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Design of a Monitoring System for Fertilizing Palm Oil Trees Based on Internet of Things for Measurements Soil PH

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Abstract: Palm oil is one of the country's foreign exchange contributors. In Indonesia, palm oil is used as a raw material for producing oil, such as cooking oil, industrial oil and fuel. Palm oil plays an important role in the oil sector industry, but to get the best yields it is necessary to pay attention to soil pH conditions. Therefore, a monitoring system was made on the fertilization of oil palm trees based on soil potential of hydrogen (pH) measurements based on the Internet of Things (IoT). This system can determine the value of soil pH levels and soil moisture with the help of system tools in the form of sensors to display the value of levels to the Licquid Crystal Display (LCD). The value of the content that has been read from the LCD will enter the owner's smartphone in the form of a blynk application to monitor the plant. Sensors installed on system tools in the form of soil pH sensors and soil moisture sensors. The components needed to build an IoT system are microcontrollers, solar cells, battery management systems, batteries, stepdowns, LCDs. After testing and data collection, pH sensors have a good correlation with levels 4-5 and humidity sensors with levels of 65-80%. So that with this system, it can help plant owners find out the condition of soil pH and soil moisture through the blynk application and can be implemented in oil palm plants.

Keywords: Palm oil tree, Pertilizer, IoT, Monitoring, pH

1. INTRODUCTION

Palm oil is one of the contributors to the country's foreign exchange, in Indonesia palm oil is used as a raw material for producing cooking oil, industrial oil, and fuel. Palm oil has an important role in the oil industry, namely it can replace coconut as a source of raw material. The process of oil palm as an industrial plant also has an important role, namely the fertilization process in oil palm cultivation. Based on Warta Ekonomi data, in 2006 Indonesia became the number one producer of palm oil in the world. Based on central bureau of statistics data, the export figure for palm oil in 2019 was 29.5 million tons, 0.2 million tons more than the previous year. With total palm oil production in 2019 reaching 48.4 million tons, an increase of around 12 percent from 2018. Based on Mundi index data for 2021, Indonesia has palm oil production of up to 44,500 thousand Metric Tons (MT), the highest in the world.

On the island of Sumatra, to be precise in Riau Province which is called one of the largest palm oil producers in Indonesia, palm oil production in Riau Province is 8.63 million tons in 2021. This amount is equivalent to 18.67% of the total palm oil production which is 46.22 million tons. Due to the very large amount, the soil in Riau has the characteristics of peat soil. This type of soil is very suitable for planting crops such as oil palm because the pH of peat soils ranges from 2.7 to 5.0. The oil palm plant itself is suitable for planting in soil with a pH of 4.0-6.5. Therefore Riau is one of the provinces that has the most professions as oil palm farmers in the country. Oil palm farmers, especially in the business sector, carry out planting and caring for oil palm in a very good way in order to get quality palm oil to achieve high productivity. Checking and monitoring the condition of the soil is very necessary and it must have an optimal humidity of 75% -80% so that it is not too dry or wet, because based on data that drought during the dry season causes failure to form new bunches of oil palm fruit. In addition, a stable pH of around 4.0-6.5 is needed so that the nutrients in the soil are not disturbed. In oil palm cultivation, the fertilization process is a very important stage. In the process of fertilizing oil palm, most of them still use the manual method in terms of watering and fertilizing and cannot know the value of soil moisture and soil pH.

Measurement of soil pH moisture in oil palm fertilization is designed to use a pH sensor as a measure of the acidity level of liquid fertilizer and soil moisture as a measure of soil moisture level when water is added. Then for ESP 32 to analyze it to display the LCD (liquid crystal display) as the sum of the levels of pH and humidity levels produced by the module, ESP 32 sends information data to Blynk using the internet network sourced from hotspots or wifi modems (MIFI) so that the application blynk displays graphs in real-time clock.

