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Design and Construction of a Current and Voltage *Monitoring* System as an Indicator of Disturbances in IoT-Based *Runway Edge Lights*

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Abstract : *Runway lighting is a critical facility that supports the safety and reliability of airport operations, particularly during nighttime operations and adverse weather conditions with limited visibility. This study aims to design and implement an Internet of Things (IoT)-based current and voltage monitoring system as an indicator of disturbances in a runway edge light prototype. The proposed system utilizes an ACS712 current sensor, a ZMPT101B voltage sensor, an ESP32 microcontroller, a 16x4 LCD display, and the Blynk platform. The monitored parameters include current and voltage, which are processed by the ESP32 and transmitted via a Wi-Fi network for real-time monitoring. The test results show that the prototype successfully measured voltage values ranging from 203 V to 220.5 V and current values ranging from 1.90 A to 2.03 A, with a monitoring success rate of 100%. The system successfully identified normal conditions, undervoltage, overcurrent, and electrical circuit interruption based on predefined thresholds of 209–231 V for normal voltage and 1.8–2.0 A for normal current. Data transmission to the Blynk dashboard achieved a 100% success rate with an average delay of 1.22 seconds. The developed prototype demonstrates the feasibility of real-time electrical parameter monitoring and preliminary disturbance indication for runway edge light models under laboratory testing conditions.*

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Introduction

Runway edge light is one part of the *Airfield Lighting* system that functions to provide visual guidance for pilots in identifying runway boundaries, especially at night and in limited visibility conditions. The reliability of these lighting facilities is one aspect that needs to be considered because disturbances in the lights or their electrical system can affect the availability of visual facilities on the runway. In practice, checking the condition of the lights can still involve direct inspection so that the process of identifying disturbances in facilities with a large number of light points can take time. This condition drives the need for a *monitoring* system that can provide information on equipment conditions more quickly and measurably. Research on *airfield lighting* also shows that *monitoring* the condition of the lights is an important part of supporting the efficiency of maintenance and reliability of airport lighting facilities.

Various approaches have been developed to monitor lighting conditions and electrical parameters. Anugrah used the ACS712 and ZMPT101B sensors to obtain current, voltage, and power parameters so that both sensors can be used as a basis for measuring electrical parameters. Another approach was applied by Putra et al. on the *Runway Threshold Identification Light* (RTIL) *monitoring* system by utilizing ESP32, ACS712 sensors, ZMPT101B, light sensors, and gyroscopes. This system has the advantage of integrating several parameters with a microcontroller to support operational *monitoring* of lights in an *Airfield Ground Lighting* laboratory environment. However, the focus of this research is still directed at learning activities and operational *monitoring* of RTIL.

The use of IoT has also been applied more specifically to *airfield lighting* facilities. Andeni developed a *Prototype IoT-Based Airfield Lighting On/Off Monitoring System* (ALMOS) using ACS712 sensors, Arduino Uno, PLCC, and ESP32 to monitor lamp conditions in *real-time* through a web-based interface. This approach has the advantage of allowing lamp status to be monitored remotely and reducing reliance on direct lamp condition checks. However, the parameters used are primarily intended to determine the ON/OFF status of the lamp. Radwitya and Alkadri's research uses a combination of ACS712, ZMPT101B, LCD, and Blynk to monitor current and voltage in real-time. Despite the similarities in hardware and IoT platforms, the application is still aimed at household electrical installations, not runway lighting systems.

Based on this approach, there is an opportunity to develop a *monitoring* method that not only shows the ON/OFF condition of the lamp or displays the value of electrical parameters, but also uses changes in current and voltage as a basis for providing *fault* indications.

Previous research has shown that current and voltage sensors can be used to obtain information about electrical conditions, while IoT technology allows measurement results to be sent and monitored in real time. However, the simultaneous application of these two parameters as indicators of runway edge light disturbances is still relatively limited. Therefore, the focus of this research is how to continuously obtain current and voltage parameters, determine conditions based on predetermined threshold values, and convey this information through *real-time monitoring* media.

