DETECTION TOOL FOR UNDERGROUND CABLE LINES AND CONNECTIONS IN DISTRIBUTION SYSTEMS BASED ON RADIO FREQUENCY IDENTIFICATION (RFID)

Lindu Adji Ramadhani*, Rifdian I.S, Setyo Hariyadi S.P

Politeknik Penerbangan Surabaya, Jalan Jemur Andayani I No 73, Kota Surabaya, 60236
**Corresponding Author. Email:* linduadjiramadani@gmail.com

Abstract

Medium Voltage Cable Channels is one construction used by airports in distributing medium voltage electricity. The ground cable connection is a point that often experiences interference. In the use of this construction, Electical Technician has a major problem, including the absence of an medium voltage cable channels lane map. So that need a long time in the process of finding connections that experience interference. The unresolved problems have caused efficiency and optimization of handling disturbances in networks with low medium voltage cable channels construction. This Final Project aims to provide innovation for PLN in resolving these problems using the Radio Frequency Identification (RFID) system. In its application, this tool can be combined with equipment that has been used in the search process for the location of the connection that has a disturbance, namely the Reflectometer and Amplifier. This system utilizes electromagnetic waves produced by RFID Reader that will be received by RFID tags that are buried in the ground. In its application, This tool is capable of reading distances with a maximum depth of 30 centimeters in the ground.

Keywords: SKTM, XLPE, RFID system, ground cable jointing, cable jointing

INTRODUCTION

Airports have various considerations in choosing the type of construction on the distribution network. Generally, airports choose to use SKTM as a construction model. In SKTM, the cable construction is buried under the ground at a certain depth and protected against outside mechanical influences. The type of insulation used in this cable is XLPE (Cross-Linked Poly Ethylene). Using this type of channel will reduce Obsacle in the airport area, especially the airside area, as disturbances due to friction between trees and cables, being hit by trees, kites, and so on, can be minimized. The view of the airport becomes more beautiful without the existence of support poles and also low-voltage cables that are not arranged on the side of the road.

The interference that usually occurs in the distribution system is located at the connection point of two cables connected with the "XLPE insulated ground cable jointing" technique. The jointing approach combines two cables with a particular material that has the same function as the cable material. This technique is used to restore the construction of the ground cable as before. This is important to maintain the durability of the cable.

Although the material used has the same function as the ground cable layer, the possibility of breakdown voltage still exists. Because the quality of the jointing decreases over time due to low insulation resistance, it can cause interference caused by heat loss and corona effects around the cable jointing. Another problem technicians often encounter in using ground cables is that there still needs to be data on ground cable lines. If jointing needs to be handled immediately, technicians need a long time, about 4-7 days, to find the damaged jointing point. In addition, the cable embedded under the ground may be intentionally shifted due to the construction of a project that requires the cable to be shifted. Of course, this is ineffective electricians and area technicians work more to speed up finding points.

From these problems, it is necessary to innovate by installing identity signs suitable for several corners of the ground cable turns and underground cable jointing locations where it is not visible from the ground. Generally, there are two other methods. The first is the coordinate technique methodology, with the help of a compass sensor. However, this method still has the disadvantage of a less precise coordinate point. The second is a combination methodology of electromagnetic and seismic wave emission transmitted through a planted signal transmitter. However, the disadvantage of this transmitter is that there must be an embedded power source, which reduces the tool's effectiveness.

For this reason, this final project discusses the design and actualization of a method of finding ground cable lines and Radio Frequency Identification (RFID)-based jointing points with the advantage of eliminating the need for resources in the tool and providing the right location point to the user. The frequency receiver is on the RFID Tag, planted under the ground. In contrast, the transmitter is located on the RFID detector, which emits electromagnetic waves to the RFID Tag.

METHODS

The working principle of this device is that the 12v battery as a power supply connects the RF ID Reader with a battery whose previous voltage has been reduced to 9v. The voltage output from this battery is 9Vdc which corresponds to the working voltage of the RFID Reader but does not correspond to the working voltage of the microcontroller, which has a working voltage of 9Vdc. Then the battery is connected to a 5v regulator IC which functions as a voltage-reducing device from 9V to 5V, corresponding to the microcontroller's working voltage. Then, the RFID reader as a signal transmitter will produce UHF (Ultra High Frequency) electromagnetic waves of 868MHz - 956 MHz, which the RFID Tag will capture in the ground.

If the RFID Reader is placed at the point where the RFID Tag is embedded, the Tag will use the electromagnetic waves emitted by the RFID Reader to become a source of electric power for the RFID Tag. This electric power receives and provides return signals to the RFID reader. Then, the raw signal received by the RFID Reader is processed by the microcontroller, namely the NodeMCU. NodeMCU will process the data that will produce output as Tag ID appearance on LCD16x2 and Blynk application.