2. LITERATURE REVIEW

As science develops, it causes many innovations in the field of technology that make it easier for humans to carry out their daily activities. One technology that is experiencing rapid development is the use of sensor technology as a control and monitoring system. In the preparation of this thesis, the authors were inspired by several previous research references related or related to this thesis. Some of these studies are as follows. In a journal conducted by [1-3] entitled "Design a monitoring system for soil moisture and air temperature based on GSM SIM900A and Arduino Uno", in his research it was stated that a system can control the environmental conditions of hydroponic plants using ethernet shield for sending data via the internet, then with the special Android application Blynk watering hydroponic plants can be monitored and controlled remotely. As for the research, the control and monitoring system will be carried out via SMS, namely by using the SIM900A GSM module, this module will send messages about plant conditions to the user without having to be connected to the internet.

In a journal conducted by [4-5] "Analysis of multi-node monitoring systems using real-time clock receivers", in his research it was stated that the system uses three sensor nodes, each of which can perform ultrasonic sensor readings for monitoring and Real Time Clock (RTC) to perform actuator scheduling. Data from sensor readings is sent to the master node via the nRF24L01+ transceiver module which operates at a frequency of 2.4 GHz. Meanwhile at the master node, the data that has been received will be displayed on an LCD and stored on a memory card in a spread sheet format. In a journal entitled “IoT based palm oil monitoring and seeding system” by [6-8] it is stated that his research has developed a website-based application that can control the system remotely. In this study using ESP32 as hardware and software components, capacitive soil moisture sensors to measure soil moisture, soil pH sensors to measure soil acidity or base level, and ultrasonic sensors to calculate the remaining fertilizer water. The control system that is run can schedule automatic water sprinkling in the morning and evening and fertilization on oil palm trees can be controlled using the on/off button.

In a journal entitled "IoT-Based oil palm nursery Design" by [9-11], in his research he conducted a design tool that can monitor and control hardware or tools built as well as interfaces between users by using the website and internet access. The system design created can monitor oil palm nurseries, taking into account the optimal air temperature for oil palm seedlings by using the DHT22 sensor as input for temperature conditions and a mist maker as the output to maintain optimal air temperature for oil palm seedlings. Control and irradiation use the LDR sensor to detect light, if it is dark it will turn on the grow light and vice versa. Meanwhile, the soil moisture sensor is used to maintain the humidity of the oil palm plant seeds and is equipped with the timing of flushing the plants using the RTC module.

In a journal entitled "IoT based spirulina plant growth monitoring system" by [12-15], his research carried out monitoring and optimizing the parameters needed for the development of spirulina growth, because spirulina growth was hampered or even failed to be influenced by parameters that needed by spirulina is not obtained optimally. The tools used for monitoring consist of Arduino Nano, NodeMCU ESP-8266, DS-18B20 temperature sensor, BH-1750 light sensor, pH sensor module, and turbidity sensor module used to monitor spirulina harvest time. Each sensor used has an error of 1.2% for the light sensor, 0.37% for the water temperature sensor, and 0.76% for the pH sensor. Data obtained from the system will be sent to the server and then displayed on the android application that has been designed. In addition, the data obtained from the sensors can also trigger the actuators that have been made. The actuators used in this system include actuators for temperature, actuators for pH, and actuators for light. By using this monitoring system, the percentage increase in spirulina growth was obtained by comparing turbidity in cultures that did not use monitoring tools with cultures that used monitoring tools of 3.59% [16-17].

3. METHODOLOGY

Prior to the existence of a fertilization monitoring system for oil palm trees, there was already an ongoing system where the system was still manual and required inadequate manpower and time. The analysis of the running system can be seen in Figure 1.

