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Design of a Hydroponic Smart Farm System with Web-Based IoT in Bireuen Regency

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ABSTRACT

The development of science and technology is growing so rapidly that it encourages people to continue to think with the aim of finding solutions to existing problems so as to help with daily work. One of them is the use of controlling and monitoring systems for agricultural cultivation land. The research aims to understand design of a hydroponic smart farm system with web-based internet of things (IoT) in Bireuen Regency. This research is carried out from August to September 2022. This section describes the concept of hydroponic system design with IoT and observation techniques to see how far the process of implementing IoT is implemented in hydroponic plants. The results show that the system can find out and display data obtained from several sensors that have been installed on hydroponic plants, such as light sensors, Ph sensors, and DTS sensors. This system can also be used to control or control a four-channel relay that is used to control several actuators installed, such as 1 water pump, 2 fertilizer pumps, fans, and lights via the website. Even this system has an additional command that is used to control the relay by utilizing the website.

Keywords: Hydroponic, Smart Farm System, Internet of Things

INTRODUCTION

The development of science and technology is growing so rapidly that it encourages people to continue to think with the aim of finding solutions to existing problems so as to help with daily work. One of them is the use of controlling and monitoring systems for agricultural cultivation land.

The use of technology has been widely applied where the use of automatic technology has been so advanced that the use of daily activities can be done automatically because humans will not always use conventional methods (Rahmat et al., 2019). In addition, narrow land is also an obstacle for modern farmers now in cultivating agricultural land with the hydroponic system, which is expected to be the best solution for farmers with innovations that apply current technology for farmer efficiency on narrow land both in the yard of the house.

Based on direct surveys in the field, the factors that determine the failure of a plant's growth are almost 80% influenced by the wrong technique or method of watering plants. This is caused by watering that is done manually, so that not all plants get water intake evenly which can cause plants to wither (Irsyam and Tanjung, 2019).

The use of the internet of things (IoT) is a solution in dealing with problems that occur in the use of technology related to plant cultivation both in agriculture and plantations where the use of this technology can produce much more efficient and maximum results.

Today's technology continues to encourage people to continue to develop and think more advanced and even creative towards new things. The field of knowledge and technology is developing so rapidly that

many innovations are created to ease human work, including in daily life.

Hydroponics is a method of growing plants or vegetables without soil, but using a solution of mineral nutrients mixed with water. Since this solution will be used as a food source for plants or vegetables, it is necessary to control or manage many factors in this liquid. Some examples of variables that we have to control are the PH value or concentration and electrical conductivity of the nutrient solution (Ruengittinun et al., 2017).

Lettuce growth depends on nutrient pH and electrical conductivity. For example, a good pH level for lettuce is 6.0-6.5, while the recommended electrical conductivity level is 0.8-1.2 (Arafat, 2016). Factors need pH and electrical conductivity to monitor 24 hours during the growth period. Many lettuce growth periods are not monitored in real time, thus causing crop failure (Helmy et al., 2017).

In this paper, we propose a system to facilitate farmers to monitor the greenhouse without going to the hydroponic greenhouse one by one by building a nutrient film technique hydroponic monitoring system based on a website so that it can facilitate the monitoring and control of irrigation and fertilizer using the website.

The research aims to understand design of a hydroponic smart farm system with web-based IoT in Bireuen Regency.

LITERATURE REVIEW

Hydroponics

Hydroponics is the cultivation of plants without using soil media. Hydroponics does not need much water and requires more nutrients for plant growth. Because it does not depend too much on soil media, hydroponic cultivation does not really need a very large area. In the successful application of a hydroponic system, several important factors must be considered (Rahmawati, 2018). Factors that need to be considered are water and pH.

Hydroponic farming systems require a large area of land. However, hydroponic greenhouses in urban areas cannot be placed in only one place, thus requiring a system to monitor the large number of greenhouses in separate locations. A farmer may have more than one nutrient tank in the greenhouse. So, farmers need more efforts to monitor nutrient tanks and greenhouses one by one in different areas (Helmy et al., 2017).