Instrument/tool design

This subchapter will discuss the planning of the tool, which consists of a discussion of hardware and software. Furthermore, this will cover the evaluation and gauging of the financial device with regards to BLDC motors through the use of measuring equipment.

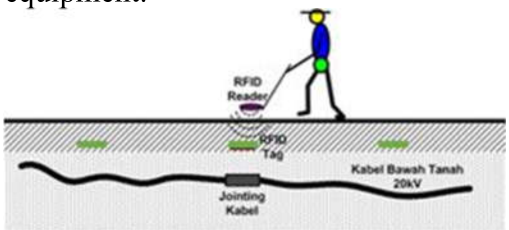

Figure 1 Design of Underground Cable Line and Connection Detection Tool in Distribution System Based on RFID

This tool is designed with user comfort and safety in mind. With two main parts, namely the arms, and legs, this tool has functional and amenity values. In addition, this tool's construction design uses a relatively strong and lightweight material, namely galvalume iron, with a size of 2x2 cm.

As shown in Figure 1 above, the arm aims to make it easier for users not to bend over using the tool. The arm has main components, namely NodeMCU and 16x2 LCD. This component is connected by a cable that goes to the RFID Reader at the foot of this tool. In addition to the RFID Reader, at the bottom, there is also a 12v battery and other supporting components such as Stepdown, IC Regulator, and RS- 232 to USB.

How to work Instruments/tools

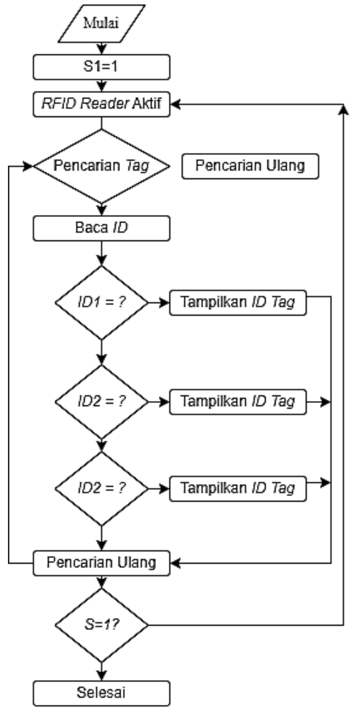

Figure 2 Flowchart System

As can be explained in Figure 2, the flowchart of this Final Project system consists of the following:

1. Start
   This is the start of the system.
2. Initialization
   The preparation process. Introduction of all variables to be used.
3. RFID active
   RFID Reader is ready for operation
4. Tag Detection
   The process of searching for RFID Tags that are buried under the ground. If detected (YES), the RFID Reader will forward the ID data read to the NodeMCU. If not seen (NO), the RFID Reader will remain active.
5. Read ID data
   NodeMCU does this process to read the data that matches the Tag code to be forwarded to the following command.
6. Buzzer on

This is the output when a Tag is detected.

7. Display the Tag ID on the 16x2 LCD.
   The Tag ID read by the NodeMCU will be displayed on the 16x2 LCD.
8. Read another Tag
   After finishing displaying data for one Tag, if the user wants to read another Tag ID (YES), it will return to the "RFID Reader active" command. If the user decides to finish the command (NO), then the system will be completed.

Table 1 RFID Tag Specifications

Specification	Description
Dimension	155x32x10 mm
Protocol Tag	ISO18000-6C (EPC C1G2)
Materials	ABS
Color	Black
Frequency	860-960 MHz
Collision Queue	Yes
Water resistance	Certification IP65
Weight	26 g

Following Table 1 above, although the tag above has the same frequency as the card-shaped tag, it has a more excellent range than the card-shaped one because it has the EPC-C1G2 protocol tag.

By the description at the beginning, this tool has two main functions, namely as a tracking device for the location of underground cables and a tracking device for the location of the 20 KV XLPE cable jointing point. For this reason, the RFID tags planted underground have differences in the encoding entered in the NodeMCU. Each point RFID Tag has a unique numbering code that distinguishes it from other RFID Tags.

RFID card protectors are used to protect RFID cards from various factors that can cause RFID cards not to function optimally. RFID card protectors are essential to plan so that cards stored underground by underground cable lines are not damaged due to water seepage and pressure from the ground surface. For this reason, the material used in making this card protector is insulated plastic to avoid water seepage entering the RFID card. Moisture in the area around the RFID card can reduce the card's strength in signal reception.

