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Prototype IOT-based Soil PH Measurement Tool with Esp8266 at UPT Palawija Tanjung Selamat

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ABSTRACT

The goal of this research is to build and create a prototype tool capable of monitoring soil pH automatically by employing Internet of Things (IoT) technology using NodeMCU ESP8266 at UPT Palawija Tanjung Selamat. The challenge is in the limited time and effort required for manual soil pH measurement, which can impede the process of routinely checking soil quality. The technique uses a pH sensor coupled with a NodeMCU ESP8266 to wirelessly send data to an Internet of Things platform. The instrument will be built to be able to provide data in real time to the monitoring system and measure the pH of the soil on a regular basis. To guarantee the precision of the test results in this instance, the pH sensor will be meticulously calibrated. The ultimate product of this prototype design is anticipated to be a device that can continuously monitor the pH of soil without requiring direct input from land managers or farmers. It is anticipated that this instrument would offer precise and trustworthy data regarding the degree of soil acidity at the site under remote observation. Therefore, it is anticipated to improve soil management's efficacy and efficiency and allow for prompt remedial action in the event that data collection warrants it.

Keywords
IoT,
Soil Ph,
pH Sensor ,
ESP8266.

1. Introduction

Agriculture is a vital sector in fulfilling food needs and maintaining a country's food security. In an effort to increase agricultural productivity, a deep understanding of soil conditions is something that needs to be considered. One important parameter in determining soil health is soil acidity or pH. Accurate and efficient soil pH measurement is key in designing an optimal agricultural strategy (Yustisiani, 2014).

In this context, technological research and development is a must to advance the agricultural sector (Mutma'inah, 2018). Therefore, this research presents an innovative solution in the form of a prototype of an Internet of Things (IoT)-based soil pH measuring instrument using the Esp8266 module (Liandana et al., 2019). This research is focused on the Tanjung Selamat Palawija Technical Implementation Unit (UPT) as the implementation and testing location for this tool.

Research on IoT-based soil pH measuring devices has been widely developed (Gregoryan et al., n.d.). Among them are related to factors that can affect soil pH (Ramli & Herawati, 2019); (Widiasmadi, 2020); (Pramartaningthyas et al., 2022), soil quality (Wardah et al., 2019);(Khosin et al., 2022)Soil moisture is measured through several tools that utilize are based on the Internet of

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Things (IoT). The Internet of Things (IoT) can be well developed with some modifications(Noor et al., 2019); (Sanjaya et al., 2020).

In this study, researchers designed a prototype IoT-based soil pH measuring instrument, expected to make a significant contribution in monitoring and managing soil conditions in real time. The application of this technology in UPT Palawija Tanjung Selamat is expected to increase efficiency in monitoring soil pH, provide timely information to farmers, and support smarter decision making in agricultural land management. Through this research, it is expected to make a positive contribution to the development of agricultural technology in Indonesia, especially in the context of measuring soil pH automatically and connected to the IoT network (Mahmudin et al., 2020). Thus, the implementation of this prototype tool at UPT Palawija Tanjung Selamat is expected to be the foundation for the development of similar technology in supporting sustainable and efficient agriculture. The solution is t o place sensors in the cultivation field to measure soil efficiency with IoT technology using NodeMCU ESP8266.

In this research it is explained how the sensing data will be processed and stored in the cloud and from the cloud the data will be forwarded to the person in charge of the registered UPT Palawija Tanjung Selamat through their pH one or device in a form that the user can understand. Also if the soil pH level is low the app suggests pesticides to be used to improve cultivation. This will greatly help farmers who are far from the land, and improve crop cultivation (Syafiqoh & Yudhana, 2018).

2. Research Methods

In the research method phase, this activity includes several steps. including direct observation and sampling of agricultural land in UPT Palawija Tanjung Selamat including system design and sample testing. At this stage, the author will compile a system block diagram, system flowchart, and design a series of tools that will be used to build a monitoring system. The block diagram of the Internet of Things (IoT)-based soil pH and moisture monitoring system (Noor et al., 2019) can be found in the figure illustrating the block diagram.