As a solution, this study proposes an *Internet of Things* (IoT)-based current and voltage *monitoring* system with ESP32 as the data processing center, ACS712 sensor for current measurement, and ZMPT101B sensor for voltage measurement. The sensor readings are processed by ESP32 and compared with predetermined condition parameters to provide an indication of normal conditions or disturbances in the runway edge light model. The measurement information is then displayed via a 16x4 LCD as a local *monitoring* medium and the Blynk platform as a remote *monitoring* medium. With this approach, changes in electrical parameters can be observed in *real-time* and used as initial information in identifying conditions such as *undervoltage*, *overcurrent*, or indications of Electrical Circuit Interupption. The system design in this study remains as a prototype/model, so the results are not intended as a direct controller for runway edge light facilities at airports.

The main contributions of this research include: (1) designing a *monitoring* system for current and voltage parameters on a runway edge light model using ESP32, ACS712, and ZMPT101B; (2) implementing current and voltage parameters as indicators to differentiate between normal conditions and several indications of electrical disturbances; (3) integrating LCD and Blynk to display *monitoring*

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results locally and in *real-time* via an IoT network; and (4) evaluating system performance based on sensor reading capabilities, condition detection, data transmission, and *monitoring* result display. These objectives and scopes are in line with the problem formulation in your thesis regarding system design, disturbance detection, *real-time* data transmission, and *monitoring* dashboard performance.

This article is further structured into several sections. The second section discusses the literature review and previous research that formed the basis for the system's development. The third section describes the research methods, hardware and software design, and testing procedures. The fourth section presents the test results and a discussion of system performance. The fifth section compares the study with previous research, while the sixth section presents the research conclusions.

Literature Review

Runway Lighting and Runway Edge Light

The runway lighting system is a lighting system installed around and along the runway and serves as a visual reference for pilots during landing, take-off, and safe taxiing of aircraft. This system plays a crucial role in ensuring flight safety, especially in conditions of limited visibility such as nighttime or inclement weather. Runway lighting is regulated and adjusted according to airport category, operating hours, visibility, weather, and ATC control. The runway lighting system consists of several types of lights placed at specific locations along the runway according to their function. Runway lighting has a light intensity setting so that the visuals can be seen clearly by pilots and can be selected to turn on the system according to conditions, functions, and needs. Each type of installed light has a different color and lighting characteristics as visual information for pilots. The following are several types of runway lighting shown, among others:

Runway Edge Lights White runway edge lights installed on the left and right sides to indicate the width and length of the runway. Based on the various types of runway lighting, this study focuses on runway edge lights because they function as runway boundary markers and play a crucial role in assisting pilots during takeoffs and landings.

Airfield Lighting System (AFL) and Disturbances in the Runway Edge Light System

The *Airfield Lighting* (AFL) system is a specialized electrical system used to supply and control lighting on the airside of an airport, including runway lighting. The AFL system is designed to ensure operational reliability and safety with electrical characteristics that differ from conventional lighting systems. In the AFL system, runway lighting is connected using a constant current series circuit that functions to regulate the electrical current to maintain a constant level. Light intensity in runway lighting is regulated by changing the supplied current level so that the brightness of the lights can be adjusted to operational needs and environmental conditions. Types of disturbances that commonly occur in runway lighting systems include lights not turning on, decreased light intensity, current and voltage disturbances, and damage to electrical components such as broken cables or bulbs. In addition, other factors such as environmental factors, the presence of standing water on the runway, humidity, and corrosion can also cause a decrease in lighting system performance. If disturbances are not immediately addressed, they can cause problems that have the potential to affect flight safety. Disruptions to the runway lighting system can reduce the effectiveness of visual guidance for pilots and potentially affect flight operational safety if not addressed immediately.

Current Sensor and Voltage Sensor

In measuring the amount of electric current flowing in a circuit. In the runway lighting *fault* detection system, the ACS712 current sensor functions to monitor the current stability in the runway light circuit. ACS712 works based on the Hall effect and is capable of measuring both AC and DC currents with several measurement range options. If a *fault* occurs such as a light failure or a broken cable, the read current value will decrease or change drastically. Thus, the current sensor can be used as a primary indicator in detecting abnormal conditions in the runway lighting system. The ZMPT101B voltage sensor is a sensor used to measure AC voltage with the principle of a mini voltage transformer.

