DESIGN OF AN IOT-BASED REMOTE MONITORING SYSTEM FOR YOGYAKARTA AIRPORT LOCALIZER WITH AUTOMATIC CHANGEOVER AND REAL-TIME NOTIFICATION FEATURES

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Abstrak — *This research on remote monitoring design aims to determine the condition and control the Localizer equipment in normal or alarm conditions. It can also assist in changing over during ground checks, accessible via smartphone using the Blynk app. This design uses an optocoupler sensor to detect the electrical current flowing through the LEDs on the Localizer Remote Control Unit (RCU). This allows the indicator readings to be sent to the Internet of Things (IoT) using a NodeMCU Wi-Fi module that communicates serially with an Arduino. The IoT functions to display real-time conditions and control the Localizer equipment in normal or alarm conditions, accessible via smartphone using the Blynk app. The tool I will design is an Internet of Things-based remote monitoring localizer. It is hoped that this remote monitoring tool will facilitate technicians in determining the condition of the Localizer and assist in changing over during ground checks.*

Keywords: *Localizer, Remote Monitoring, Arduino Nano, NodeMCU, IoT, Blynk App.*

1. INTRODUCTION

Observing weather elements is essential. Rapid technological developments are driving the creation of efficient and easy-to-use systems, including remote control based on the Internet of Things (IoT). The IoT concept enables connectivity between users and equipment, as well as between devices, without the constraints of distance. In aviation, technological advancements are crucial for supporting safety and comfort, including in the development of navigation aids such as the Instrument Landing System (ILS). The ILS consists of three main components: the localizer, the glideslope, and the marker beacon. The localizer serves to guide the aircraft to the runway centerline during landing. In accordance with Decree 83/VI/2005, navigation equipment such as the localizer must undergo periodic ground testing twice a month as a form of monitoring and preventive action by technicians. At the Perum

LPPNPI Yogyakarta Branch, ground testing is conducted at night, but the limited number of technicians makes it difficult to change over the localizer equipment. To address this, a remote monitoring system is needed that allows technicians to monitor localizer conditions in real time and perform changeovers remotely. Based on these needs, the author designed a simple Arduino-based device that can read the localizer's condition and send this information via an IoT network to a smartphone using the Blynk application. Using this device, technicians can still monitor the localizer's status even when they are far from the location, making testing activities more effective and efficient.

2. RESEARCH METHOD

In this study, the author used an engineering method with a Research and Development (R&D) approach, focusing solely on the design

and testing of a remote monitoring system for the Normarc NM7013 Internet of Things (IoT)-based localizer. The research stages included identifying technician needs in the field, designing a system using Arduino Nano and NodeMCU, hardware assembly, software programming, and integration with the Blynk application on a smartphone. Testing was conducted to ensure the system could display normal or alarm status and perform changeover remotely. Evaluation was based on the results of functional tests in the device's operational environment

2.1. Research Framework
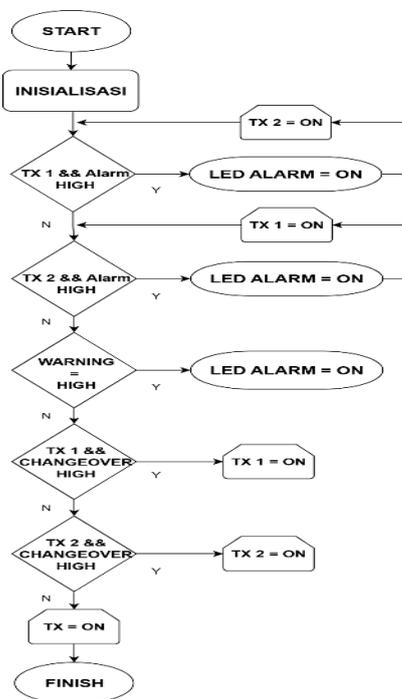
Flowchart of How the Design Works
Source: Researcher (2021)

