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Smart Shallot Farming: Prototype of Internet of Thing (Iot)-Based Shallot Farming System as a Sustainable Agricultural Innovation

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A B S T R A C T

The shallot commodity is an important agricultural commodity for the food economy, its price often experiences a high increase especially when entering the dry season. The current constraints of shallot farming spend more time and energy because the whole process is done manually which makes farmers experience losses and incur more costs. To overcome these obstacles, researchers innovate to offer Smart Shallot Farming, this system can be applied to shallot farming to simplify and save the cost of maintaining shallot plants. This innovation in shallot farming will simplify and save the cost of shallot plant maintenance. The application of Salfarm on shallot farming is expected to be a technological innovation to improve national resilience in agriculture.

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INTRODUCTION

Indonesia is a country with an agricultural land area of 7.4 million hectares, the vast agricultural land makes Indonesia an agricultural country and most of its people work in the agricultural sector. One of the leading agricultural commodities in Indonesia is shallot farming, domestic shallot productivity reached 1.8 million tons in 2020 (BPS, 2020). With high productivity, Indonesia is the largest producer and consumer of shallots in the world. This agricultural potential can be developed into sustainable agriculture by incorporating technological innovation so as to increase shallots to become a superior agricultural commodity.

Onion production is usually carried out by the community with simple agricultural patterns such as using rice fields or agricultural gardens. Onion farming is seasonal so there is often turmoil between demand and supply which causes soaring prices. the price also experienced a fairly high increase especially when entering the dry season. This makes it necessary for efforts to increase the productivity of onion farming and high harvest success.

Onion farming is also prone to problems that cause decreased productivity and even crop failure. Problems in shallot farming include the need for a regular watering process, frequent pest attacks, and fertilization that still uses manual methods (Basuki, 2014). In addition, the maintenance process also takes longer because the whole process is done manually, this is what makes farmers experience losses and incur more costs (Gunawan, Sari Marlina, 2019).

The process of watering shallots is usually done in the morning routinely, this process takes a long time because the process is still done manually or with a water pump diesel engine. Farmers who use diesel engines complain that the cost of purchasing fuel oil is quite expensive. This shows that there is a need for technological innovation in shallot farming that is environmentally friendly and can increase productivity.

Based on these various problems, the author offers an innovation with a paper entitled "Smart Shallot Farming". This technology can be applied to shallot farming to simplify the process of watering and fertilizing so as to increase yield productivity. Smart Shallot Farming has a concept of agriculture that is monitored in terms of pest control, water needs, watering time and has integrated the Internet Of Things (IoT) which is connected to a Smartphone. The application of this technology can be one of the supporters of optimizing the role of students in innovation and technology to increase national resilience in agriculture, achieve food security, improve nutrition and promote sustainable agriculture, this is in accordance with point 2 of the Sustainable Development Goals (SDGs).

THEORETICAL REVIEW

Onion Farming

Red Onion (Allium cepa var ascalonicum (L) Back) is a plant that spices a variety of dishes. The origin of this plant is from Pakistan, Iran, and the mountains to the north, then cultivated and sub-tropical and tropical seasoning. (Arnold Turang, et al. 2017. Onion producing areas in Indonesia are: Cirebon,

Brebes, Wates, Tegal, Kuningan, Samosir, and Lombok. According to data from the Central Bureau of Statistics in 2020, domestic onion productivity reached 1.8 million tons, this is in line with the increase in public demand for shallots.

Onion farming is also prone to problems, one of the factors that cause failure and problems in agricultural commodities is due to the low application of technology in its implementation. This is then used as an evaluation to improve the agricultural system so that productivity increases. Furthermore, according to Rika Revica (2020) explains that technology in agriculture needs to be applied so that farmers no longer depend on the season but can be carried out based on planting mechanization, so that the planting to harvesting process can be carried out precisely, accurately both from labor, planting time and harvesting process.

Climate and Soil for Onion Farming

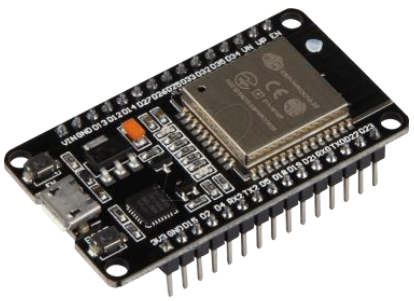
Dry areas are ideal for the growth of shallot plants. These plants require at least 70% of the recommended amount of sunlight. The relative humidity is between 50 and 70 percent, while the air temperature ranges from 25 to 32°C. In areas with an average air temperature of 22°C, shallots can grow into bulbs. Onion plants will not produce bulbs if the ambient temperature is less than 22°C. Therefore, lowlands with a sunny atmosphere are the places where shallot plants grow. 5 In addition, shallot plants need to be fertilized with organic fertilizer or manure, which is believed to improve soil physical properties and contribute nutrients (Samawati, et al., 2022).