This sensor produces an analog signal that can be read by a microcontroller, thus enabling *real-time* voltage monitoring. In this study, the ZMPT101B sensor is used to monitor voltage changes in the runway edge light model as an indicator of system *fault*s. The combination of data from the current sensor and the voltage sensor provides more accurate information in detecting *fault*s. The measurements

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are not at the high voltage of the real runway lighting, but rather measurements at the *low-voltage*/simulation side.

Internet of Things (IoT) and ESP32

Internet of Things (IoT) is a network of physical devices that are interconnected and can share data with each other via the internet. Physical devices are equipped with sensors, actuators, and internet connectivity to send and receive data in real-time. In this study, IoT technology is used to send data from current and voltage sensor readings from the ESP32 microcontroller to a *monitoring* platform via the internet network. Thus, the condition of the runway edge light can be monitored in *real-time* without having to conduct direct inspections on site. In this study, the ESP32 microcontroller is used which has the advantage of a low-cost system, and also low power with a WiFi module integrated with the microcontroller chip and has dual-mode bluetooth and power-saving features making it more flexible. ESP32 is a microcontroller introduced by Espressif System which is the successor to the ESP8266 microcontroller.

This microcontroller includes an on-chip WiFi module, making it highly suitable for developing *Internet of Things* applications. The ESP32 itself is not much different from the more familiar ESP8266, but it's more complex.

LCD, Blymk. and *Real-Time* Monitoring

In this study, a 16x4 LCD is used as a local display medium to display current, voltage, and system status values directly. To ensure the prototype can be used in real-time, Blynk is used as a *monitoring* medium to display current, voltage, and runway edge light condition status data sent by the ESP32 microcontroller via a *Wi-Fi* network. Data received by the Blynk platform is displayed in the form of indicators, graphs, and measurement values, making it easier to monitor system conditions in real-time. Blynk was chosen because it has an easy-to-use interface, supports *real-time* data communication, and can be integrated with the ESP32 via an internet network.

Voltage Standard Based on SPLN No.1:1978

Voltage is a crucial parameter in determining the operating conditions of electrical equipment. Voltage values outside specified limits can impact load performance and indicate a disturbance in the electrical system. In this study, the voltage limit is determined based on SPLN No. 1 of 1978 concerning Standard Voltages, which stipulates a service voltage tolerance of ±5% of the nominal voltage.

This study uses a nominal voltage of 220 V. Based on this tolerance, the lower and upper limits of the voltage are calculated using Equations (1) and (2). The lower limit is obtained by subtracting 5% of the nominal voltage from 220 V, while the upper limit is obtained by adding 5% of the nominal voltage. Thus, the voltage range used as a reference for normal conditions in this study is 209–231 V.

The similarities:

$$V_{min} = V_n - (0,05 \times V_n)$$

$$V_{max} = V_n + (0,05 \times V_n)$$

Information:
V_{min} : Minimum limit of normal voltage (Volt)
V_{max} : maximum limit of normal voltage (Volt)
V_n : nominal system voltage (Volt)

Table 1 Voltage Limit Based on Nominal Voltage 220 V

Condition	Voltage Range
Undervoltage	< 209 V
Normal	209–231 V
Overvoltage	> 231 V

Based on the calculation results, a voltage of 209–231 V is used.as a reference range for normal conditions. Values below 209 V are categorized as *undervoltage*, while values above 231 V indicate

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voltage conditions outside normal limits. These limits are then used as one of the parameters in the condition classification process in the *monitoring* system.

Previous Research

Previous research served as the basis for determining the approach used in developing the *monitoring* system. Several studies have implemented current and voltage sensors, microcontrollers, and *Internet of Things* technology to monitor electrical parameters and airport lighting facilities. The differences in the objects, observed parameters, and *monitoring* methods of these studies are previously became the basis for determining the position and contribution of this research.