This research is designed to produce a remote monitoring system that can be used by technicians to monitor the condition and perform changeover of Localizer equipment, especially during the ground check process. The main objective of this design is to improve technicians' work efficiency by enabling real-time monitoring of equipment conditions and providing early warnings if an alarm or warning occurs, so that corrective actions can be taken immediately before more serious damage occurs. This system is designed to be able to display the operational status of the Localizer (TX1, TX2, alarm, and warning)

via a smartphone device using the Blynk application, which is connected to the system via NodeMCU. Data is obtained using an optocoupler sensor that samples signals from the LED indicator on the Localizer Remote Control Unit (RCU). The Arduino Nano acts as the main controller of the system and processes input from the sensor, while the NodeMCU acts as a connector between the Arduino and the internet network via serial communication. Thus, the condition of the equipment can be monitored remotely and displayed in real-time on the smartphone. The system design also allows for two modes of operation: automatic, where the Arduino will directly perform changeover if an alarm is detected, and manual, where the technician can perform changeover via the application. The system flowchart describes the overall workflow of the tools and programs, from data sampling by the optocoupler to sending and displaying the data to the monitoring application.
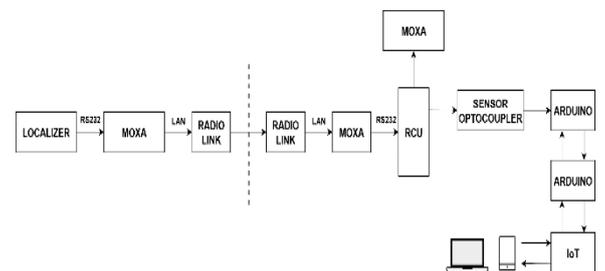
Block Diagram of Design Implementation
Source: Author's Work (2021)

2.2. Research Time and Location
The research and design of the Normarc NM7013 Localizer remote monitoring system was conducted at the Perum LPPNPI Yogyakarta Branch and implemented at Adisutjipto Airport. The design process took place from March to August 2021.
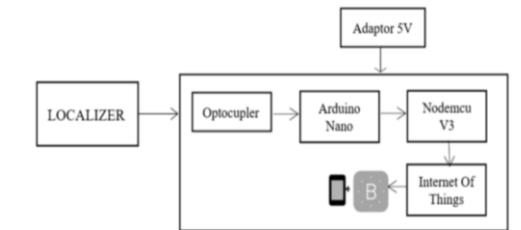
2.3. Research Instruments
This design process was made possible with the support of the following tools.
2.3.1. Hardware components:
• Arduino Nano
• PC817 optocoupler sensor
• 5V adapter

• *Buzzer*
• *Nodemcu EPS8266*
• *LED*
• *5V adapter*
• *USB cable*
• *28 AWG ribbon cable*
• *Smartphone*
Software components:
• *Arduino IDE*
• *Blynk app*

2.4. Research Criteria

Block Diagram of Remote Monitoring Localizer Design
Source: Author's Work (2021)

The Normarc NM7013 Localizer remote monitoring system is designed to monitor conditions and perform changeovers automatically or manually using Internet of Things (IoT) technology. The main devices used include a 5V adapter as a power supply, an Arduino Nano as a data processing center, and a NodeMCU as a Wi-Fi module that sends data to the internet. An optocoupler sensor is used to detect the status of the indicator LED on the Localizer Remote Control Unit (RCU). When the LED lights up, the optocoupler sends a signal to the Arduino as input. The Arduino then processes the data and sends it to the NodeMCU, which displays conditions in real-time via the Blynk application on a smartphone. The system is equipped with a buzzer as an audible indicator when an alarm condition is detected. In automatic mode, the Arduino will activate the changeover independently when an alarm status is detected. Meanwhile, in manual mode, technicians can control the changeover directly through the Blynk application. This design allows technicians to monitor and control the Localizer remotely efficiently, especially during night testing or when the number of technicians is limited.

3. *RESEARCH RESULTS AND DISCUSSION*

This research designed two interconnected circuits: a monitoring circuit and a simulation circuit for the Normarc NM7013 Localizer. The Arduino Nano acts as the data processing center and communicates serially with the NodeMCU. The system uses four optocoupler sensors connected to pins D11 (TX1), D12 (TX2), A0 (Alarm), and D13 (Warning) to collect data on the localizer's condition. Data read by the Arduino is sent to the internet via the NodeMCU V3 for display in a smartphone application using Blynk. The system can be switched from TX1 to TX2 automatically when the sensor detects an alarm, or manually via a custom device or smartphone. As an additional indicator, a buzzer is installed on pin A6 of the Arduino and activates when an alarm is detected on one of the TXs. The entire concept in this research utilizes serial communication between the Arduino and the NodeMCU to enable real-time monitoring of the localizer's condition via a mobile application.

