application as the interface for farmers so as to provide convenience for the farmers in the field. Based on the results of the research that has been done, there are a few problems that occur in the field as follows:

1. Going waste water when watering process due to the abundance of water used for watering crops cultivation is not appropriate.

2. The dosage of nutrients that are not suitable to make plants grow is not optimal because it usually just estimate the dose of nutrients that are worn and not using a raw measure recommended by nutrition.

3. Control of the OPT is chemical i.e. using pesticides often cause problems due to the use of different types of pesticides and administering doses on the plants that do not comply will result in losses for farmers and the plant itself.

2.2.2 analysis of system architecture

Analysis of system architecture is the system to be built, the plant maintenance system applications in the cloud it will communicate with the Raspberry Pi bridged by the web service using JSON, language exchange here is a picture of the architecture design of Analysis System.

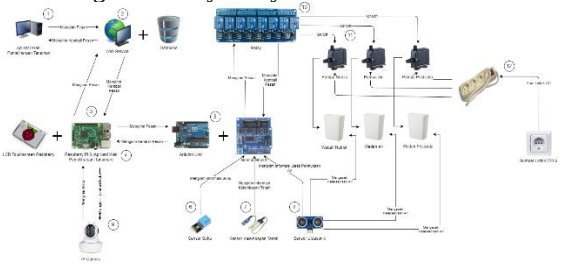


Figure 1. Design Of System Architecture

The following is a description of the image of architecture Architecture Prototype plant maintenance System On Modern Auto in Conventional Agricultural Greenhouse Based Internet Of Things.

1. this web Application will be used by farmers, farmers can see the data of land, land use, monitoring and control devices.

2. Web service is used as the data exchange between the plant maintenance system web application on Raspberries Pi with a database on the server.

3. Raspberry Pi installed in the greenhouse as interface application for farmers with mounted LCD touch screen.

4. Besides Raspberry Pi is also useful for bridging data obtained from the Arduino to proceed to the web service.

5. The Arduino is used to read the value of both digital and analog sensors sensor by installing additional modules i.e. Arduino Sensor Shield, shield sensor module is used to facilitate the installation of the sensors.

6. Temperature Sensor used is DHT11, this sensor is used to measure the temperature and

humidity of the air, but also to check the conditions of temperature and humidity in the greenhouse, if the temperature and humidity facilitate kan for the watering of nutrients.

7. soil humidity Sensor used is the SKU: SEN0114, the sensor used to measure the humidity of the soil, but also check the humidity of soil, soil conditions are dry, moist or very moist.

8. ultrasonic Sensor used is the HC-SR04, sensors are used to measure the surface of the water as well as the availability of nutrients, pesticide availability in each of its container.

9. The camera used is Escam IP Camera, used to monitor the State of the land in realtime.

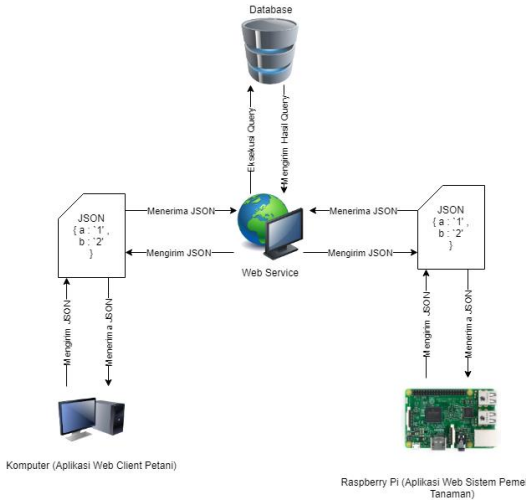
10. the automatic switch is used as a Relay for perangakat electronics, in accordance with the input data on the Arduino, this relay will switch on and off of the pump.

11. Pump Submersible Pump sump pump is used as a nutrient, water pumps, and pumps of pesticides.

12. electrical Terminal as a divider of the main source of the power source.

2.2.3 Analysis Web Service

In the development of a web-based service Developed by data exchange-based JSON. The Web service will be connected to the database. The Web service will accept data from a plant maintenance system web application on Raspberries and the Pi data is stored to the database, then in the second application requires that data then the web service will transmit data according to the needs of the application. Here is a picture of the Groove web service data.