Table 2 Discussion of Previous Research

No	Author (Year)	Research Content	Linkage to Research	Novelty/Difference with Research
1	Iyan Anugrah (2017)	Developing an electric power meter using ACS712 current sensor and ZMPT101B voltage sensor to calculate electrical parameters and electric power.	It is the basis for using the ACS712 and ZMPT101B sensors for measuring electrical parameters.	Previous research focused on measuring electrical power, while this research uses changes in current and voltage as indicators for detecting disturbances in IoT-based runway edge lights.
2	I Gede Dharma Adi Putra, RB Budi Kartika W., and Yayuk Suprihartini (2020)	Developing an RTIL lamp operational *monitoring* system using ESP32, ZMPT101B sensor, ACS712, light sensor, gyroscope, website and buzzer as learning media in the AGL laboratory.	Both use ESP32, ACS712 and ZMPT101B sensors for *monitoring* airport visual aids facilities.	Previous research focused on *monitoring* RTIL operational conditions and learning media, while this research focuses on detecting runway edge light disturbances based on *real-time* current and voltage changes via the IoT dashboard.
3	Afra Nabilah Andeni (2025)	Designing a *Prototype IoT-Based Airfield Lighting On/Off Monitoring System* (ALMOS) using ACS712, Arduino Uno, PLCC, and ESP32 sensors to monitor AFL lamp conditions in *real-time* via web monitoring.	Both discuss IoT-based *airfield lighting system monitoring* using ESP32 and current sensors.	This study only monitors the ON/OFF status of the AFL lights, while the research conducted by the author monitors current and voltage parameters as indicators of disturbances in the runway edge lights so that it can provide more detailed information on electrical conditions.
4	Erick Radwitya and Syarif Ishak Alkadri (2026)	Designing an Arduino-based electric current and voltage *monitoring* tool using ACS712 and ZMPT101B sensors and displaying data via LCD and Blynk.	Both use ACS712, ZMPT101B sensors, LCD, and IoT platform for *monitoring* electrical parameters.	The research was applied to household electrical installations, while this study implements the concept in runway edge light simulations in the airport sector.

Method

Types and Approaches of Research

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This study uses an experimental method with a quantitative approach to design and test a current and voltage *monitoring* system as an indicator of disturbances in runway edge lights. The experimental method is used because the study involves the process of designing a prototype, implementing hardware and software, and testing the system under several predetermined electrical conditions. The main parameters observed are current and voltage values obtained from the ACS712 and ZMPT101B sensors. The reading results are then processed by ESP32 to determine the system condition based on predetermined threshold values. Testing is carried out on a runway edge light model using a mini *bulb* as a simulation load, so that the developed system is used as a prototype and not as a direct control device for runway edge light facilities at airports.

System Working Principle

The *monitoring* system works by continuously capturing current and voltage values from the runway edge light model. An AC voltage source is used to supply the load, while an ACS712 sensor is placed in series with the load line to measure the current flowing, and a ZMPT101B sensor is installed in parallel to measure the AC voltage. The output signals from both sensors are read through the ESP32 ADC pin and then processed based on predetermined threshold values. The processing results are used to determine system conditions, then displayed on a 16x4 LCD and sent via a *Wi-Fi* connection to the Blynk platform. With this mechanism, changes in electrical parameters and indications of system conditions can be monitored locally or via a dashboard in real-time.