3.1. *Design Stages*
The initial stages in designing the Localizer remote monitoring system include software preparation and hardware design, including:

3.1.1. *Preparing the Hardware*
- *Adapter. This adapter converts AC voltage to 5.41V DC, sufficient to power the Arduino Nano and NodeMCU. The voltage is distributed through a DC socket and an ON/OFF switch, which is also connected to an indicator LED to indicate the system's active status.*
- *Arduino Nano. Acts as the data processing center. During programming, the Arduino is connected to a laptop via USB, while during normal operation, it is powered by the adapter. The Arduino receives input from the optocoupler sensor and sends it to the NodeMCU V3 via serial communication (TX–RX). To avoid conflicts during programming, the*

serial connection is temporarily disconnected.

- *NodeMCU V3. Functions as a Wi-Fi module with an ESP8266 chip that sends localizer status data to the Blynk app on a smartphone. This module communicates with the Arduino Nano via the TX and RX pins and is powered by the adapter via the ON/OFF switch.*
- Optocoupler sensor
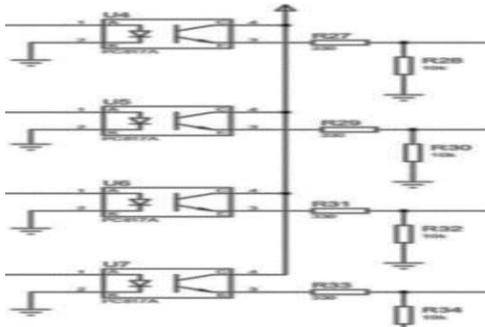
Optocoupler Sensor Circuit
Source: Author's Work (2021)

This sensor is used to sample the LED status on the Localizer Remote Control Unit (RCU). It detects changes in electrical current through the LED's light intensity and then generates a digital signal as input for the Arduino. This sensor ensures that the TX1, TX2, alarm, and warning signals are accurately read and displayed in real-time in the monitoring application.

3.1.2. Preparing the Software

Installing the Arduino IDE. First, download the Arduino IDE application from https://www.arduino.cc/, then proceed to the installation stage.

Arduino IDE Software Installation
Source: Author's Work (2021)

3.1.3. Designing a Microcontroller Program

To execute a command on the Arduino Nano and NodeMCU V3, an instruction/program must first be entered into the microcontroller IC on the Arduino Nano and NodeMCU V3. This includes the serial port usage, character usage, initial usage, delay usage, and the desired commands for the microcontroller. After the program is created, testing is necessary to determine whether the Arduino IDE (Integrated Development Environment) application uploaded to the Arduino and NodeMCU V3 is correct or whether any improvements are needed. This testing is performed by verifying or compiling the created program.

3.1.4. Setting Up the Interface with BLYNK

Blynk software is used as a monitoring and control interface in the Internet of Things (IoT)-based Localizer remote monitoring system. This application supports various microcontroller platforms and is available for both Android and iOS. Blynk provides a digital dashboard with drag-and-drop functionality, making it easy to design interfaces without requiring mobile programming skills. In this study, the author created a single-page interface titled "Monitoring Localizer," which displays the LED indicator status of the Localizer Remote Control Unit (RCU). Communication between the Node MCU and Blynk uses virtual pins, with 18 pins used to display indicator status and two pins for sending changeover commands. Some of the virtual pins used include:V0: Alarm
- V1: *Warning*
- V2: *Normal*
- V3: TX1 *On Air*
- V4: TX2 *On Air*
- V6: *Warning Maintenance*
- V7: <u>Warning Low Battery</u>
- V8: *Integrity Warning*

A notification feature has also been added to provide automatic alerts when an alarm is detected, even if the app is closed, as long as Blynk is in play mode. Additionally, a manual changeover button is available directly through the app, allowing technicians to control the device remotely.

nterface Design Display with BYLNK
Source: Author's Work (2021)

The final Blynk interface is designed to resemble the RCU Localizer panel, allowing technicians to monitor and control the system in real time via smartphone. In the Arduino Nano program, the author defines several system conditions. Normal conditions occur when TX1 functions as the primary transmitter and TX2 as the backup. In this state, changeover can be done manually via the Blynk app on the smartphone.