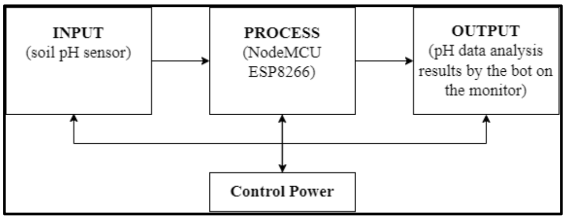

Figure 1. Block Diagram

In the illustration presented in Figure 1, the NodeMCU ESP8266 acts as the core of the system, coordinating all system operations and getting power from the mains. The soil pH sensor and YL- 69 soil moisture sensor act as input data providers, which are then sent to the Arduino Uno. Arduino Uno functions as a container to store data from the two sensors and display the information directly using a 16x2 LCD. The data received by the Arduino Uno is then sent to the NodeMCU ESP8266 to be analyzed. Furthermore, the results of this data processing are displayed on the Telegram application through the help of pre-programmed bots.

Figure 2 shows that the monitoring system operates in accordance with the design. The NodeMCU ESP8266 will operate according to the pre-entered program, instructing all connected devices according to the commands from the NodeMCU ESP8266. Initially, the NodeMCU ESP8266 will send a command to the Arduino Uno to request data from two sensors. After getting the pH and soil moisture data, the values will be displayed on the 16x2 LCD. The data from the two sensors are then sent back to the NodeMCU ESP8266 and displayed in the Telegram application through the help of Telegram bots, which will respond to the appropriate commands from the user.

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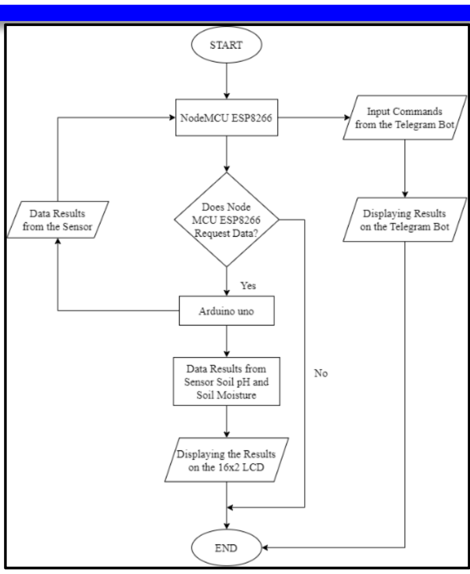


Figure 2. System Flow Chart

3. Results and Discussion

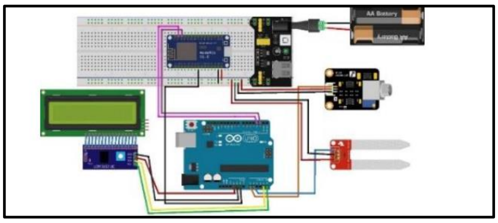
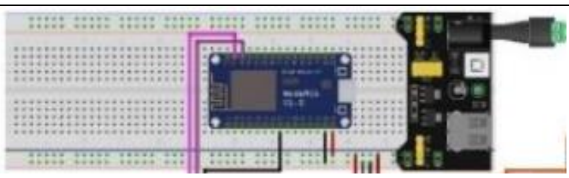
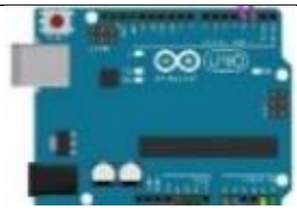


Figure 3. System Framework Design

Below is a table explaining the components contained in the monitoring system above which are interconnected to make the system run as planned.

