Development of Prototype Smart Control Systems to Support IoT and LoRA-Based Smart Farming in Smart Agriculture Applications

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Abstract— **Indonesia is an agrarian country; it can be seen from the extent of agricultural land in Indonesia, which has enormous potential. However, managing such an area of land is not optimal if farmers only work on it. The quality of agricultural products depends on the experience and instincts of farmers in understanding the land conditions and crops. Of course, these results are less when compared with the calculated calculations. We are here to help farmers manage their agricultural land from these problems. Iotanic offers products in the form of IoT devices that can monitor and automate agricultural land. With the precision farming method, the monitoring data will be precise, and the execution of agricultural management will become more precise and automated thanks to the resulting data. The manufacture of the product starts by analyzing the device's needs to be produced. These needs are in the form of hardware development needs in the form of IoT devices and software development in the form of applications. This analysis develops the device into a prototype product ready to be tested. These activities will produce IoT products and software to help farmers manage their agricultural land. To be able to produce these devices, production costs and the value of products/services are required funds amounting to 24,998,200.00**

Keywords—IoT, LoRA, Agricultural, Farmers

I. INTRODUCTION

Indonesia is an agricultural country that has excellent power in agriculture. According to data from the Ministry of Agriculture of the Republic of Indonesia (2019), there were 29.3 million hectares of non-rice field agricultural land and 7.4 million hectares of rice fields. The Central Statistics Agency (BPS) recorded the number of farmers as of 2019 reaching 33.4 million. With its enormous strength, the agricultural sector is one of the main economic drivers of Indonesia. The economy in agriculture can continue to grow and develop due to the growing need for human food.. Agricultural Land Area Development (Agricultural Data Center and Information System - Ministry of Agriculture 2020)

The potential of agricultural land area to increase the productivity of agricultural products is a complex strategy to implement in Indonesia; this is because the land conversion that has occurred until now continues. BPS noted that the area of raw paddy fields experienced an increase in the conversion of paddy agricultural land into residential and industrial land. In 2017, the land area, which was initially 7.75 million hectares, became 7.1 million hectares in 2018.

In working on agricultural land, it is necessary to control agricultural needs, such as irrigation, the addition of fertilizers, soil nutrients, temperature, humidity, and soil and water PH. Farmers' limitations in controlling extensive agricultural conditions make agricultural maintenance difficult [1] [2]. Often farmers go back and forth from home to the fields to open and close irrigation canals and do watering one by one traditionally, thereby reducing the effectiveness of farmers. Control of soil nutrients, temperature, humidity, pH, and water must also be carried out individually with different tools [3] [4] [5]. In general, farmers visit their lands to see the moisture or condition of the soil periodically and irrigate agricultural land according to the farmer's perspective. Most agriculture in Indonesia still uses traditional methods for monitoring and controlling. The traditional method results are less than optimal because the activities are carried out manually. Human error can still occur when using traditional techniques.

From these problems, the author sparked the idea of a tool and application to control agricultural land and suggested treatment and automatic irrigation. An IoT (Internet of Things) and LoRA-based Smart Control Systems in Artificial Intelligence-Powered Smart Agriculture Applications. The potential that can be explored is using Internet of Things technology as automation in agriculture. IoT technology can automate monitoring and controlling activities so that plants are well maintained and maintained to produce optimal products.

II. RESEARCH METHODS

The research methods carried out successively are literature study, system design, and system testing based on quantitative analysis. The design of this system consists of system block diagrams, system flow diagrams, and system circuits.

A. Block Diagram

The block diagram of the system is an overview of the whole so that the block diagram can produce a system that can work and function as desired. This system has a block diagram shown in Fig. 1.

IoTanic is a Smart Agriculture technology that applies Smart Control Systems based on IoT (Internet of Things) and LoRa to create effectiveness and efficiency and improve the quality of agricultural products. This technology can help farmers improve agricultural products' quality by providing agricultural land information such as; NPK, air humidity, wind direction, soil PH, and water PH [6] [7] [8].