Software Testing

1. Prepare tools such as NodeMCU, Arduino, USB cable, laptop, and Arduino software.
2. Provide a 5VDC input source for Arduino and a power source for the sensor.
3. USB cable is connected between Arduino and the laptop.
4. Open the Arduino programming application.
5. Click the verify instruction on the Arduino.
6. The bottom display will show 'Done Compiling', indicating that the program has no errors.
7. Perform upload instructions to provide program work to Arduino. If the writing success for upload appears, the Arduino program has been successfully entered into the Arduino device.

Data Analysis Technique/Results Validation

The data collection methods used in writing the final project include:

1. Literature study method, namely, digging, tearing, and examining theories that support the solution of the problem being studied.

2. Literature method, namely the search for references and information related to the planning of the tool to be made based on books, journals, internet sites, and lecturers and relatives.
3. Observation method, by making observations when going to the field to obtain information to support the report's contents and can be accounted for.
4. Calculation analysis method, which is to analyze the construction calculations of existing components.
5. Experiment method, which is used by testing and collecting data on the results of experiments on the tool's design.
6. Discuss the implementation of guidance and consultation with lecturers and other parties who should help in the performance of this tool design.

RESULTS AND DISCUSSION

Testing is done to determine the range of electromagnetic signals that can be received by RFID tags that will be planted underground. This test is essential in planning a system that requires a deep enough distance to approach the standard laying of medium voltage distribution cables, around 80 cm (Book V of the Medium Voltage Electric Power Network Construction Standards).

This test is carried out by burying the RFID Tag underground with a depth ranging from 5 cm to 60 cm with a reading distance of every 5 cm. Given one of the properties of electromagnetic waves that will reflect waves when aimed at solid media, and will be forwarded in the air media, then in this test will use a plastic container as a medium for electromagnetic wave propagation and used as a protective medium for RFID Tags from ground pressure.

Integration testing on this system is in the form of data displayed on the LCD Display Module. If the data appears above, the system has run according to plan.

This test is carried out to determine if the battery life period has a load by existing system planning.

1. Battery Capacity Calculation
   Battery Capacity = 7000 mAh = 7 Ah
   Wh Battery Power = Battery Nominal Voltage x Battery Capacity = 11,1 V x 7 Ah
   = 77,7 Wh
2. Nominal Current of the System
   The nominal current of the system is obtained from the datasheet.

Table 2 Current on individual components

Current Dissipation	RFID Reader	650 mA
Maximum Current on each I/O Pin	NodeMCU	16 mA
I/O Pins that used	NodeMCU	16 Pin

Following Table 2 above, the accumulated current in the RFID Reader and NodeMCU is:

a. Current Consumption of RFID Reader = 650 mA = 0,65 A
b. Current Consumption of the NodeMCU = 416 mA = 0,416 A

3. Power Calculation of the System

Power on RFID Reader

P = V x I
= 9 x 0,65
= 5,85 W

Power on *NodeMCU*

P = 5 x 0,416
= 2,08 W

Total Power
Ptotal = 5,85 + 2,08 = 7,93 W

4. Battery Life Capacity Calculation

$$\frac{\text{Battery Power}}{\text{Total Power System}} = \frac{77{,}7\ Wh}{7{,}93\ W}$$

= 9,79 Hours (0,79 x 60 = 42,4 minutes)

= 9 Hours 42 minutes 24 seconds

RFID Reader Testing Using Battery

This test aspires to try the performance of the RFID Reader when using a power supply from a battery with a working voltage of around 11-12V. Following the datasheet described in the previous chapter, the operating voltage of the RFID Reader is 9V. However, the RFID Reader has a voltage regulator in its circuit, so it does not require a voltage reducer so that the power supply matches the working voltage of the RFID Reader.

The tools and materials used are as follows:

a. A RFID Reader
b. A RFID Tag
c. A RS 232 to USB connector
d. A Laptop

Testing Steps:

a. Connect the RFID Reader with a power supply using a 12V battery.
b. Connect the RFID Reader with RS 232 to the USB connector and connect the connector to the laptop.
c. Set up the demo program on the laptop
d. Access the RFID Tag ID in the demo program according to the explanation described above.

Table 3 RFID Tag ID reading result by RFID Reader

ID	Times
E2000015151800271710 65A8	73
E200001515180123160075AC	20
E2000017591101731480 82DA	9

Table 3 above is the ID of each Tag that can be seen through the demo/SDK program that has been briefly shown in testing the depth of RFID Tag coverage buried under the ground.