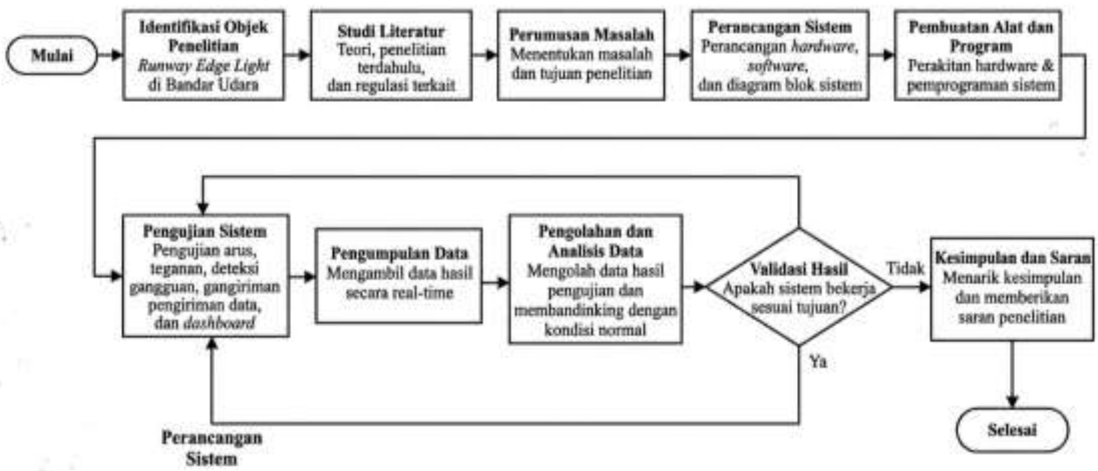

Figure 1 System Block Diagram *Monitoring Runway Edge Ligh*

Figure 1 shows the interrelationships between the components of the *monitoring* system. The ACS712 and ZMPT101B sensors serve as input for current and voltage parameters, while the ESP32 acts as a data processing unit. The processed results are forwarded to the LCD as a local display and Blynk as an IoT-based *monitoring* interface. This structure allows electrical parameters to be processed and displayed without involving direct load control functions.

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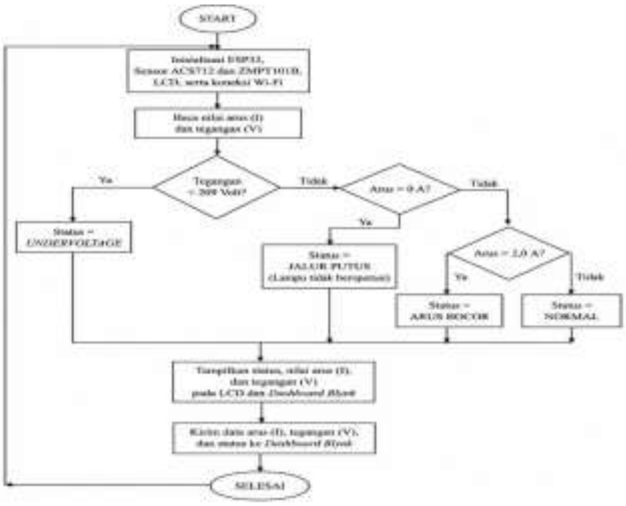

Figure 2 Flowchart of the Intrusion Detection Algorithm

Figure 2 shows the Flowchart of the *fault* detection algorithm used to determine the condition status of the runway edge light based on the results of current and voltage readings. After obtaining values from both sensors, the ESP32 compares these parameters with predetermined threshold values. Voltages in the range of 209–231 V are used as a reference for normal conditions, while voltages below 209 V indicate an indication of *undervoltage*. A current value of more than 2.0 A is used as an indication of overcurrent, while a current value of 0 A indicates a possible disconnected line or non-operating load. The classification results are then displayed on the LCD and sent to the Blynk dashboard.

Hardware Specifications

The hardware used in this study consists of several main components integrated to form an *Internet of Things* (IoT)-based current and voltage *monitoring* system. Each component has different functions and characteristics according to system requirements. The hardware specifications used can be seen in Table 3.

Table 3 Tool Specifications

No	Component	Specification	Function
1	ESP32	Dual Core 240 MHz, WiFi, Bluetooth	Main microcontroller
2	ACS712 Sensor	5 A Hall Effect Current Sensor	Measuring current
3	ZMPT101B Sensor	AC Voltage Sensor Module	Measuring voltage
4	16x4 LCD + I2C	16x4 Character Display	Displaying local data
5	Junior High School	Input 220 VAC Output 5 VDC	Power supply
6	ESP32 Power Shield	Expansion Board	Make connection easier
7	Mini Bulb	5 Volt	Runway edge light simulation load
8	Blynk	IoT Platform	*Real-time* monitoring

Software Design

The software is designed to manage the sensor reading process, data processing, condition determination, and sending information to the *monitoring* platform. The ESP32 program is used to read the ACS712 and ZMPT101B sensor output, convert and process the values, then determine the system status based on predetermined parameter limits. The processed data is then sent via a Wi-Fi network to Blynk and displayed on a 16x4 LCD. The software also manages the display of system condition status so that changes in electrical parameters can be monitored directly through local devices or IoT dashboards.