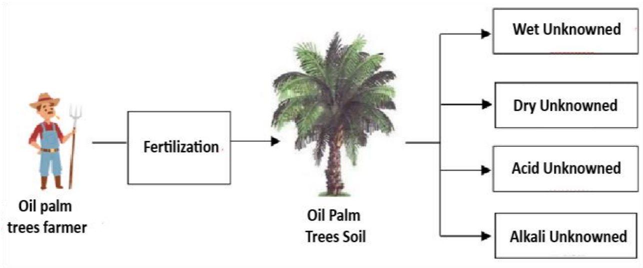


Figure 1. Conventional method to pertilizer palm

The concept of a fertilization monitoring system for oil palm trees aims to help or facilitate a job in terms of checking oil palm trees without being on a plantation. Where this system is designed to carry out remote checks and will also make it easier when oil palm trees experience problems in fertilizing either from soil pH levels that experience moisture or drought also the process of oil palm tree mechanisms will be maintained. In more detail, the system to be built can be seen in Figure 2 as follows.

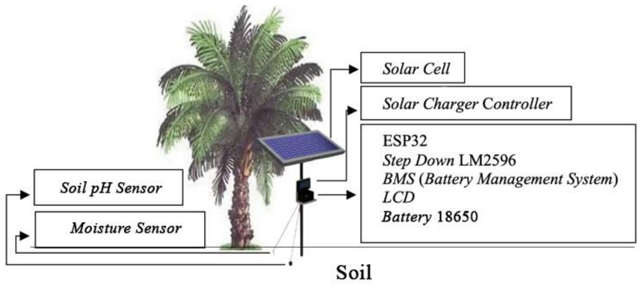


Figure 2. Proposed new method to paertilizer the palm

The following is how the fertilization monitoring system works on oil palm trees based on the picture below. The design of a monitoring system tool for fertilizing oil palm trees based on soil pH measurements based on the IoT is designed to use the main power source that comes from solar cells and the microcontroller used is ESP 32 which has a Wi-Fi device available in it. The system consists of 2 sensors and 1 LCD which have their respective purposes. The sensors used are a pH sensor and a humidity sensor. The humidity sensor will read the moisture in the peat soil, when the levels in the peat soil increase, the LCD will display the humidity value. Likewise, the pH sensor will read the level of acidity and alkalinity in oil palm plants. The information used by the sensor will be forwarded to the user by connecting ESP 32 to the data server, namely the Blynk Application. Figure 3 shows the flowchart of system excecution in palm pertalizer.

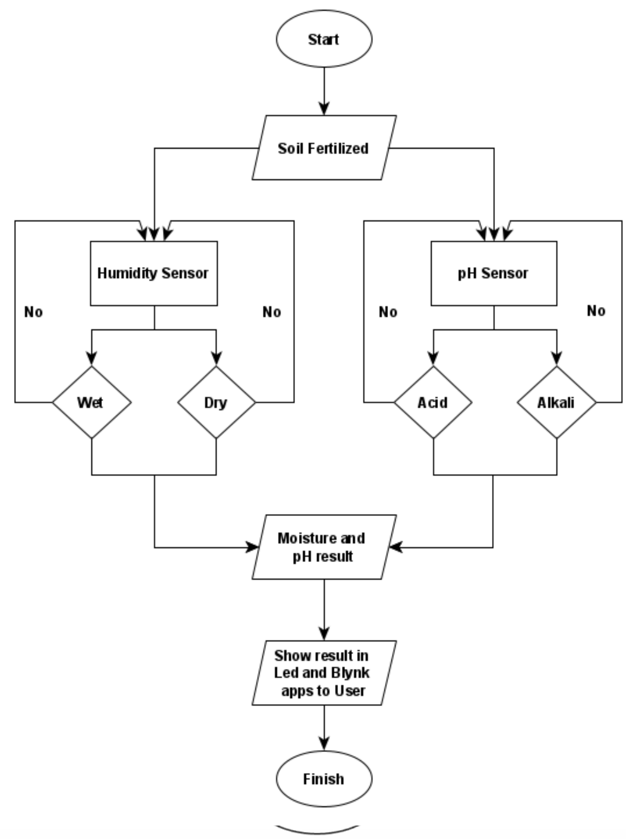


Figure 3. System flowchart for palm pertilizer

4. RESULTS AND DISCUSSION

Figure 4 explains the hardware design components of the oil palm tree fertilization monitoring system based on soil pH measurements based on the IoT. In this system, the microcontroller is connected to several sensors and other devices. The energy source in this system is obtained from a solar cell that takes sunlight to be stored in a battery that has been calibrated by the solar charge controller and stepped down so that the voltage does not exceed capacity, then the sensor reading will work and display the value. The values in the form of humidity sensors and soil pH will be displayed via the LCD.