IoTanic is a product of agricultural technology that monitors agricultural land. In Indonesia, there are already agricultural applications such as CI Agriculture, which collects data from agricultural land and then processes it into information for farmers. However, the technology is still limited to monitoring only. IoTanic offers automation features to manage farmland. This feature is the first technological product innovation in agriculture that implements monitoring and automation of agricultural land. Requirements in product development in table I and Software Requirements in table II

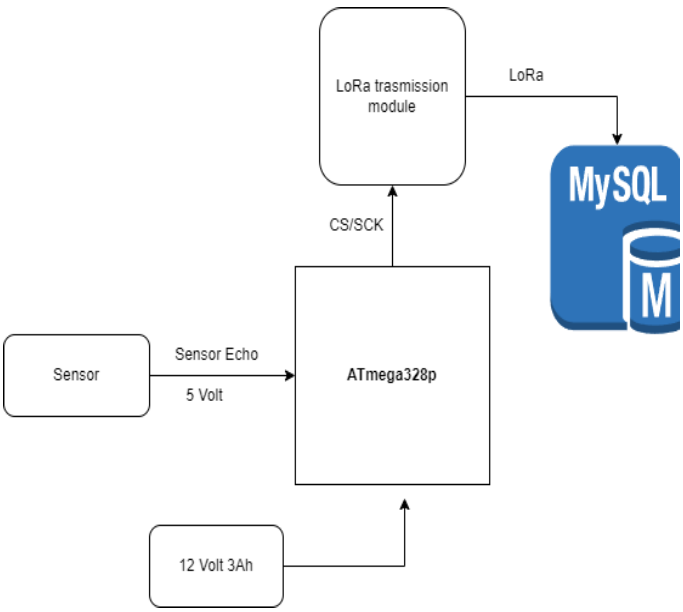

Fig. 1. Block diagram system

TABLE I. HARDWARE REQUIREMENTS

Hardware Requirements	
1	Laptop 8GB RAM, 512GB SSD
2	ATmega328p SMD
3	LoRa. Antenna
4	Dragino LoRa Gateway
5	Sensor
6	VPS Server

Circuit diagram between end device and agricultural land monitoring sensor Figure 3

The sensor used in measurement RS485 Soil NPK Sensor nitrogen phosphorus Potassium tester 3 in 1 soil nutrient detector. This study uses NPK, PH, Humidity and Conductivity senors to determine current soil conditions. It can be buried in the soil for a long time, resistant to long-term electrolysis, corrosion resistance, vacuum potting, and completely waterproof. Sensor datasheet table. III. The circuit diagram of the end device PCB measuring 4x2.5 cm, the device that will be spread on the agricultural land is custom-made and assembled by yourself Fig. 2.

TABLE II. HARDWARE REQUIREMENTS

Hardware Requirements	
1	Arduino IDE
2	Visual Studio Code
3	MongoDB
4	NodeJs
5	ReactNative
6	Web Browser

TABLE III. SENSOR DATASHEET

Information	Value
Power supply	5-30VDC
Maximum power consumption	≤0.15W
Operating temperature	-40~80℃
NPK parameters	
Range	1-1999 mg/kg(mg/L)
Resolution	1 mg/kg(mg/L)
Precision	±2%FS
Response time	≤1S
Protection grade	IP68
Probe material	316 stainless steel
Dimensions	45*15*123mm
Output signal	RS485

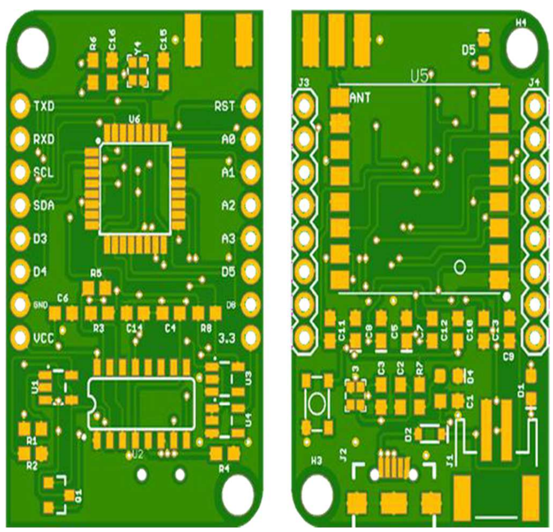

Fig. 2. Circuit diagram PCB

III. RESULT AND CONCLUSION

From the results of this study the parameters measured were NPK, PH, Humidity and Conductivity from the measurement results the data stored in the database server. Data collection was carried out at the location of Mojolaban Sukoharjo District. Measurements produce data on the table. IV. The unit information of each measurement is as follows