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Wiring Design and System

The circuit design is done by connecting an AC voltage source, ACS712 current sensor, ZMPT101B voltage sensor, ESP32, 16×4 LCD, power supply, and one load in the form of a mini *bulb* as a runway edge light model. The ACS712 sensor is installed in series on the load path to measure current, while the ZMPT101B is used to read the AC voltage. The ESP32 receives the output of both sensors through analog input and processes the data to determine the system condition. The SMPS power supply is used to provide the DC voltage required by the microcontroller circuit and the simulation load. *Monitoring* system circuit.

Testing Variables and Parameters

The research variables consist of independent variables and dependent variables. The independent variables are changes in electrical parameters, including current and voltage values from the ACS712 and ZMPT101B sensors. The dependent variable is the condition or status of the runway edge light generated by the system based on the processing of these parameters.

Table 4 Testing Variables and Parameters

Variables	*Parameter*	*Reference*
Independent Variable	Voltage and Current	220 V ±5% and 1.8–2.0 A
Dependent Variable	System Status	Normal/*Fault*
Disturbance Condition	*Undervoltage*	Voltage < 209 V
Disturbance Condition	Overcurrent	Current >2.0 A
Disturbance Condition	Electrical Circuit Interupption	Current = 0 A

Testing Procedures

Testing was conducted to evaluate the system's ability to read electrical parameters, identify *fault* conditions, transmit data in real time, and display *monitoring* results on the dashboard. Current and voltage *monitoring* tests were conducted by observing sensor output values under predetermined operating conditions..

Table 5 Types of System Testing

Testing	*Objective*
Current and Voltage Monitoring	Knowing the sensor's ability to read electrical parameters
Intrusion detection	Knowing the system's ability to classify conditions
Real-time data delivery	Knowing the success and time of data delivery
Monitoring dashboard	Ensure the displayed status matches the system conditions.

Data Analysis Method

Data analysis was performed quantitatively by comparing current and voltage values under normal and *fault* conditions. The test results were used to evaluate the accuracy and reliability of the runway edge light *fault* detection system. The equation was used to determine the average time required for the system to transmit *monitoring* data to the IoT platform in real time.

$$\bar{D} = \Sigma D / n \quad (1)$$

Information:
$\bar{D}$= average *delay* (seconds)
ΣD = total number of test result *delays* (seconds)
n = number of test data

Data Delivery Success Analysis

Description: The number of data successfully received is the same as the total data successfully received by the IoT platform. The number of data sent is the same as the total data sent by the system. This equation is used to evaluate the reliability of data communication in the *monitoring* system being developed.

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Success = (Successful Data / Total Data) × 100% (2)
Information:
Number of data successfully received = total data successfully received by IoT platform. Number of data sent = total data sent by the system.

Determination of Voltage Disturbance Limits

Determination of normal and *fault* conditions is carried out based on a voltage tolerance limit of ±5% of the nominal system voltage. The electrical voltage used to supply electronic devices is usually a 1-phase (220 volt) or 3-phase (380 volt) electrical voltage. Based on SPLN No.1:1978, the service voltage tolerance limit is +5% and -10% of the nominal voltage. The nominal voltage in question is 220 volts so that the standard means the electrical voltage must not be more than 231 volts or less than 198 volts. In this study, a nominal voltage of 220 volts was used so that a normal voltage range of 209 volts to 231 volts was obtained. Values outside this range are categorized as voltage disturbance conditions (*undervoltage* or overvoltage).

$$V_{min} = Vn - (0.05 \times Vn)$$
$$V_{max} = Vn + (0.05 \times Vn) \quad (3)$$

Results and Discussion

Current and Voltage *Monitoring* Test Results

Current and voltage *monitoring* tests were conducted to determine the system's ability to read electrical parameters at runway edge lights using the ACS712 sensor and the ZMPT101B sensor integrated with the ESP32 microcontroller. Testing was conducted 15 times with varying current and voltage values to determine the stability of the sensor readings and the success of data transmission to the IoT-based *monitoring* platform.

