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Design of a Soil Nutrient Measuring Device for NPK (Nitrogen, Phosphorus, Potassium) Case Study of Cayenne Pepper Based on Arduino Nano V3 ATmega328P

1st Agil Soni Arafat
Teknik Elektro
Universitas Muhammadiyah Tasikmalaya
Tasikmalaya
agilsoniarafat7@gmail.com

2nd Ari Yuliati
Teknik Elektro
Universitas Muhammadiyah Tasikmalaya
Tasikmalaya
aryuli@umtas.ac.id

3rd R. Yovi Manova M.
Teknik Elektro
Universitas Muhammadiyah Tasikmalaya
Tasikmalaya

Abstract—Fertile soil electronic soil is essential for plant growth, and its quality significantly impacts crop yields. To help farmers measure the nutrient content of their soil more easily and accurately, innovative technology is required. In this case study, we present the design of a soil nutrient measuring device for Nitrogen, Phosphorus, and Potassium (NPK) that focuses on cayenne pepper. The device uses NPK sensors that can detect soil nutrients when inserted into the ground. The data collected by the sensors is sent to an ARDUINO Nano V3 ATMEGA328P, where it is processed and displayed as analog signals on a screen. The device can be customized according to the user's testing or cultivationneeds, making it a useful tool for optimizing plant growth and crop yields.

Keywords—Arduino Nano V3 Atmega328P, sensor, NPK

I. INTRODUCTION

Indonesia as an agricultural country is the main source of livelihood for the Indonesian population (Roidah, 2013). One of the leading crops from the agricultural sector is cayenne pepper (Capsicum frutescens L.). National chili production in 2009 was 1,378,727 tons with a productivity of 5.89 tons per ha (Central Statistics Agency, 2011). Reporting from the Market and Basic Needs Monitoring System (SP2KP) page of the Ministry of Trade, one of the commodity prices for cayenne pepper has experienced fluctuations. The quantity and quality of agricultural products is a reflection of the condition of the soil (Christensen, 2001)[14]. Plants decline when there are insufficient levels of nutrient supply. Providing the right type of fertilizer and amount depends on the nutrient content available in the soil. The NPK element is an essential macro nutrient for chilies, which functions in the metabolic and biochemical processes of plant cells (Havlin et al., 2005)[6] and is significant in plant development and is needed in large quantities. The innovation was carried out by designing a tool that can see and measure the amount of NPK nutrient content according to testing or cultivation needs.

II. RELATED WORKS

Manuscript Research discussed in this article includes: The NPK nutrient status map takes the availability of NPK elements in the soil, in low, medium, high conditions. Because it is used as a basis for determining the type and dose of fertilizer. If the NPK nutrient status and soil pH are known, then choose the type and dose of fertilizer. So it can increase efficiency and reduce losses due to fertilization. (Buana Sains Vol 18 No 2: 109–124, 2018)[7]. How to make a tool to detect the amount and display the nutrient content of N, P and K in the soil

Referring to the problems and research questions, this research aims to create an NPK soil nutrient measuring device based on the Arduino Nano V3 ATMEGA328P. Validation and Reliability Test of the NPK soil nutrient measuring tool in the cultivation trial room.

A. Cayenne Pepper (Capsicum Frutescens L.)

Cayenne pepper is a type of vegetable that is cultivated commercially in tropical countries. It is recorded that various chili species have been domesticated, but only Capsicum annum L. and C. frutescens L. have economic potential (Sulandari, 2004)[8]. Cayenne pepper (Capsicum frutescens L.) is a type of horticultural vegetable that has small fruit with a spicy taste.

B. NPK Nutrients

NPK Nutrients are a type of compound fertilizer that contains more than one nutrient to increase soil fertility. The NPK nutrient is an essential macro nutrient for plants, namely the metabolic and biochemical processes of plant cells[6]. Nitrogen is a builder of nucleic acids, proteins, bioenzymes and chlorophyll (Marschner, 1986)[9]. Phosphorus as a builder of nucleic acids, phospholipids, bioenzymes, proteins, metabolic compounds, and part of ATP is important in energy transfer (Uchida, 2000)[13]. Potassium regulates the balance of ions in cells, which functions in the regulation of various metabolic mechanisms[6]. Generally, cultivated chilies obtain NPK nutrients from inorganic fertilizers and organic fertilizers. Excessive use of inorganic fertilizers can damage the physical, biological and chemical properties of the soil. Analysis of soil nutrient content greatly influences the nutrient recommendations that will be provided (Amisnaipa et al.)[10].

C. Arduino Nano

Microcontroller Atmega 168/Atmega 328 is popular for its small size and practicality, open source, both hardware and software. The main component of Arduino is an 8 bit microcontroller, Atmega brand, Atmel Corporation. (Rimbawati, et al., 2019)[11]. Arduino Nano was created on the basis of an ATmega328.

D. RS485 Sensor

Sensor to detect NPK content in soil and determine soil fertility. The sensor uses the RS485 communication protocol, allowing data to be sent over quite long distances at high speed.

The stainless steel probe of the soil NPK sensor can be buried in the soil for a long time and is resistant to long-term electrolysis, salt and alkali corrosion, applied to detect alkaline soil, acid soil, substrate soil, nursery soil & coconut bran soil (Pratama et al, 2021)[12].

E. RS485 Module

The RS485 module is a serial data communication technique for communication between one unit and another at a distance of 1.2 km, to connect 32 load units at once using only two cables without requiring the same ground reference between one unit and another. Loads connected to the network are computers, microcontrollers and other equipment (Vitria, 2008). LCD (Liquid Crystal Display 20x4) display device replaces the function of a CRT (Cathode Ray Tube) display.