KONDISI RCU LOCALIZER	
ALARM	OFF
WARNING	OFF
NORMAL	ON (HIJAU)
TX1 ON AIR	ON (HIJAU)
TX2 ON AIR	OFF

LED Indicator Condition on the Default Localizer RCU
Source: Author's Work (2021)

When an alarm occurs, the main transmitter (TX1) will experience interference and the alarm indicator LED will light up, while the system will automatically changeover to TX2. In addition, users will still be able to changeover manually via smartphone. In this condition, the buzzer will sound as a sign of a problem with the transmitter. The Blynk application will also send an automatic notification to the smartphone with the message: "localizer alarm is on, fix it immediately." The notification will continue to appear as long as the alarm LED on the RCU Localizer is still on.

KONDISI RCU LOCALIZER	
ALARM	ON (MERAH)
WARNING	OFF
NORMAL	OFF
TX1 ON AIR	ON (MERAH)
TX2 ON AIR	OFF

Condition of the LED Indicator on the Localizer RCU When the TX1 Alarm Is Issued
Source: Author's Processed Results (2021)

KONDISI RCU LOCALIZER	
ALARM	OFF
WARNING	OFF
NORMAL	ON (HIJAU)
TX1 ON AIR	OFF
TX2 ON AIR	ON (HIJAU)

LED Indicator Condition on the Localizer RCU When TX1 Alarms and Switching Over to TX2
Source: Author's Processed Results (2021)

Although the Blynk app can be closed when not in use, it must remain in play mode for alarm notifications to remain active automatically.

3.2. Research Results
Testing was conducted to ensure the Localizer remote monitoring system functioned as intended. Tests were conducted under several key conditions, with readings from the optocoupler sensor sent to the Blynk smartphone app in real time.

3.2.1. Default Condition (Normal)
Initial testing was conducted under normal conditions, with TX1 active and TX2 standby, and vice versa. The system successfully displayed the status via the LED indicators on the RCU and the Blynk application. Optocoupler readings showed a HIGH (1) status when the LED was on, and LOW (0) when it was inactive.

X1 On Air and TX2 Standby
Source: Author's Work (2021)
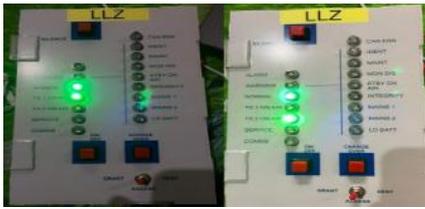
Normal Conditions in the RCU Localizer Simulation
Source: Author's Processed Results (2021)

OPTOCOUPLER	TX1 On Air dan TX2Standby		TX2 On Air dan TX1Standby	
	NILAI	KONDISI	NILAI	KONDISI
ALARM	0		0	
WARNING	0		0	
NORMAL	1		1	
TX1 ON AIR	1	ACTIVE	0	STANDBY
TX2 ON AIR	0	STANDBY	1	ACTIVE

Optocoupler reading data for normal conditions
Source: Author's processed results (2021)

3.2.2. *Alarm Condition*
The alarm condition test is performed by activating the alarm switch. The system automatically switches from TX1 to TX2. The buzzer activates as a warning, and the Blynk app sends a notification to the smartphone.

Alarm LED display and RCU simulation
Source: Author's work (2021)

Alarm changeover conditions
Source: Author's work (2021)

OPTOCOUPLER	TX1 On Air dan TX2Standby		TX2 Changeover dan TX1Alarm	
	NILAI	KONDISI	NILAI	KONDISI
ALARM	1		0	
WARNING	0		0	
NORMAL	0		1	
TX1 ON AIR	1	ACTIVE	0	STANDBY
TX2 ON AIR	0	STANDBY	1	ACTIVE

Sensor readings during TX1 and TX2 alarm conditions
Source: Author's Processed Results (2021)

3.3. *Warning Conditions*
Warning condition testing is performed by turning on the warning switch. The system randomly detects conditions such as Maintenance, Integrity, and Lobatt. The warning status is displayed in Blynk, and the indicator LEDs illuminate accordingly.