2.2.4 analysis of Data communication

Data communication is a very important thing in building an application. Because of the absence of communication of data, an application that is built will not be able to walk properly. Data communication applications used in plant maintenance System On Modern Auto in Conventional Agricultural Greenhouse Based Internet Of Things this is to use for communication between Arduino Serial Arduino with Raspberry Pi whereas for the exchange of data between computers namely Pi Raspberry with a JSON-based web service. The following is the flow of data communication between devices.

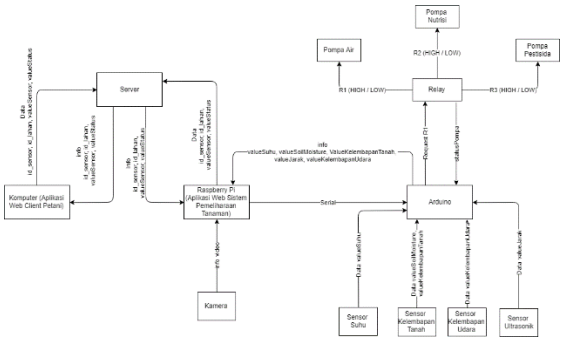


Figure 3. The Flow Of Data Communication

The following is an explanation of the flow of data communications:

1. all the sensors send a data value fromeach sensor is to the Arduino.

2. send data in the form of a video Camera.

3. The Arduino will send request R1, R2, R3 to the Relay if there is a Serial that was included (HIGH or LOW).

4. The Arduino will send data with the JSON format ke Raspberry Pi.

5. accept the entered Serial Arduino from Raspberry Pi in accordance with interactions or conditions occur.

6. Raspberry Pi will submit periodic data (id_sensor, id_lahan, valueSensor, valueStatus) to the Server and vice versa Server also sends the info (id_sensor, id_lahan, valueSensor, valueStatus) to the Raspberry Pi if needed.

7. the computer will receive periodic info (id_sensor, id_lahan, valueSensor, valueStatus) from the Server and vice versa also receives data Server (id_sensor, id_lahan, valueSensor, valueStatus).

2.2.5 Analysis Workflow Raspberry Pi, Arduino, Web services on plant maintenance System

Workflow Raspberry Pi, Arduino and Web Service on plant maintenance System serves as a device of farmers who used to run the plant maintenance systemapplications, and as an interface for interaction with web applications that farmers there is Raspberry in Pi. Arduino is used to controlling electronic devices as well as transmit data from multiple sensors that will be processed by the plant maintenance system web application on Raspberries Pi. While the web service is used to bridge the data exchange between web client applications and web applications farmers plant maintenance system that is in Pi database with Raspberry on the server. Here is a picture of the workflow in the plant maintenance System.

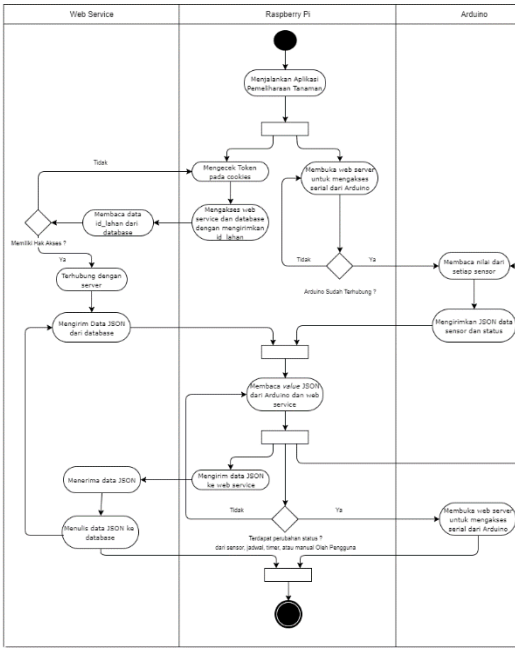


Figure 4. Workflow Raspberry Pi, Arduino, Web services on plant maintenance System