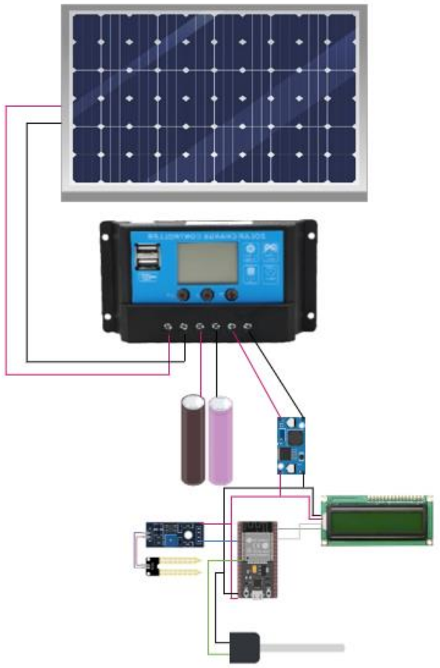
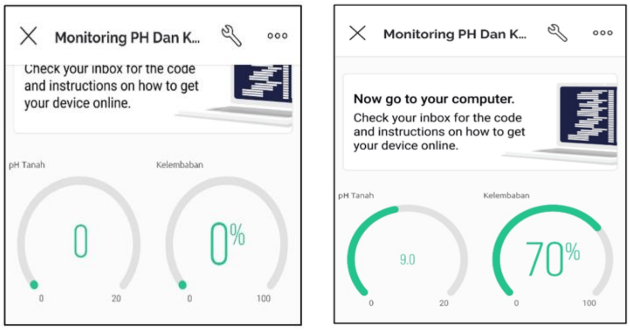


Figure 4. Complete system design powered by solar cell

Figure 5 explains the results of the system design. This monitoring system tool uses a straight iron 1 meter long. At the top end of the iron, there is a solar cell that functions to capture sunlight, then in the middle of the iron there is a block board and a box whose contents consist of several components designed by the system shown in Figure 5.

Figure 5. Assemblied system (a) complete system (b) modules

The design of this software uses an application called Blynk. In the Blynk application, there will be some information on Soil pH and Soil Moisture data. The following is a picture of the software design using the Blynk application below. Figure 6 explains the face-to-face design in the Blynk application entitled "Soil PH and Moisture Monitoring". In the picture, there is also a notification whether the system is connected online or offline. In the application section, if you want to connect the application online, the user must turn on MiFi (Hotspot) on the cellphone and turn on the monitoring system tool. The following is an image to find out the results of the software design below.



(a) (b)

Figure 6. Blynk connected to system (a) before (b) after

At this testing stage it was carried out in a palm oil plantation in the city of Bagansiapiapi, Jalan Pulau Baru, the soil in the plantation was peat soil. This test is carried out in the morning until the evening and is carried out after fertilization. Fertilizing oil palm trees is around 2 weeks using dolomite liquid fertilizer. Testing on oil palm plantations is shown in figure 7.

Figure 7. System tested in the field of palm

A soil pH sensor is a tool to detect acidity and alkalinity in the soil. Soil pH levels for testing range from 1-14 on the pH scale. The soil pH sensor test was carried out using three ways to compare the soil pH scale. Testing of the pH and three-way sensors is shown in figure 8.

Figure 8. System setup in the palm field

Soil and three-way pH sensor tests were carried out around the palm trees to increase accuracy in testing. The following is a test of the soil and three-way pH sensors in table 1 below.