Solar Panels

Solar Panel is a tool for converting sunlight energy into electrical energy. To utilize the potential of solar energy there are two kinds of technology that have been applied, namely photovoltaic solar energy and thermal solar energy (Nurlaila Amna, 2016). The working principle of solar cells is that these electrons and holes can move in the material to produce an electric current. In addition to saving energy, the use of solar cells will preserve the environment because the use of this tool does not cause pollution at all.

ESP 32 Microcontroller

ESP 32 is a microcontroller which is the successor of the ESP8266 microcontroller. For ESP 32, it is equipped with a WiFi module in a chip so that it is possible to create an Internet of Things (IoT) application system (Muliadi, Al Imran. 2020).



Picture 1. ESP 32 Microcontroller

Internet of Things

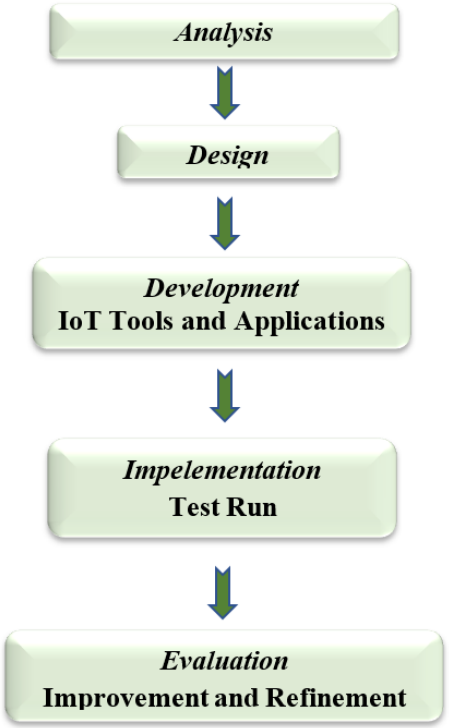
Internet of Things (IoT) is a concept in which an object has the ability to transfer data over a network without requiring interaction from human to human or from human to computer (Burange & Misalkar, 2015). IoT aims to extend the continuous connectivity of the internet that allows us to connect machines, appliances, and other physical objects with networked sensors and actuators. This allows machines to collaborate and even act on new information obtained independently (Efendi, 2018).

App Inventor

App Inventor is a platform to facilitate the process of creating simple applications without having to learn or use too many programming languages. We can design android applications as desired using a variety of layouts and components available. App Inventor allows new users to program computers to create software applications for the Android operating system (Unisayogya, 2020).

METHODOLOGY

The research conducted used the Research & Development (R&D) method. This research model applies the ADDIE model which consists of five stages of the process including analysis, design, development, implementation and evaluation. The purpose of applying this research method is research to develop a product so that a new product will be obtained to test the effectiveness of the product and the new product produced is able to provide a solution to a problem. The procedure for making this tool consists of seven stages starting from problem identification analysis and literature study to feasibility evaluation and refinement.



Picture 2. Research Steps

Analysis

Problem identification is carried out by looking at the analysis of needs in the shallot farming sector and the weaknesses obtained are the stages of watering and fertilizing shallots which are carried out manually, so it requires a lot of energy and time in the conventional watering and fertilizing process. This is considered less effective and certainly affects shallot production.

The next stage is a literature study to collect data, namely primary data in the form of theories obtained by the literature review method. The literature can be in the form of valid print and electronic media in the form of articles, journals, books, and others related to each other. The collection of theoretical basis and literature study is an initial preparation made to find out the mechanical components of the tool and electronic components in order to work optimally.

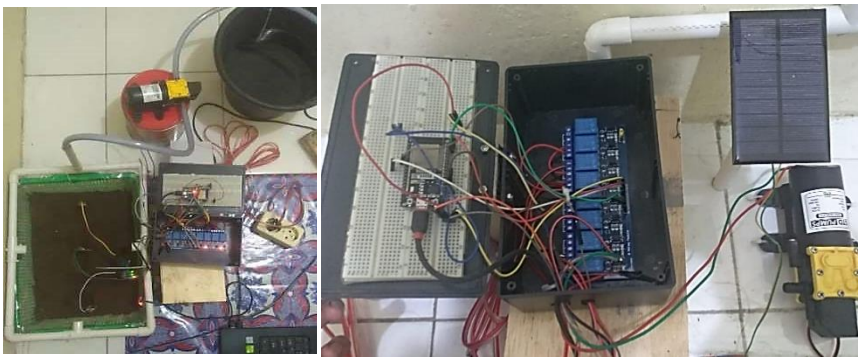
Design

The design of the tool begins with collecting the theoretical basis of each component. Next is to design the physical form of the tool to be developed. The process of making this tool must be done carefully and thoroughly and through testing stages to ensure that the tool can work optimally.