NPK = mg/kg

EC/conductivity = us/cm

PH = pH

Moisture = %Rh

TABLE IV. MEASUREMENT RESULTS OF NPK, PH, MOISTURE, CONDUCTIVITY

N	P	K	PH	Moisture	EC
29	91	115	5.06	95.8	1500
29	95	115	5.06	95.8	1500
28	99	116	6.00	95.8	1500
29	98	115	5.07	95.8	1500
30	98	116	5.50	95.8	1500
31	98	115	5.50	95.8	1500
30	97	115	5.50	95.8	1500
32	97	116	5.07	95.8	1500
30	96	118	5.07	95.8	1500
29	98	118	5.07	95.8	1500
31	99	118	5.07	95.8	1499
28	99	118	5.06	95.8	1499
26	100	116	5.07	95.8	1499
30	101	115	5.07	95.8	1499
24	101	115	5.08	95.8	1499
29	101	115	5.09	95.8	1499
29	100	115	5.06	95.8	1499
29	101	116	5.06	95.8	1499
30	104	116	5.06	95.8	1499
31	118	117	5.06	95.8	1500
31	115	117	5.50	95.8	1500
32	110	115	5.50	95.8	1500
32	105	119	5.09	95.8	1500
31	106	118	5.09	95.8	1500
31	109	116	5.10	95.8	1500
29	108	119	5.10	95.8	1500
29	108	119	5.10	95.8	1500
28	108	119	5.20	95.3	1500
27	108	118	5.25	95.3	1500
26	108	117	5.26	95.3	1500
28	108	113	5.26	95.3	1500
29	108	113	5.27	95.3	1500
30	108	113	5.27	95.3	1500
31	105	110	5.28	95.3	1500
32	106	110	5.45	95.3	1500
30	106	115	5.45	95.3	1500
30	106	115	5.50	95.3	1500
31	106	115	5.50	95.3	1500
31	111	118	5.51	95.3	1500
32	111	118	5.51	95.3	1500
30	105	117	5.51	95.5	1500
31	105	117	5.51	95.5	1500
30	105	117	5.50	95.5	1500
30	110	115	5.50	95.5	1500
31	110	115	5.50	95.5	1500
31	110	115	5.09	95.5	1500
31	108	115	5.09	95.5	1500
30	108	115	5.09	95.5	1500
30	108	115	5.50	95.5	1500
28	107	115	5.50	95.5	1500