Internet of Things (IoT)

Internet of Things (IoT), is a concept that aims to expand the benefits of continuously connected internet connectivity that allows us to connect machines, equipment, and other physical objects with network sensors and actuators to acquire data and manage their own performance, thus enabling machines to collaborate and even act on newly acquired information independently (Arafat, 2016). IoT is an idea where all objects in the real world can communicate with each other as part of an integrated system using the internet as a liaison. For example, Closed Circuit Televisions installed along the road are connected to the internet connection and put together in a control room that may be tens of kilometers away. or a smart home that can be managed via a smartphone with the help of an internet connection. Basically, IoT devices consist of sensors as data collection media, internet connections as communication media and servers as information collectors received by sensors and for analysis.

The initial idea of IoT was first raised by Kevin Ashton in 1999 in one of his presentations. Now many large companies are starting to explore IoT, namely Intel, Microsoft, Oracle, and many others. Many predict that the influence of IoT is "the next big thing" in the world of information technology, this is because IoT offers a lot of potential that can be explored. A simple example of the benefits and implementation of IoT, for example, is a refrigerator that can notify its owner via short message service or email about what food and drinks have run out and must be stocked again.

The productivity of hydroponic lettuce cultivation is very important. But

hydroponic lettuce growers face risks all the time. Recently, many researchers introduced IoT technology-based hydroponic systems to improve the quality of medium lettuce cultivation. In addition, IoT-based hydroponic systems can significantly reduce production losses (Puengsungwan and Jirasereeamornkul, 2019)

Raspberry Pi

The Raspberry Pi is a single-board computer the size of a credit card. The raspberry pi is equipped with all the functions like a complete computer, using a system-on-a ARM chip that is packaged and integrated on a PCB (circuit board). This Raspberry Pi is able to work like a computer in general with the ability to run the Linux operating system and its applications such as LibreOffice, multimedia (audio and video), web browsers, or programming (Prihantono et al., 2013).

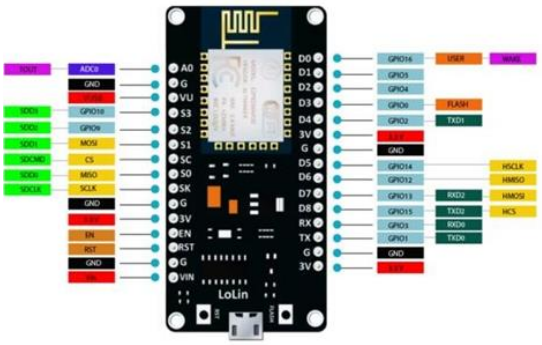
Figure 1. Rasberry Pi

NodeMCU

NodeMCU is basically an extension of the ESP 8266 with e-Lua based firmware. The NodeMcu is equipped with a micro USB port that functions for programming and power supply. In addition, the NodeMCU is also equipped with push buttons, namely the reset and flash buttons. NodeMCU uses the Lua programming language which is a package from esp8266. Lua has the same logic and programming structure as c, only the syntax is different. If using Lua then.

Can use the Lua loader and Lua uploader tools. In addition to the Lua language, NodeMCU also supports Arduino IDE software by making a few changes to the Arduino IDE board manager. Before using this board, it must be flashed first so that it supports the tools that will be used. If using the Arduino IDE, use a suitable firmware, namely the firmware output from the AI-thinker which supports AT Command. For the use of the Firmware loader tool, the NodeMCU firmware is used (Irsyam and Tanjung, 2019).

Figure 2. NodeMCU



TDS Meter Sensor

The microcontroller already has a ph up and a ph down. The next process will be reading the ppm sensor. If the ppm sensor data is more than the ppm setpoint, it will proceed to the process of reading the pH, ppm and volume sensors. If not, it will proceed to the process of adjusting the ppm sensor data with the ppm setpoint using nutrient solution A and nutrient B. From the process of reading the pH, ppm and volume sensors, it will proceed to the process of sending the pH, ppm and volume sensor data to the database and back to the data collection process setpoint ph, ppm and volume from database.

The TDS sensor is used to detect the concentration of the nutrient solution, so it can be detected precisely when the solution requires additional nutrients.

pH Sensor

The water pH sensor (SEN0161) is a sensor that detects the acidity of a liquid. The working system of the pH sensor (SEN0161) is located on a pH probe made of glass. The chemical reaction at the tip of the pH probe causes a voltage and from that voltage is measured in pH units. The working principle of pH is that the more electrons in the sample the more acidic the