Picture 3. Technology Design

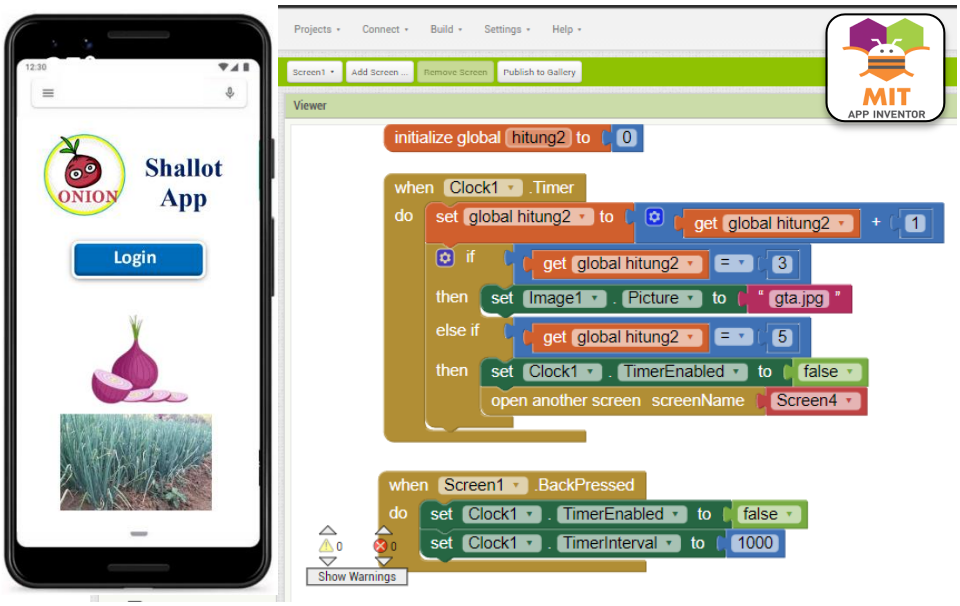
Development

After the design stage, the next step is to implement the assembly of prototype mechanical and electronic components of the tool in the form of making frames, making boxes, assembling electronic components of parts that have been designed to be implemented into shallot watering and fertilization tools.



Picture 4. Assembly of Electronic Components of the Tool

At this stage, an application is made using the MIT App Inventor website coding and making automatic watering and fertilization system applications. The application created is called the Shallot-App application.



Picture 5. Application Display Design

Implementation and Testing

In using a control device, testing is needed so that the resulting tool can work properly. This test is carried out to find out how effective it is to control a shallot garden.

Step testing procedures and data collection of shallot watering and fertilization tools.

a. Install the tool on the farm and adjust to the layout in the design.
b. Turn on the tool by plugging the power cord jack into the power source / socket in the panel box, then press the ON button to turn it on and make sure the wifi is ready.
c. This tool can turn off automatically if the soil moisture reads a high level of humidity and will turn on again if the sensor reads low soil moisture.
d. Conduct 12x tests with a distance of HST each test 1-9 HST for the watering process with a distance of 10 HST for the fertilization process this aims to find out whether the moisture in shallots is sufficient every day.
e. When testing, do it at the same hour, namely 9 am because that time is an effective watering process.

Evaluation

After conducting the trial process, the next stage is the evaluation process to discuss the advantages and disadvantages of Salfam as an innovative automatic plant watering and fertilizing machine. In dry weather the system will automatically adjust the humidity needed so that it does not dry out according to a specified schedule. In rainy weather the system will

automatically turn off the pump until the humidity decreases and the motor will reactivate when in accordance with the predetermined hours.

RESULTS

Smart Shallot Farming Technology Concept

In general, shallot farmers use manual methods for the process of watering and fertilizing shallots, which takes a long time. Shallot farming also experiences various other problems including farmers lacking attention from the government, long droughts that have the potential to result in crop failure and the availability and increase in fuel prices as a source of energy for the sprinkler machines used. This condition shows that there is a need for a technological innovation that is environmentally friendly in shallot farming.

This innovation can be done by utilizing Smart Shallot Farming (Onion Red Agriculture Technology) so that it can increase shallot production, especially during the dry season. In addition, Smart Shallot Farming has a more controlled agricultural concept in terms of pest control using ultrasonic waves, water requirements, watering times and soil moisture. Smart Shallot Farming is automatically arranged with a microcontroller and integrated Internet Of Things (IoT) connected to a Smartphone The application of this technology can be one of the supporters of optimizing the role of students in innovation and technology to realize agricultural development as an effort to improve sustainable agriculture.