TX1 warning display and simulation
Source: Author's Processed Results (2021)

Warning conditions in the simulation
Source: Author's Processed Results (2021)

OPTOCOUPLER	TX1 On Air dan Warning		TX2 On Air dan Warning	
	NILAI	KONDISI	NILAI	KONDISI
ALARM	0		0	
WARNING	1		1	
NORMAL	0		1	
TX1 ON AIR	1	WARNING	0	STANDBY
TX2 ON AIR	0	STANDBY	1	WARNING

Warning sensor reading data
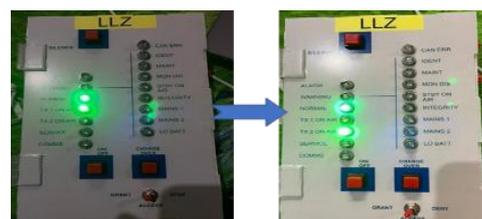Source: Author's Processed Results (2021)

3.4. *Changeover Testing*
Warning condition testing is performed by turning on the warning switch. The system randomly detects conditions such as Maintenance, Integrity, and Lobatt. The warning status is displayed in Blynk, and the indicator LEDs illuminate accordingly.

RCU Localizer Simulation Tool
Source: Author's Work (2021)

3.5. *Interpretation of Research Results*

From the results of the RCU Localizer monitoring simulation tool design trials, the optocoupler's operating principle is that if there is voltage flowing through the sensor to the LED, the sensor value becomes 1 (HIGH). If there is no voltage flowing through the sensor, the sensor value is 0 (LOW). The optocoupler sensor can read digitally in only two states: 1 and 0, so the read data remains stable.

RCU Localizer Monitoring Display System Default Indicator
Source: Author's Processed Results (2021)

By default, the design system makes TX1 the primary Localizer transmitter and TX2 the backup Localizer transmitter. So when the first monitoring design is turned on, the TX1 On Air indicator is ON and the TX2 On Air indicator is OFF. The test results can be seen in the image and table below: lizer Indicator Default System Source: Author's Processed Results (2021)

Indikator	Nilai Optocoupler					
	Tx1 Acti	Tx2 Acti	Tx1 Warni	Tx2 Warni	Tx1 Alar	Tx2 Alar
Alarm	0	0	0	0	1	1
Warning	0	0	1	1	0	0
Normal	1	1	0	0	0	0
TX1	1	0	1	0	1	0
TX2	0	1	0	1	0	1

Hasil Pengujian Secara Keseluruhan Sistem
Sumber:Hasil Olahan Penulis (2021)

4. *CONCLUSION AND RECOMMENDATIONS*
4.1 *Conclusion*

* *The Internet of Things (IoT) is a revolutionary technology that connects devices via the internet to increase efficiency and automation. From smart homes to the healthcare sector, IoT is having a significant impact on various aspects of our lives. While it faces challenges in terms of security, cost, and infrastructure, the benefits it offers are significant.*

* *It increases efficiency and speed in monitoring the condition of navigation equipment, and allows technicians to perform preventive actions and changeovers remotely without having to be present on-site.*

* *The smartphone-based remote monitoring and changeover system successfully monitored alarm status and controlled the Localizer in real time using Arduino and the PC817 Optocoupler sensor.*

* *The implementation of IoT application technology will simplify and increase the efficiency of monitoring alarm status on Localizer equipment at the Perum LPPNPI Yogyakarta Branch.*

* *The use of this system will make technicians' work more effective, especially in monitoring and responding to alarm conditions.*

4.2 *Recommendations*

* *Future development of Internet of Things systems is recommended to include more complex and adaptive features to align with technological advances and broader operational needs.*

* *The Internet of Things (IoT) is not just a technological trend, but has become an integral part of innovation in various fields, including healthcare, energy, transportation, and the environment. The author strongly hopes that in the future, and in line with developments in the technological era, with the increasing need for automation and data utilization, IoT will become a key factor in unlocking new efficiencies in various sectors. Furthermore, IoT also plays a significant role in the*

5. REFERENCES

[1] Alfirdaus, M. H. (2024). Jurnal Sistem Informasi dan Teknologi Jaringan Perancangan dan Implementasi Sistem Monitoring Kualitas Udara Berbasis IoT. 1, 24–30.