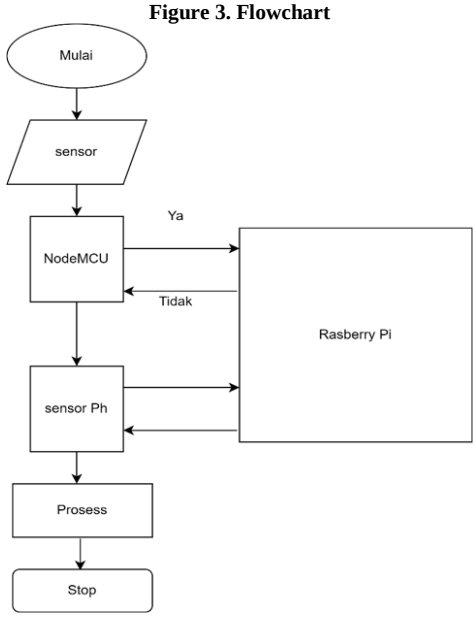
value will be and vice versa, because the bar on the pH meter contains a weak electrolyte. Based on S. Nakoaka and A. Yamada in their research, they stated that changes in pH levels will affect the photosynthetic activity of plants, because CO_2 easily dissolves in water and lowers pH. Maximum plant growth can be achieved by increasing its capacity (Helmy et al., 2017). Because the pH value can have an effect on the photosynthetic activity of plants, the pH level in aqueous solutions must be controlled to avoid damage to plants.

RESEARCH METHODS

This research is carried out from August to September 2022. This section describes the concept of hydroponic system design with internet of things (IoT) and observation techniques to see how far the process of implementing IoT is implemented in hydroponic plants.

Flowchart

Figure 3. Flowchart



Schematic Circuit

The author will describe the stages of research, stages of analysis and stages of system design. The schematic circuit here is to connect the light sensor, ph sensor and tds sensor with a microcontroller to the rasberry Pi to function as a database that will display its output on computers and cellphones, while the relay functions as a switch that is used to run the water pump, fertilizer pump, lights, and fans.

Hardware Block Diagram

In the hardware diagram block there are light sensors, Ph sensors and TDS sensors that are connected to the microcontroller as sensor data which is then connected to the rasberry Pi as a database that functions to store data from each sensor and stored in a database that will be displayed on a PC or cellphone.

The data from the rasberry will be captured by the second microcontroller which functions as an output which will send data to the relay as a command to move the water pump, fertilizer pump, lights, and also fans.

The system works by taking data from the sensor to be sent to the rasberry Pi then the processed data results are sent back to the rasberry Pi to be received by the microcontroller and carry out watering and fertilizer application. Based on Figure 4 describes the general description of the system and processing in general.

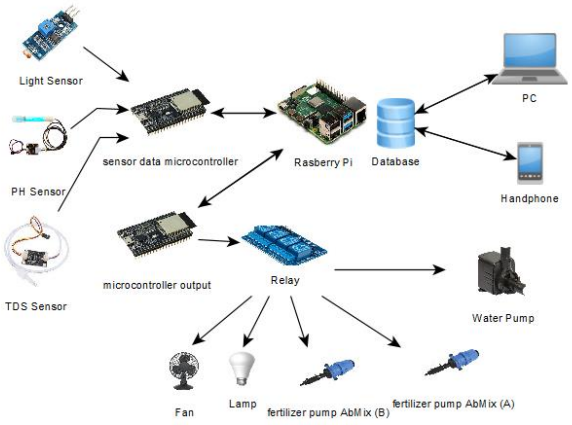
The stages of the system are as follows:

1. Sensor data in the form of parameters that come from light sensors, Ph sensors, TDS sensors.
2. Data from the sensor will be processed by the microcontroller.
3. Sensor data that has been sent by the microcontroller will be stored as a database by the rasberry Pi to be used as monitoring data.
4. After the circuit between the sensor and the microcontroller is done. Running then sensor data will be sent to the second microcontroller as output.
5. The sensor data that has been sent to the second microcontroller will send data to the relay to determine the output in the form of commands for watering, fertilizing, turning on the lights and also the fan.
6. The output data that has been sent by the rasberry Pi will be taken by nodemcu to

perform the relay configuration command.