Table 1. Tested results data based on system recorded

No	Time	Field Testing		*Error* (%)
		Soil pH Sensor	*Three-way*	
1	09:15	5,0	6,0	0.16
2	10:12	5,0	5,0	0.00
3	11:10	5,0	6,0	0.16
4	12:15	5,0	5,0	0.00
5	13:07	4,0	5,0	0.20
6	14:10	4,0	5,0	0.20
7	15:25	4,0	4,0	0.00
8	16:12	4,0	4,0	0.00
9	17:25	4,0	4,0	0.00

Testing of the pH sensor was carried out at different times, based on table 1 it is explained that the soil pH sensor test is not much different from the comparison test tool, namely threeway. Refer to table 1, to get the error results, the error calculation is carried out as follows. Soil pH sensor testing at 09:15.

$$Nilai\ error = \left(\frac{Nilai\ pembanding - Nilai\ sensor}{Nilai\ pembanding}\right) x\ 100\%$$

$$= \left(\frac{6{,}0-5{,}0}{6{,}0}\right) x\ 100\% \quad (1)$$

$$= \left(\frac{1}{6{,}0}\right) x\ 100\ \%$$

$$= 0{,}16\ x\ 100\ \%$$

$$= 0{,}16\ \%$$

From the data table 4.1, 9 trials were carried out, the calculation of the average error value for each test is as follows:

$$Nilai\ error\ rata - rata = \frac{jumlah\ nilai\ error}{Banyaknya\ error} \quad (2)$$

$$= \frac{(0{,}16 + 0 + 0{,}16 + 0 + 0{,}2 + 0{,}2 + 0 + 0 + 0)}{9}$$

$$= \frac{0{,}72}{9} = 0.08 = 8\ \%$$

5. CONCLUSION

Based on the results of the research and testing that have been described, it can be concluded that:

1. The design of a monitoring system tool for fertilizing oil palm trees based on soil pH plays an important role in fertilization so it can affect the availability of nutrients in oil palm trees.
2. The use of the IoT can facilitate real-time monitoring of soil pH and soil moisture and provide accurate and fast information to oil palm farmers.

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REFERENCES

[1] M. of T. Directorate of Land Transportation, "Guideline for Railway Transportation System for Crossing in Road Junction," Jakarta, 2015.

[2] D. of L. Transport, "Indonesia Master Plan in Train Transportation," Jakarta, 2018.

[3] N. Chaithra, P. C. Shruthi, V. Rashmi, V. Akhil, and S. S. M. Saqquaf, "An IoT Based Railway Security System for Automated Manning at Level Crossings," in *2018 3rd IEEE International Conference on Recent Trends in Electronics, Information & Communication Technology (RTEICT)*, 2018, pp. 2457–2461, doi: 10.1109/RTEICT42901.2018.9012435.

[4] M. M. Eid and M. I. F. Allah, "Automated Railway Security System," in *2019 6th International Conference on Advanced Control Circuits and Systems (ACCS) & 2019 5th International Conference on New Paradigms in Electronics & information Technology (PEIT)*, 2019, pp. 54–64, doi: 10.1109/ACCS-PEIT48329.2019.9062886.

[5] M. S. Hossain, M. J. Al-Hossain, and S. H. Alam, "Automated Railway Track Changing Model with Real-Time Centralized Monitoring Interface," in *2019 IEEE International Conference on Robotics, Automation, Artificial-intelligence and Internet-of-Things (RAAICON)*, 2019, pp. 52–55, doi: 10.1109/RAAICON48939.2019.24.

[6] B. P. P. Varna, D. Bhaskar, A. H.M., and V. K. Agrawal, "Solution to Unmanned Railway Crossing Using Satellite and GPS Based Approach," in *2018 4th International Conference for Convergence in Technology (I2CT)*, 2018, pp. 1–4, doi: 10.1109/I2CT42659.2018.9058149.