Advantages and disadvantages of the tool

After conducting several tests on several components as well as testing integrated and synchronized systems as a whole, there is a summary of the results of the discussion through an explanation of the advantages and disadvantages of the tool as follows:

Tools Advantages

1. Technicians or operators can monitor or monitor underground cable lines and connections with the sensor output on Blynk.
2. This detection tool can be accessed through Blynk on all devices, be it a Personal Computer (PC) or smartphone.
3. Can be installed on lines and connections easily.

Tools Disadvantages

1. Requires a program processing device with better processor, VGA, and RAM specifications to speed up the classification process.
2. Requires sensors with better specifications to capture signals with better results to increase accuracy during the classification process.

CLOSURE

Conclusion

After carrying out the entire research methodology to complete this final project and already knowing the shortcomings and advantages of the system that has been made, the conclusions of the preparation of this final project are:

1. RFID Reader and RFID Tag can be developed into a detection tool for underground cable lines and connections that can facilitate technicians in finding lines or connections quickly.

Figure 3 Detection Tool

2. In the process that occurs in the NodeMCU microcontroller system can distinguish the RFID identity. Tag as an underground cable line or as a jointing point location.
3. Sensors and tags on the tool will generate electromagnetic waves generated by the RFID detector then the sensor output will be displayed through the LCD and Blynk application.
4. There is plastic as a protector Tag stockpiled under the ground is not broken due to ground movement.
5. By the test results, the RFID Reader in areas with underground cables can reach a maximum depth of 30 cm. In comparison, areas without obstacles in the soil can get a depth of 40 cm.

Suggestions

After designing and making this final project, many things are expected to be developed using the RFID (Radio Frequency Identification) system. Therefore, it is necessary to evaluate to improve the system's performance which can be developed in the future. Namely in terms of:

1. The selected RFID Reader has an antenna (gain) of 12 dbi to increase the range of the electromagnetic signal generated.
2. Increase the work function of the system, which is improved in the form of detectors and can also be equipped with GPS.
3. Improve the microcontroller and add output from the detection results in the form of data that can find areas that have been repaired or are prone to damage.
4. Can increase the use of protectors using fiber or materials stronger than plastic.

REFERENCES

[1] Abduh, Syamsir. 2013. Gangguan Pada Kabel Bawah Tanah. Diakses pada 25 Oktober 2018.

[2] Bolic, Miodrag, David Simplot-Ryl, dan Ivan Stojmenovic. 2010. RFID Systems Research Trends and Challenges. Chichester: John Wiley & Sons Ltd.

[3] Cipta Alpha Teknologi. 2015. Teknologi Sistem RFID. Diakses pada tanggal 18 Juli 2019.

[4] DigitalTechno. 2018. Pengenalan Teknologi RFID (Radio Frequency Identification). Diakses pada 20 Oktober 2018.

[5] Electron. Datasheet H3 9662 dan Datasheet WZ-G16. Diakses pada tanggal 19 Oktober 2018.

[6] Gueabans. 2018. Cara Kerja Perpindahan Data Pada RFID Reader. Diakses pada 31 Oktober 2018.

[7] Kumar Gangwar, Rajesh, Swati Singh, dan Sweta Agarwal. 2014. Designing an UHF RFID Reader Antenna. Diakses melalui pada tanggal 4 Januari 2018.

[8] Pandey, Anil. 2017. How Do RFID Tags and reader antennas work? Diakses pada tanggal 2 Januari 2019. https://www.analogictips.com/rfid-tag-and-reader-antennas/

[9] Pratama Metalindo. Kabel Bawah Tanah dan Sambungan Kabel. Diakses pada tanggal 29 Oktober 2019. https://www.neliti.com/publications/522363/sistem-kerja-pelacakan-kabel-bawah-tanah-20kv-dari-gardu-tembok-kmpb-menuju-kmrc

[10] Roymond, Eric S. 2017. How to Become a Hacker. Diakses pada tanggal 4 Januari 2019. http://www.catb.org/~esr/faqs/hacker-howto.html

[11] Tekno, Jejak. 2017. Mengenal Tipe Media Penyimpanan: Memory Cards (2). Diakses pada 19 Juli 2019. https://kumparan.com/jejaktekno/mengenal-tipe-media-penyimpanan-memory-cards-1

[12] Violino, Bob. 2005. The History of RFID Technology. Diakses pada tanggal 2 November 2018. https://www.rfidjournal.com/the-history-of-rfid-technology

[17] Yulius. 2014. Radio Frequency Identification (RFID). Diakses pada 20 Oktober 2018. https://publication.petra.ac.id/index.php/teknik-informatika/article/view/8822