2.2.6 Analysis Nutrients used

The use of nutrients in cultivated plants in the genus Allium i.e. garlic (Allium sativum) and onion (Allium we have a load). Basically can use various kinds of fertilizer that meets the criteria and the needs of the crop nutrient elements, because the needs of macro and micro nutrient elements in plants are to be fulfilled. Here liquid organic fertilizers I use is a liquid organic fertilizer pomi red. Each liter of liquid organic fertilizers contain red pomi 5.09% N, P205 4.30% and 5.46% K2O. macro nutrient elements content is maximum to the size of the organic fertilizer. Red pomi also contain varying quantities of micro nutrient elements is right for cultivation of plants in the genus Allium especially garlic (Allium sativum) and onion (Allium we have load), namely Fe 410 ppm Mn ppm 737, 440 ppm Cu, Zn 354 ppm, B 250 ppm, 12 ppm CO and Mo 3 ppm. The advantages of liquid organic fertilizer pomi red are pomi red contain growth hormones and various microorganisms that are very favorable for the soil and plants, Red also has Pomi pH 4.55. A dose of liquid organic fertilizer use pomi red is by dissolving 5 cc pomi red/liters of water.

2.2.7 the Non Functional requirements analysis

Non functional needs analysis is the analysis required for the specification of system requirements. Non functional requirements specification is a detailed specification of the things that will be done when the system is implemented. This analysis is required to determine the required input specification system, output to be generated by the system and the scope of the process used to process the inputs into the desired output. Non-functional requirements that are needed to build this system consists of three things, including hardware requirements, software requirements, and the needs of the user.

2.2.7.1 needs analysis Hardware

The hardware will be used based on the minimum requirements that must be met, namely:

1. Computer hardware for farmers
2. Raspberry Device 3 to Pi in the greenhouse 3. Hardware Smartphones For Farmers
4. The Hosting Server Hardware
5. Hardware Arduino Uno
6. Hardware Relay
7. Cameras Hardware
8. Hardware SKU: SEN0114
9. Hardware HC-SR04
10. DHT11 Sensor Hardware

2.2.7.2 needs analysis Software

Software needs analysis is an analysis process more emphasis on the aspects of the utilization of the software. The following is a table of specifications minimum requirements the software on the computer that will use the application.

Table 1. The Minimum Specification Of Computer Software

Komputer

Software	Kebutuhan minimal
Sistem Operasi	Microsoft Windows 7
Web Browser	Google Chrome

The following is a table of minimum requirements for the specification of software on Raspberry Pi who will use the application.

Table 2. The Minimum Software Specifications Raspberry Pi

Perangkat Lunak	Kebutuhan minimal
Sistem Operasi	Raspbian Jessie with PIXEL 2017.04.10
Web Browser	Chromium
Node JS *Version*	7.9.0

The following is a table of minimum requirements for the specification of software on the server hosting the web application you want to install the maintenance plant monitoring and web service.

Table 3. The Minimum Specification Of The Hosting Server Software

Perangkat Lunak	Kebutuhan minimal
cPanel *Version*	64.0 (build 19)
Apache *Version*	2.4.25
PHP *Version*	5.6.30
MySQL *Version*	10.0.30-MariaDB
Architecture	x86 / x64
Operating System	Linux
Perl *Version*	5.10.1
Kernel *Version*	2.6.32-673.26.1. lve1.4.22.el6.x86_64

2.2.7.3 User needs analysis

Analysis of the users intended to find out who the user is involved along with their characteristics so that it can be known to the user

experience and level of pemahan against the computer. The following is an analysis of the needs of the user.

Table 4. Analysis Of User Needs

No	Pengguna	Spesifikasi
1	Petani	Pendidikan SMP sampai dengan SMA Dapat menggunakan sistem operasi Windows Dapat menggunakan aplikasi berbasis web
2	Operator Pengolah Data	Pendidikan S1 Dapat Menggunakan sistem operasi Windows Dapat menggunakan aplikasi berbasis web

2.2.8 a functional needs analysis

Describe the process of functional needs analysis activities will be applied in the system and explains the requirements necessary in order that the system can be built properly and in accordance with the needs of the system.

2.2.8.1 Use Case Diagram

Use case diagram is a diagram that shows the functionality of a system or class and how the system interacts with the outside world and explains the system is functionally a sighted user.