Table 6 Current and Voltage *Monitoring* Test Results

No	Voltage (V)	Current (A)	Reading Status	
			LCD	IoT
1	220.5	2.03	Succeed	Succeed
2	219.8	2.01	Succeed	Succeed
3	218.7	1.99	Succeed	Succeed
4	216.4	1.97	Succeed	Succeed
5	216.8	1.95	Succeed	Succeed
6	215.2	1.94	Succeed	Succeed
7	213.9	1.93	Succeed	Succeed
8	212.4	1.92	Succeed	Succeed
9	210.8	1.91	Succeed	Succeed
10	209.7	1.90	Succeed	Succeed
11	208.4	1.91	Succeed	Succeed
12	207.5	1.98	Succeed	Succeed
13	206.7	1.99	Succeed	Succeed
14	205.8	1.94	Succeed	Succeed
15	203.0	1.90	Succeed	Succeed

Table 6 shows the test results indicating that the system is able to obtain current and voltage values in each test. Variations in the reading results indicate changes in the electrical parameters of the load used. These values are then used as input for the ESP32 in determining system conditions based on predetermined parameter limits. These results indicate that the ACS712 and ZMPT101B sensors can be used as electrical parameter acquisition devices in the runway edge light prototype. 4.3 Runway Edge Light Electrical *Fault* Detection Test

Fault detection testing was conducted to determine the system's ability to identify changes in electrical conditions based on current and voltage parameters. Testing was performed by simulating normal, *undervoltage*, *overcurrent*, and Electrical Circuit Interupption conditions. Normal conditions were defined based on a voltage range of 209–231 V and a current of 1.8–2.0 A, while values outside these parameters were used to indicate *fault*s.

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Table 7 Disturbance Detection Results

No	Voltage (V)	Current (A)	System Condition	Indication of Disturbance
1	220.5	1.95	Normal	No disturbance
2	219.8	1.98	Normal	No disturbance
3	218.7	1.99	Normal	No disturbance
4	216.4	1.92	Normal	No disturbance
5	214.8	1.90	Normal	No disturbance
6	212.6	1.88	Normal	No disturbance
7	210.4	1.91	Normal	No disturbance
8	209.0	1.90	Normal	Still within 5% tolerance
9	206.8	1.99	*Undervoltage*	Need to check the cable path
10	203.0	1.90	*Undervoltage*	Possible voltage drop on the line
11	201.5	1.87	*Undervoltage*	Need to inspect the cable connections
12	198.4	1.85	*Undervoltagee* Weight	Indication of supply or cable *fault*
13	220.2	2.15	*Over Current*	Possible leakage current
14	219.7	2.24	*Over Current*	Cable insulation check required
15	220.1	0	The line on the light is broken	Lights out

Based on Table 7, tests 1–8 show normal conditions because the voltage is in the range of 209–231 V and the current is within the normal operating range of the prototype. In tests 9–12, the voltage is below 209 V so the system classifies the condition as *undervoltage*. Furthermore, tests 13 and 14 produce currents of 2.15 A and 2.24 A, respectively, so the system gives an overcurrent indication. In test 15, a current of 0 A indicates no current flowing through the load and the system identifies it as an indication of a Electrical Circuit Interupption or a lamp not operating. Data transmission testing was conducted to determine the system's ability to transmit current and voltage readings from the ESP32 to the Blynk platform via a *Wi-Fi* network. Parameters observed included *delay* time and successful data reception. Testing was conducted 10 times to determine the stability of data communication during the *monitoring* process.