Smart Shallot Farming Design

The design of Smart Shallot Farming technology innovation is as follows:

Picture 6. Smart Shallot Farming Design

Tool Description

IoT-based shallot watering and fertilization tool is a technology that can facilitate shallot farming by adjusting humidity levels according to schedule and fertilizer needs. This can run automatically and can be set via a smartphone. This tool applies an IoT system that can facilitate the management and maintenance of shallot farming without having to monitor directly. As for the components of the tool used panel boxes, solar panels, sensors, actuators and ESP32 microcontrollers as tool control. The application of IoT to the tool can provide benefits, namely the monitoring process and command of a system can run via the internet so that its use can be effective, easy and efficient.

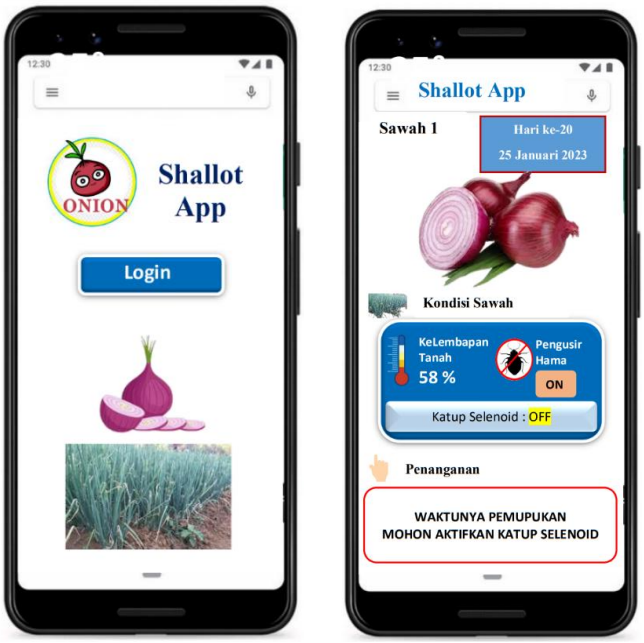
Smart Shallot Farming Works

IoT-based shallot watering and fertilization tools are composed of several kinds of components, which are equipped with sensors as a regulator of humidity levels needed by plants and solar panels for electrical energy sources. and equipped with a fertilization system that is set using a solenoid valve and Smart Shallot Farming is equipped with midges so that crops are expected to be free from pest problems.

Internet of Things (IoT) and Smart Shallot Farming Application

Internet of Things (IoT) is a concept where an object has the ability to transfer data over a network without requiring interaction from human to human or to computer. At this stage, coding is made on the microcontroller and GUI (Graphical User Interface) coding which contains commands for midges, monitoring temperature, and soil moisture needed. Control using the GUI supports the sensor to interface with the microcontroller.

The application is used to remotely monitor the condition of shallot farmland. The results of the IoT sensors are used to monitor soil moisture conditions using the Shallot App. The results of the sensor can be read through a smartphone, to monitor if there is a problem in Smart Shallot Farming easily and more efficiently than having to check the condition of the farm directly.



Picture 7. Application Display Design

Advantages of Smart Shallot Farming Tool

Based on the application of the Smart Shallot Farming Innovation prototype, it has the following advantages:

a. Components and materials can be easily obtained.
b. Easy and practical in watering and fertilizing.
c. Easy maintenance and use of tools because it is controller-based.
d. Save time and energy to do watering and fertilizing.

CONCLUSIONS AND RECOMMENDATIONS

Provide some conclusions and the implementation of the research results**.** After conducting a series of planning, experiments, and prototype testing, the following conclusions were obtained. IoT-based irrigation control tool for shallot plants equipped with sensors and actuators has 3 features, namely monitoring, controlling and scheduling. For sensor readings, sending and receiving data from the thinkspeak server and NTP server data can be received properly in terms of synchronized sensor readings and data transfer between ESP32 and the server runs smoothly without problems.

This tool can be applied to large agricultural land by multiplying the tool according to the size of the existing land. The weakness of the system is still using the ESP 32 chipset whose data transfer speed cannot be as fast as a PC and limited input output address, maybe it can use the latest chipset that has many input outputs and fast data transfer speed.

FURTHER STUDY

The application of this agricultural technology will be able to become the latest breakthrough for the future and can summarize the finances for shallot farming and designs that are easy to apply on farms. Further implementation of this research needs support from:

a. Shallot farmers
   Utilizing this technology so that agricultural methods can be carried out easily and costs incurred can be minimized.
b. Government
   Improve its performance in creating agricultural technology so that national food security can be created.
c. Researchers
   Researchers conduct further research so that the ideas made can be realized and provide benefits to shallot farmers so as to improve sustainable agriculture.

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