[7] G. Singh, P. Kumar, R. K. Mishra, S. Sharma, and K. Singh, "Security System for Railway Crossings using Machine Learning," in *2020 2nd International Conference on Advances in Computing, Communication Control and Networking (ICACCCN)*, 2020, pp. 135–139, doi: 10.1109/ICACCCN51052.2020.9362976.

[8] M. Kyriakidis, S. Simanjuntak, S. Singh, and A. Majumdar, "The indirect costs assessment of railway incidents and their relationship to human error - The case of Signals Passed at Danger," *J. Rail Transp. Plan. Manag.*, vol. 9, pp. 34–45, 2019, doi: https://doi.org/10.1016/j.jrtpm.2019.01.001.

[9] O. F. Abioye *et al.*, "Accident and hazard prediction models for highway–rail grade crossings: a state-of-the-practice review for the USA," *Railw. Eng. Sci.*, vol. 28, no. 3, pp. 251–274, 2020, doi: 10.1007/s40534-020-00215-w.

[10] K. B. Q. Chowdhury, M. R. Khan, and M. A. Razzak, "Automation of Rail Gate Control with Obstacle Detection and Real Time Tracking in the Development of Bangladesh Railway," in *2020 IEEE 8th R10 Humanitarian Technology Conference (R10-HTC)*, 2020, pp. 1–6, doi: 10.1109/R10-HTC49770.2020.9356986.

[11] A. Blagojević, S. Kasalica, Ž. Stević, G. Tričković, and V. Pavelkić, "Evaluation of Safety Degree at Railway Crossings in Order to Achieve Sustainable Traffic Management: A Novel Integrated Fuzzy MCDM Model," *Sustainability*, vol. 13, no. 2. 2021, doi: 10.3390/su13020832.

[12] K. Wang and Z. Wang, "Robustness Verification of Railway Level Crossing Control System by Formal Method," in *2018 12th International Conference on Reliability, Maintainability, and Safety (ICRMS)*, 2018, pp. 230–233, doi: 10.1109/ICRMS.2018.00050.

[13] G. Caimi, L. Kroon, and C. Liebchen, "Models for railway timetable optimization: Applicability and applications in practice," *J. Rail Transp. Plan. Manag.*, vol. 6, no. 4, pp. 285–312, 2017, doi: https://doi.org/10.1016/j.jrtpm.2016.11.002.

[14] E. Krmac and B. Djordjević, "An evaluation of train control information systems for sustainable railway using the analytic hierarchy process (AHP) model," *Eur. Transp. Res. Rev.*, vol. 9, no. 3, p. 35, 2017, doi: 10.1007/s12544-017-0253-9.

[15] A. Rehman, S. Latif, and N. A. Zafar, "Automata Based Railway Gate Control System at Level Crossing," in *2019 International Conference on Communication Technologies (ComTech)*, 2019, pp. 30–35, doi: 10.1109/COMTECH.2019.8737833.

[16] R. Dunbar, C. Roberts, and N. Zhao, "A tool for the rapid selection of a railway signalling strategy to implement train control optimisation for energy saving," *J. Rail Transp. Plan. Manag.*, vol. 7, no. 4, pp. 224–244, 2017, doi: https://doi.org/10.1016/j.jrtpm.2017.09.002.

[17] E. A. Kadir, H. Irie, and S. L. Rosa, "Intelligent system in container terminal for speed-up handling process," in *ACM International Conference Proceeding Series*, 2018, doi: 10.1145/3233740.3233743.

[18] L. N. Pattanaik and G. Yadav, "Decision Support Model for Automated Railway Level Crossing System Using Fuzzy Logic Control," *Procedia Comput. Sci.*, vol. 48, pp. 73–76, 2015, doi: https://doi.org/10.1016/j.procs.2015.04.152.

[19] E. Abdul Kadir, S. M. Shamsuddin, D. Karya, and S. L. Rosa, "New Algorithm for Fast Processing RFID System in Container Terminal," *Int. J. Electr. Comput. Eng.*, 2016, doi: 10.11591/ijece.v6i1.pp283-291.