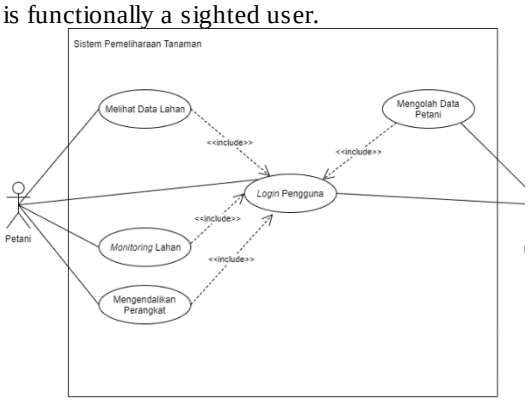


Figure 5. Use Case Diagram

2.2.8.2 Class Diagram

The class Diagram is a diagram of the structural model the set of classes, interfaces, collaboration and their colleagues. The class Diagram is shown with a box which is basically divided into three sections, namely the class name, attributes, and methods or operations. The following is the Class Diagram of plant maintenance System.

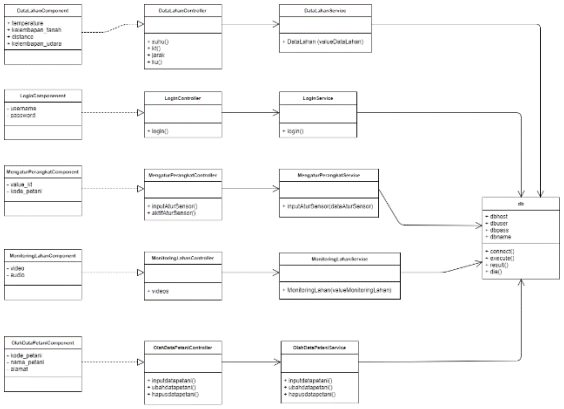


Figure 6. Class Diagram

2.2.9 the Analysis Database

Database analysis is activities to analyze the data that will be processed and stored in the database. This is represented in the analysis of where the data came from and the attributes of the data. The database is divided into three namely Entity Relationship Diagrams (ERD), the scheme of relations and the structure of the table.

2.2.9.1 Entity Relationship Diagrams (ERD)

Entity Relationship Diagram (ERD) is a technique for describing information required in the system, and the relationship between the data, to describe it used some notation and symbols. In this system, there are some entities, namely sensors, land, log_sensor, farmer, status, operator_pd. The following are Entity Relationship Diagrams (ERD) on this system.

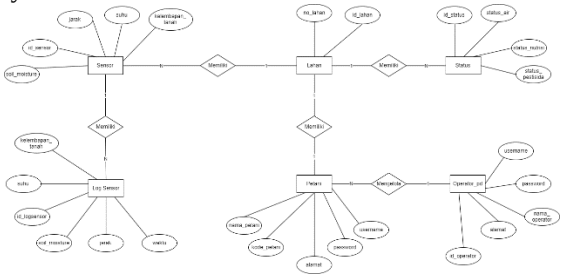


Figure 7. Entity Relationship Diagram

2.2.9.2 Relation Scheme

The partnership scheme is a series of relationships between two or more tables in a database system. Here is a schematic relation on this system.

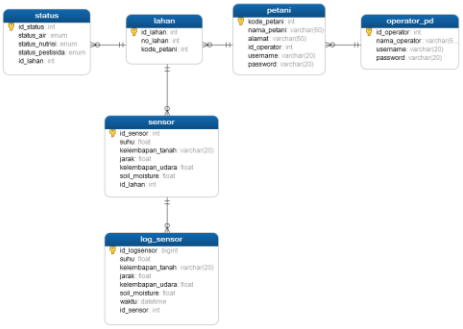


Figure 8. Scheme Relation

2.3 Testing System

System testing is an important part of the cycle of software development. The purpose of the testing of this system was to find errors or deficiencies in the software tested. Testing conducted to know the software was built already meet the criteria in accordance with the purpose of designing the software. Testing is done to sub system Farmers plant maintenance System, Web Client system farmers and sub Data Processing Operator Web system.

2.3.1 testing on Each Sub Web systems

Based on testing against existing functionality on both sub system using black boxhas done, then it can be inferred that the system built worked in accordance with expectations.