[2] B. Suhendar dan R. Fatullah, Otomatisasi Teknologi *Smart Home* Menggunakan Arduino Berbasis Internet of Things (IoT), Jurnal of Innovation and Future Technology, vol. 2, No.1, hal. 67-80, 2020.

[3] Fetter, Jr. C.W. *Applied hydro geology. Bell and Howell Company, Colombus, Ohio*, 488p.

[4] Freeze, R. A. dan Cherry, J. A. *Ground water. PrenticeHall, Inc. Engle wood Cliffs, New Jersey*, USA.

[5] *Golder Associate. Scoping Study for the Hydrogeological and Hydrological Components of the Kulon Progo Iron Sands Project.*

[6] G. A. Muhammad Salim Machfud1, Mada Sanjaya, Rancang Bangun *Auto matic Weather Station* (Aws) Menggunakan Raspberry PI, vol. II.

[7] https://www.mertani.co.id/post/aws-mertani-inovasi-teknologi-prakiraan-cuaca-dan-contoh-penerapannya.

[8] https://www.mertani.co.id/post/manfaat-aws-automatic-weather-station-mertani

[9] https://www.mertani.co.id/automatic-weather-station.

[10] Normarc 7013B-7014B pada *Instrment Landing System Instruction Manual*.

[11] N. Akhirta, Peralatan Pengamatan Automatic Weather Station (AWS), Page1.

[12] Sugiyono Metode Penelitian dan Pengembangan *Researchand Develop ment.* Bandung: Alfabeta.

[13] Slamet R.D. Analisis Kinerja Peralatan Instrumen Landing System. Jurnal Ilmiah Aviasi Langit Biru , 1-6 Domenico, P.A. and Schwartz, W.F., 1990. *Physical and chemical hydro geology. John Wiley and Sons, Inc.,* Canada, 824p.

[14] Tang, Junqiang, Li Wan, Jennifer Schooling, Pengjun Zhao, Jun Chen, and Shufen Wei. 2022. *Automatic Number Plate Recognitio*n (ANPR*) in smart cities*: *A systematic review on technological advancements and application cases*.

[15] Undang-Undang Nomor 1 Tahun 2009 Tentang Penerbangan, Pasal 1 Ayat 33 h.6 Peraturan Pemerintah Republik Indonesia Nomor 77 Tahun 2012 Tentang Perusahaan Umum (Perum) Lembaga Penyelenggara Pelayanan Navigasi Penerbangan Indonesia.

[16] V. Wiendyas Gandoria, V. Vekky, R. Repi, and A. Wibowo, Rancang Bangun Pengamat Parameter Cuaca Menggunakan Komunikasi Nir Kabel, J. Ilm. GIGA, vol. 22, No. 1.

[17] Widarti, E., Joosten, Pratiwi, P., Pradnyana, G., Indradewi, I. G., Kamilah, N., Bahtiar, A., Maysanjaya, I. M., & Sepriano. (2024). Buku Ajar Pengantar Sistem Ekonomi Indonesia. Buku Ajar Pengantar Sistem Ekonomi Indonesia (Issue January). https://doi.org/10.21070/2024/978-623-464-086-1

[18] Wijaya, K. M., Piarsa, I. N., & Wira Buana, P. (2023). *Feeding System Based on Internet of Things*. Jurnal Ilmiah Merpati (Menara Penelitian Akademika Teknologi Informasi), 11(2), 115. https://doi.org/10.24843/jim.2023.v11.i02.p06

[19] Wulandari, C., Wijayanti, D., Lestari, N., & Daulay, N. K. (2022). Prototype Sistem Monitoring Parkir Pintar Berbasis Iot (*Iinternet of Things*). Jurnal Sistem Komputer Musirawas, 7(2), 1–9.

[20] Zalukhu, A., Swingly, P., & Darma, D. (2023). Perangkat Lunak Aplikasi Pembelajaran Flowchart. Jurnal Tek nologi, Informasi dan Industri, 4(1), 61–70. https://ejurnal.istp.ac.id/index.php/jtii/article/view/351