Table 1. System Framework Components

Component	Description
	NodeMCU ESP8266 Serves as the brain of the system that drives the entire system and gets power from the power supply.
	Arduino UNO is used as a place to accommodate data from the two sensors and directly display it on the 16x2 LCD.
	16x2 LCD used to display pH and soil moisture data

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	Telegram bots are used to display pH data, soil moisture sensors, fertilizer/sulfur recommendations, and water application rates sent by the NodeMCU ESP8266 device through the application telegram.
	The soil pH sensor is used to capture soil pH data
	A soil moisture sensor (YL-69) is used to retrieve soil moisture data.
	AA batteries are used to obtain power for the system to function

Below is a table that will show the connector pins that are connected to each other in the monitoring system, which can make this system run well.

Table 2. Connected Pin Framework

Pin	Connect
ESP8266 GND pin	Breadboard GND
Vin ESP8266 Pin	Positive Breadboard
ESP8266 GND pin	Arduino Uno GND
ESP8266 Pin D1 (RX)	Arduino Uno Pin 3 (TX)
ESP8266 Pin D2 (TX)	Arduino Uno Pin 2 (RX)
5V Arduino Uno Pin	Positive Breadboard
GND Sensor Ph Pin	Breadboard GND
Output Sensor Ph Pin	A0 Arduino Uno Pin
GND Sensor YL-69 Pin	Breadboard GND
VCC Sensor YL-69 Pin	Positive Breadboard
A0 Sensor YL-69 Pin	A1 Arduino Uno Pin
GND I2C LCD Pin	Arduino Uno GND Pin
VCC I2C LCD Pin	5V Arduino Uno Pin
SDA I2C LCD Pin	A4 Arduino Uno Pin
Positive Breadboard Pins Power Supply	Positive Breadboard
Negative Breadboard Pins Power Supply	Breadboard GND

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The next stage is system implementation which involves designing the hardware and software for the previously planned monitoring system. This implementation process consists of several steps that include: Installation Hardware:

1. Hardware Design:

At this stage, the prepared hardware is assembled into a single unit to form a monitoring system. This step includes customizing and setting up the hardware to function optimally.

2. Software Design:

In the software design phase, coding is done to enable control of the entire device and integration of the device with the Telegram application. Arduino IDE is used as a platform for creating, editing, and uploading code so that the system can run as needed (Mualfah et al., 2023).

3. System Experimentation:

In this phase, the authors conducted experiments on the system with the aim of evaluating whether all components were operating in accordance with the researcher's wishes. The trial started by testing

sensor performance, which involved monitoring five soil samples spread across different areas in the Tanjung Selamat Palawija UPT. Furthermore, the bot performance evaluation was conducted with a focus on its ability to display values from the soil pH and moisture sensors, provide fertilizer/sulfur recommendations, and determine water application rates. All data was sent through the NodeMCU ESP8266 device (Sanjaya et al., 2020). These steps are expected to ensure that the developed monitoring system functions according to the specifications set in the initial design.