7. After the relay configuration is complete, the system will water the hydroponic plants.

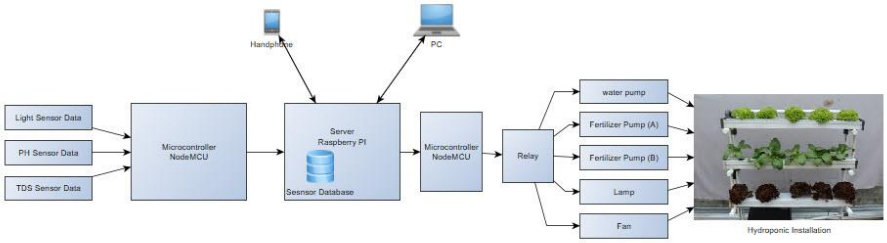
Figure 4. Hardware Block Diagram



RESULT AND DISCUSSION

Block Input Process and Output

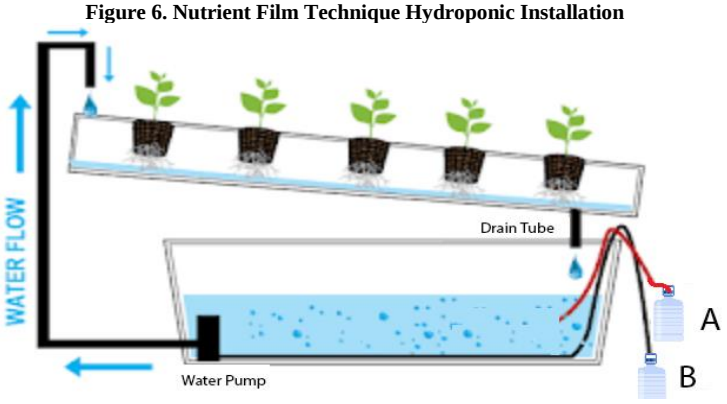
Figure 5. Block Input Process and Output



Nutrient Film Technique Hydroponic Installation

The irrigation technique used in the hydroponic installation is the nutrient film technique where gallons of ABMIX A fertilizer and gallons of ABMIX B fertilizer will be mixed according to the appropriate dose into a water holding tank so that water and fertilizer will mix which will then be distributed by a water pump through a planting pipe.

Figure 6. Nutrient Film Technique Hydroponic Installation



PH Value of Water and Fertilizer Needs

Knowing the pH of water that is suitable for hydroponic plants is one of the important things that can maximize maximum plant growth in addition to giving the appropriate fertilizer dose. To meet the nutritional needs of lettuce plants, macro and micro elements are needed that are important in meeting the nutritional needs of hydroponic plant growth that are already present in AB mix fertilizer that has been dissolved in water which has a value in the form of parts per million with the appropriate dose to maximize plant growth.

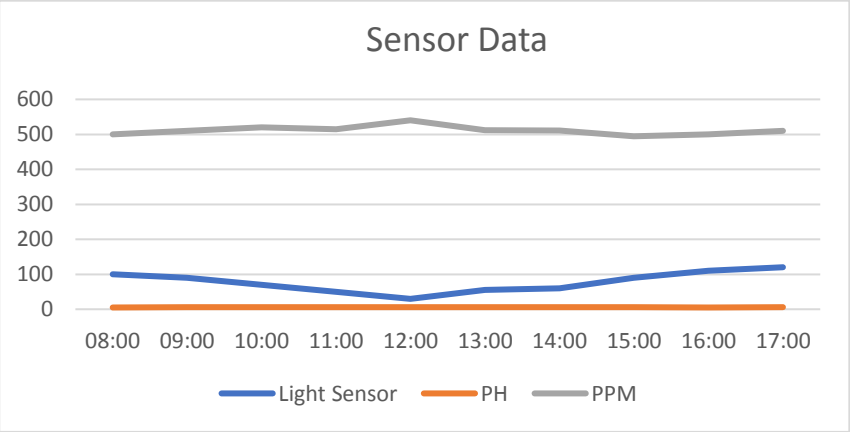
Table 1. Lettuce Plant Weekly Nutrient Needs

PPM	PH	Harvest	Weekly Nutrient Needs			
			Week 1	Week 2	Week 3	Week 4
500-800	5,5-6,5	28-35	500	600	700	800

Table 2. Monitoring Sensor Data Every One Hour

Time	Light Sensor	PH	TDS
8:00	100	5.5	500
9:00	90	5.6	510
10:00	70	5.7	520
11:00	50	6	515
12:00	30	6	540
13:00	55	5.8	512
14:00	60	5.7	511
15:00	90	5.8	495
16:00	110	5.5	500
17:00	120	5.6	510