III. METHOD

The chapter of method/material research discusses system design, divided into two parts, namely hardware design and software design.

A. System Planning

In system design, arduino and sensors are seen in figure III.1.

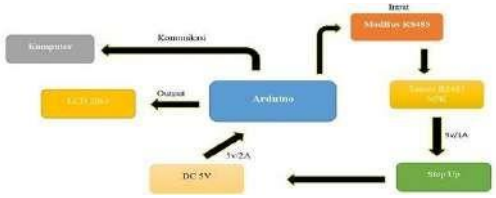

Figure III.1. System Planning

a) The RS485NPK sensor functions as a detector for the amount of NPK nutrients.

b) LCD is used to display readings from sensors that have detected the NPK nutrient content of the soil.

B. Hardware Design

In hardware design are seen in figure III.2. The design configuration are shown in the table 1,2, and 3 below.

Table 1. ModBus Hardware Pin Configuration

Modbus	Arduino	Modbus	RS485NPK
DI	D3	GND	Hitam
DE	D7	A	Kuning
RE	D8	B	Biru
RD	D2	VCC	5V

Table 2. RS485 Sensor Hardware Pin Configuration

RS485NPK	Modbus
Hitam	GND
Kuning	A
Biru	B
Cokelat	9V

Table 3. 20x4 LCD Hardware Pin Configuration

LCD	Arduino
GND	GND
VCC	5V
SDA	A4
SCL	A5

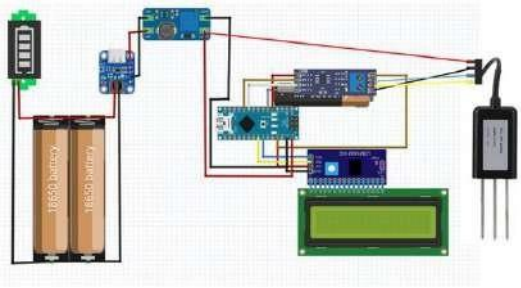

Figure III.2. Hardware Prototype

C. Software Design

In making the software, the NPK soil nutrient measuring tool, it was carried out in accordance with the design that had been made from the start. The software creation flowchart is shown in the following figure, III.3.

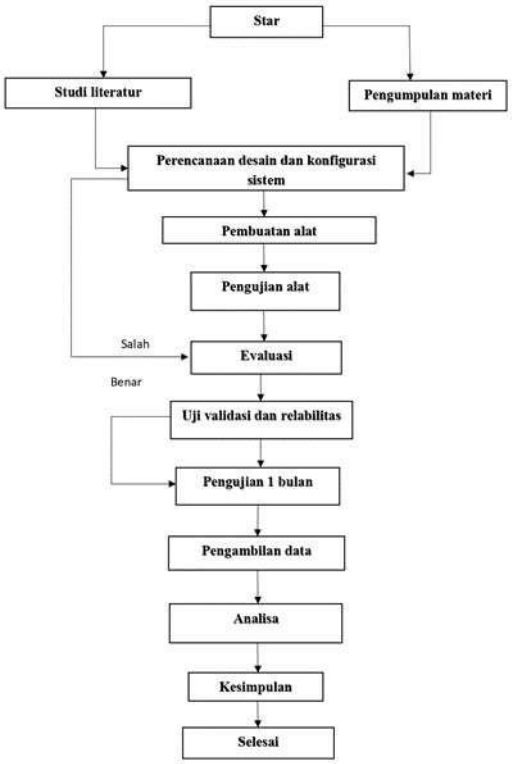

Figure III.3. Flowchart Design

IV. RESULT AND DISCUSSION

A. Tool Prototype

The research tool prototype was made with the measurement results in the figure IV.1. below, namely.

Figure IV.1. Prototype of tool measurement results

B. Testing of NPK Soil Nutrient Measuring Tools

Testing the NPK soil nutrient measuring tool includes reading Nitrogen, Phosphorus and Potassium (NPK) fertilizer in the soil so that the level or content of the soil will show the value of the NPK nutrient in the soil. The time span that is read when the tool is plugged into dry, wet or medium ground is 5 seconds. The reading value will appear N, P and K.

Meanwhile, the maximum value read by the tool itself is 255 for either Nitrogen, Phosphorus or Potassium. The reading unit on the tool is mg/kg or also known as ppm.

C. Equipment Testing for Fertilizer Application

In soil testing with the addition of pearl fertilizer, an NPK ratio of 16-16-16 was used with a dose of 2 grams on dry soil, 3 grams on medium soil, and 4 grams on wet soil. Soil tests showed different results, dry soil measurements showed an N value of 31 mg/kg, P of 0 mg/kg, and K of 39 mg/kg. Meanwhile, medium soil displays N values of 71 mg/kg, P of 14 mg/kg, and K of 79 mg/kg. For wet soil, when 4 grams of pearl NPK fertilizer was applied, the N value was 183 mg/kg, P was 62 mg/kg, and K was 190 mg/kg.

V. CONCLUSION

Research on the design of an NPK soil nutrient measuring tool, a case study of cayenne pepper plants based on Arduino v3 ATMEGA 328P using the Arduino Nano V3 Atmega328P microcontroller, RS 485 NPK sensor, RS485 to TTL Max485 conversion module, and LCD 20x4. The NPK measurement parameter has units of ppm or mg/kg. Data retrieval on the tool must be stable, which requires development towards application or website-based IoT, so that it is more stable, the programming design and configuration is more accurate, and there is precision in the final calculations.

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