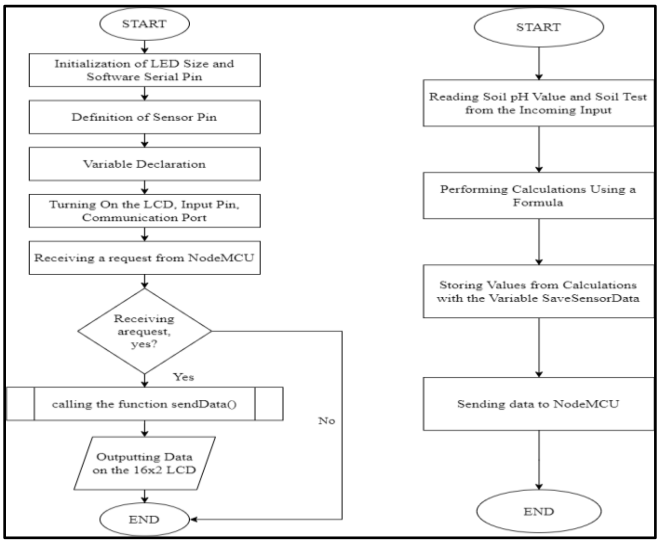

Figure 4. Arduino Uno program flowchart

Based on the design in Figure 4, the program flow on the Arduino, it is found that initialization involves determining the size of the LCD and the serial software pin which will be the serial communication line. The next step is to define the pins that will be used for the pH and soil moisture sensors, and declare the variables that will be applied in the system. In the set-up stage, configuration is done to activate the LCD, set the input pins, and set the communication port. When Arduino receives a request from NodeMCU ESP8266 by receiving the keyword "OK", the next process is to call the send data function. This function contains the results of sensor readings and sensor value calculations presented in graphical form. After that, the data is sent to the NodeMCU ESP8266 via serial communication through a predetermined port, and the results are displayed on the LCD. The NodeMCU ESP8266 Program Flow shows that.

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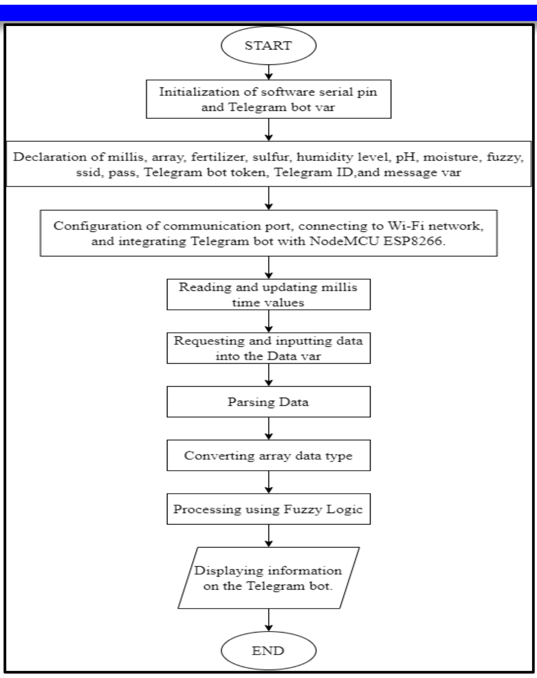

Figure 5. Program Flow on ESP8266

In the flow of the picture above, initially, the serial software pin is initialized which functions as a serial communication line and Telegram bot. Then, various variables such as millis, array, fertilizer, sulfur, humidity level, PH, Moisture, Fuzzy, ssid, pass, Telegram bot token, Telegram id, and messages used in the program are declared. After that, millis time reading and updating is done to prevent automatic reset of the NodeMCU ESP8266. The use of millis takes precedence over delay so that other programs continue to run without stopping. The NodeMCU ESP8266 requests data from the Arduino Uno by sending the word "yes" and the results are stored in the 'Data' variable. The data is then parsed because it is still combined and separated by the "#" sign to then change the data type to float and int so that it can be processed using fuzzy logic. The results of the data processing are displayed on the Telegram bot, including pH measurement values, humidity, fertilizer/sulfur recommendations, and water application rates. All information can be accessed by sending a "check" command to the Telegram bot.

4. Conclusion

This journal article discusses the prototype of an Internet of Things (IoT)-based soil pH measuring instrument using NodeMCU ESP8266 at UPT Palawija Tanjung Selamat. This research aims to build a tool that is able to monitor soil pH automatically and send real-time data to the monitoring system. This prototype uses a carefully calibrated soil pH sensor and NodeMCU ESP8266 to send data to the IoT platform. In addition, this journal also describes the program flow on the Arduino and NodeMCU ESP8266 used in the system. The test results show that the system is capable of sending sensor data via serial communication and displaying it on the LCD screen. Thus, this journal provides an overview of the implementation of an IoT-based agricultural monitoring system and the results of tests conducted on the system.

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