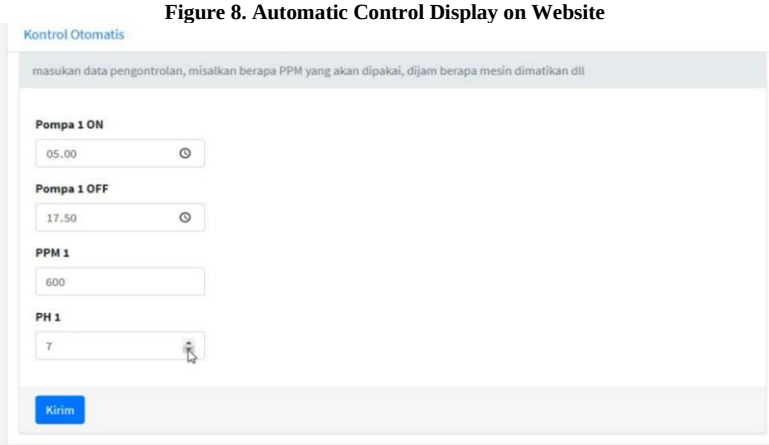
Figure 7. Sensor Data Monitoring Graph



Automatic Control

The automatic control menu on the website is used to turn on or turn off the main pump and provide ppm and Ph values to match the values entered on the website.

Figure 8. Automatic Control Display on Website



System implementation is an advanced stage of the design stage that has been carried out. After all parts of the hardware and programs of the system have been fully completed, the next step is to carry out the testing phase of the tool with the aim of whether the tool is in accordance with the predetermined design. Readings from

several sensors such as light sensors, Ph sensors and DTS sensors include air temperature and humidity data, DTS sensors to see the water content of hydroponic plants and the last stage of testing is controlling the relay for the output you want to produce.

CONCLUSION

After planning and making and testing the system. There are several research results that can be drawn from this study, including:

1. The system can find out and display data obtained from several sensors that have been installed on hydroponic plants, such as light sensors, Ph sensors, and DTS sensors.
2. This system can also be used to control or control a four-channel relay that is used to control several actuators installed, such as 1 water pump, 2 fertilizer pumps, fans, and lights via the website.
3. Even this system has an additional command that is used to control the relay by utilizing the website.

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REFERENCES

1. Arafat, M. K. (2016). Sistem Pengamanan Pintu Rumah Berbasis Internet of Things (IoT) dengan ESP8266. Jurnal Ilmiah Fakultas Teknik Technologia, 7(4), 262-268.
2. Helmy, Mahaidayu, Marsha Gresia, Nursyahid, Arif, Setyawan, Thomas Agung, & Hasan, Abu. (2017). Nutrient Film Technique (NFT) Hydroponic Monitoring System Based on Wireless Sensor Network. International Conference on Communication, Networks and Satellite (Comnetsat), IEEE, 10.
3. Irsyam M & Tanjung A. (2019). Sistem Otomatis Penyiraman Tanaman Berbasis Telegram. Sigma Teknika, 2(1), 81-94.
4. Prihantono, R.S, Shiddiqi. A,M, & Studiawan, H. (2013). Rancang Bangun Sistem Keamanan dan Pengenalan Objek dalam Ruangan Sebagai Pengganti CCTV dengan Menggunakan Raspberry Pi. Jurnal Teknik Pomits, 2, 2301-9271.
5. Puengsungwan, Supachai, & Jirasereeamornkul, Kamon. (2019). Internet of Things (IoTs) Based Hydroponic Lettuce Farming with Solar Panels. International Conference on Power, Energy, and Innovations (ICPEI), IEEE, 10.
6. Rahmat T, Sutarman, & Setyawan A. H. (2019). Sistem Penyiraman Tanaman Otomatis Berbasis Mikrokontroler Arduino Uno Pada Toko Tanaman Hias Yopi. Jurnal Sisfotek Global, 9(1).
7. Rahmawati, E. (2018). Pengaruh Berbagai Jenis Media Tanam dan Konsentrasi Nutrisi Larutan Hidroponik Terhadap Pertumbuhan Tanaman Mentimun Jepang (Cucumis sativus L.). Makassar: Uin Alauddin.
8. Ruengittinun, Somchoke, Phongsamsuan, Sitthidech, & Sureeratanakorn, Phasawut. (2017). Applied Internet of Thing for Smart Hydroponic Farming Ecosystem (HFE). 10th International Conference on Ubi-Media Computing and Workshops (Ubi-Media), IEEE, 7.

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