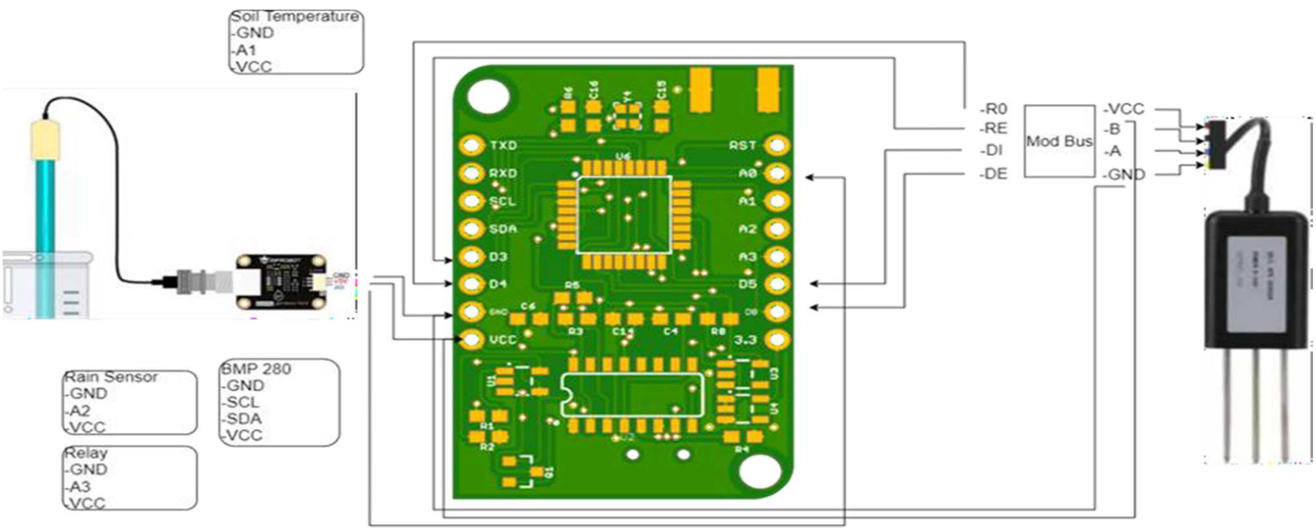

Fig. 3. Circuit diagram device

From the results of tool testing, the tool can measure the elements of NPK, PH, Moisture, and conductivity correctly and accurately. When measuring data directly connected to the data storage server.

The results of testing the battery life used are shown in the table. V in this tool uses a 12 volt 3Ah battery

From the results of battery life measurements, the tool can be lit for about 15 hours using battery power. The minimum voltage limitation of the tool is 10 volts.

To display measurement data to device users, an android application is available that can be installed on mobile devices. The appearance of the application in Fig. 4, 5. The hardware produced in this study is packaged in a box and is easy to use for measurement show in Fig. 6.

TABLE V. BATTERY LIFE TEST

Time	Voltage
03.31 WIB	12.2v
08.54 WIB	11.5v
11.03 WIB	11.4v
12.41 WIB	11.2v
15.33 WIB	11.1v
16.28 WIB	11.0v
18.12 WIB	11.0v
18.42 WIB	10.9v

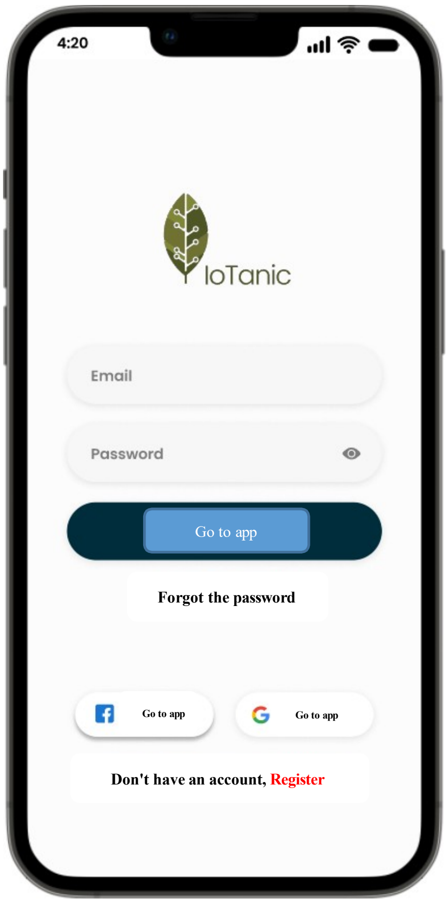

Fig. 4. the appearance of the application

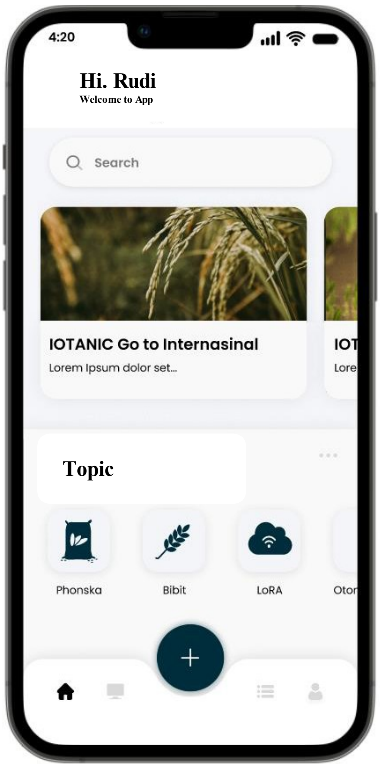

Fig. 5. The main dashboard display for measuring soil nutrient content

Fig. 6. Produced hardware

From the test results of measurements and battery life, the device that has been made is ready to be applied to support better agriculture.

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