2.3.2 hardware testing

Hardware testing aims to guarantee that the hardware can work and have a reliable quality.

2.3.2.1 Testing Soil Humidity Sensor SKU: SEN0114

Testing the soil humidity sensor SKU: SEN0114 aims to find out the level of humidity of soil as well as soil humidity detection sensitivity. Prior to testing, the sensor is connected to the Arduino to read analog output sensors that have been terkalibrasi to detect soil moisture levels. This testing is done on the initial conditions of the soil 15.60% (dry) with a weight of 350 grams of soil, as well as gradually adding water ranging from 75 ml to 250 ml. The following is a table of the results of testing performed on the sensor SKU: SEN0114.

Table 5. Testing The Soil Humidity Sensor SKU: SEN0114

No.	Berat Tanah	Banyaknya Air	Kadar Kelembapan Tanah
1	350 gram	-	15,60% (Kering)
2	350 gram	75 mililiter	59,53% (Lembap)
3	350 gram	150 mililiter	65,44% (Lembap)
4	350 gram	250 mililiter	72,51% (Sangat Lembap)

From the test results above it can be concluded that if the weight of 350 grams of soil and abundance of water more than 150 ml of soil humidity levels then it will be very moist.

dusky Testing temperature sensors DHT11

DHT11 temperature sensor test aims to find out the sensitivity of detecting temperature. Prior to testing, the sensor is connected to the Arduino to read digital output sensor which has been terkalibrasi to detect the temperature units degrees Celsius (oC). This testing is done at room temperature 22oC and will be brought near by the fire. The following is a table of the results of testing performed on the sensor DHT11.

Table 6. DHT11 Sensor Temperature Rise Test

Suhu awal 22ºC didekatkan pada Api		
No.	**Waktu Perubahan Suhu**	**Suhu Perubahan**
1	24 detik	23 ºC
2	43 detik	24 ºC
3	1 menit 0 detik	25 ºC
4	1 menit 9 detik	26 ºC
5	1 menit 18 detik	27 ºC
6	1 menit 55 detik	28 ºC
7	2 menit 3 detik	32 ºC
8	2 menit 5 detik	33 ºC
9	2 menit 10 detik	34 ºC
10	2 menit 22 detik	35 ºC

From the results of testing temperature rise above, sensitivity temperature sensors, i.e. the higher the temperature this time then it will take the longer time needed to detect a temperature hotter than 23oC to 38oC.

While the test results drop in temperature of 35oC to normal temperature 22oC within 6 minutes. The following is a table of the results of testing done on a drop in temperature sensor DHT11.

Table 7. Testing Drop In Temperature Sensor DHT11

Suhu awal 35ºC Api dimatikan		
No.	**Waktu Perubahan Suhu**	**Suhu Perubahan**
1	10 detik	34 ºC
2	24 detik	30 ºC
3	38 detik	29 ºC
4	50 detik	28 ºC
5	1 menit 13 detik	27 ºC
6	1 menit 28 detik	26 ºC
7	1 menit 49 detik	25 ºC
8	2 menit 31 detik	24 ºC
9	3 menit 18 detik	23 ºC
10	3 menit 22 detik	22 ºC

From the test results drop in temperature above, sensitivity temperature sensors, i.e., the lower the temperature at this time then it will take the longer time needed to detect a temperature colder than 38oC to 25oC.

2.3.2.3 Testing Humidity Sensor DHT 11

DHT11 humidity sensor test aims to find out the sensitivity to detect humidity. Prior to testing, the sensor is connected to the Arduino to read digital output sensor which has been terkalibrasi to detect humidity. This test is carried out when the weather is the cloudy and rainy weather. The following is a table of the results of testing performed on the Air Humidity sensor DHT11.

Table 8. Penguujian Air Humidity Sensor DHT11

No.	Tempat	Cuaca	Waktu	Kadar Kelembapan Udara

1	Balitsa (Lembang)	Mendung	Pukul 18:21:38	49%
2	Balitsa (Lembang)	Mendung	Pukul 18:21:39	49%
3	Balitsa (Lembang)	Mendung	Pukul 18:21:40	49%
4	Balitsa (Lembang)	Mendung	Pukul 18:21:41	49%
5	Balitsa (Lembang)	Hujan	Pukul 18:27:03	62%
6	Balitsa (Lembang)	Hujan	Pukul 18:27:04	62%
7	Balitsa (Lembang)	Hujan	Pukul 18:27:05	62%
8	Balitsa (Lembang)	Hujan	Pukul 18:27:06	62%

Whereas after raining humidity be 62%.

2.3.2.4 Testing Ultrasonic Sensors SR04-HC

Ultrasonic sensor testing HC-SR04 aims to know the sensitivity to detect the availability of water in the container. Prior to testing, the sensor is connected to the Arduino to read digital output sensor which has been terkalibrasi to detect the availability of water in the container. This test is performed on the containers with a height of 40 cm but reduced by the pump on the container 6 cm. Below is a table of the results of testing performed on the Ultrasonic sensors SR04-HC.

Table 9. Ultrasonic Sensor Testing HC-SR04

No.	Ketinggian Air pada Wadah	Banyaknya Air
1	34 cm	-
2	31 cm	1 liter
3	29 cm	2 liter
4	22 cm	4 liter
5	16 cm	6 liter

From the results of testing the availability of water above, each the height of a water reduced water is needed as much as 3 cm 1 liter.

2.3.2.5 Relay Testing

Relay testing aims to see the response of the series. read (). Prior to testing, the relay is already connected to the Arduino. The following is a table of the results of the testing done on the relay.

Table 10. Testing Relays

No.	Memasukkan	Respon Relay
1	Serial.read() == '1'	Mengaktifkan Relay *Channel* 1
2	Serial.read() == '2'	Mengaktifkan Relay *Channel* 2
3	Serial.read() == '3'	Mengaktifkan Relay *Channel* 3
4	Serial.read() == '4'	Menonaktifkan Relay *Channel* 1
5	Serial.read() == '5'	Menonaktifkan Relay *Channel* 2
6	Serial.read() == '6'	Menonaktifkan Relay *Channel* 3
7	Value =" Kering" dari Sensor Kelembapan Tanah diterima	Mengaktifkan Relay Channel 1 sampai value =" Sangat Lembap" dari sensor kelembapan tanah

From the results of testing the relay a try, then the test results were as expected.

2.3.3 Beta testing

Beta testing is the testing that was done objectively where tested directly onto the field i.e. to farmers and employees in Balitsa to peasant and sub system client deployment architecture prototype plant maintenance system on modern conventional agriculture in greenhouses based internet of things.

Based on the results of beta testing through interviews with the Chair of the Research Services and through a questionnaire with a few respondents in the Balitsa i.e. farmers, then it can be inferred that the architecture, the prototype plant maintenance system on agriculture modern conventional automatic in the greenhouse-based internet of things (a case study in Balitsa) is in compliance with the expected purpose i.e. can minimize wastage of water in the land; the granting of plant nutrients to be more directional; OPT control became increasingly a maximum; and can facilitate the work of farmers in the process of plant maintenance.

3. COVER

3.1 conclusions based on the results obtained from the research done in preparing the final project which refers to research purposes, then it can be inferred.

1. these Prototypes can already measure the temperature, soil moisture, air humidity, water availability, availability of nutrients, and the availability of pesticides required by plants.

2. these Prototypes already able to control just about any treatment that should be done at the plant, although not farmers are on land but able to perform plant maintenance. So as to facilitate the work of the farmers on the land.

3. Waste water on land can be minimalisir with the ground humidity sensor based on automation.

4. these Prototypes can already give the condition of the land to find what is needed by the plant cultivation in greenhouses so farmers know what the condition of the crops that are cultivated at this time.

3.2 Advice

Architecture prototype plant maintenance system on modern auto in conventional agricultural greenhouse based Internet of Things still need to be further development, including:

1. The architecture of this prototype still needs people to replenish water, nutrients, and pesticides in the container when is up so that the system can work again.

2. in implementing the architecture of this prototype would be better off in a container that is used in large-sized or directly from where water is available so that farmers are not a water refill pelu in containers.

3. The architecture of this prototype would have been better if the camera used to monitor land the pasted image recognition and be aware of any pests or bullies on the plant.

4. in implementing the prototype architecture requires expert understanding about the science of farming and cultivation process stages.

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