Table 8 *Real-Time* Data Delivery Test Results

No	Voltage (V)	Current (A)	*Delay* (seconds)	Data Received
1	220.5	2.03	1.1	Yes
2	219.8	2.01	1.2	Yes
3	218.7	1.99	1.3	Yes
4	217.4	1.97	1.2	Yes
5	216.8	1.95	1.1	Yes
6	215.2	1.94	1.3	Yes
7	213.9	1.93	1.2	Yes
8	212.4	1.92	1.4	Yes
9	210.8	1.91	1.1	Yes
10	203.0	1.90	1.3	Yes

Based on the data using equation (1) as follows:

$\bar{D} = \Sigma D / n$

$\bar{D} = (1.1 + 1.2 + 1.3 + 1.2 + 1.1 + 1.3 + 1.2 + 1.4 + 1.1 + 1.3) / 10 \; \bar{D} = 12.2 / 10$

$\bar{D} = 1.22$ **seconds**

Success (%) = (10 / 10) × 100% = 100%

Test results showed that all 10 data points were successfully received by the Blynk platform, resulting in a 100% success rate. The *delay* time ranged from 1.1 to 1.4 seconds, with an average of 1.22 seconds. These results demonstrate that the *Wi-Fi* connection used is capable of supporting *real-time monitoring* data transmission on the tested prototype.

The *monitoring* dashboard testing was conducted to ensure that the current, voltage, and condition status data sent by the ESP32 can be displayed on the Blynk platform according to the sensor readings. The dashboard is used as a remote *monitoring* medium so that users can find out the system condition without conducting direct inspections on the prototype. The system displays two main status categories, namely NORMAL and *FAULT*. The NORMAL status is given when the parameters are within the

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specified operating range, while *FAULT* is given when the system detects *undervoltage*, *overcurrent*, or a Electrical Circuit Interupption.

Table 9 *Monitoring* Dashboard Display Results

Test Conditions	System Status	Dashboard View
Normal	Normal	In accordance
Undervoltage	*Fault*	In accordance
Overcurrent	*Fault*	In accordance
Electrical Circuit Interupption	*Fault*	In accordance

The test results show that the dashboard can display current and voltage values as well as system condition status according to the ESP32 processing results. Normal conditions are displayed as NORMAL, while *undervoltage*, *overcurrent*, and Electrical Circuit Interupption are displayed as *FAULT*. Thus, the dashboard can be used as a medium for *monitoring* the prototype's electrical condition in real time. However, the dashboard used in this study still functions as a display of conditions during testing and does not yet provide data storage or *history* features.

System Performance Analysis

Based on the overall test results, the *monitoring* system is capable of performing measurement, condition detection, data transmission, and information presentation functions according to the design. In the *monitoring* test, the sensors are able to read voltage and current parameters on the simulated load. These readings are then used by the ESP32 to determine system conditions based on predetermined threshold values. In the *fault* detection test, the system can distinguish between normal, *undervoltage*, *overcurrent*, and Electrical Circuit Interupption based on changes in current and voltage values.

In terms of communication, all data from the 10 tests was successfully sent and received by Blynk with a 100% success rate. The transmission *delay* ranged from 1.1 to 1.4 seconds, with an average of 1.22 seconds. These results demonstrate that the system can provide measurement information via a dashboard with a relatively short response time under the network conditions used during testing.

Based on these results, the developed system has successfully performed its primary function as a prototype for *monitoring* the electrical condition of runway edge lights. The system not only displays current and voltage values but also processes these two parameters to provide an indication of system condition, allowing *fault* information to be accessed via the local display or IoT dashboard.

System Limitation Analysis

The system developed in this research is still in the prototype stage, and testing was conducted using a runway edge light model with a mini *bulb* as the load. Therefore, the system cannot yet be directly implemented in runway edge light facilities at airports. Implementation in actual facilities requires a licensing process, compliance with safety requirements, and adjustments to applicable airport standards and SOPs. Furthermore, the device developed in this research has not yet undergone a certification process or approval for use as an operational device in aviation facilities. Another limitation lies in the *monitoring* dashboard used. The Blynk dashboard is capable of displaying current, voltage, and condition status values in real time, but in this study it was not equipped with data storage or *history* facilities.

Thus, the displayed data primarily reflects the system's condition at the time of *monitoring* and has not been used to create a historical record of system conditions. This limitation presents an opportunity for further system development, particularly through the addition of *data logging*, historical storage, and the development of devices that meet the requirements for application in airport facilities.

Comparison with Previous Research

The results of this study show similarities and differences with previous research. The use of the ACS712 and ZMPT101B sensors in this study is similar to Anugrah's study, which utilized both sensors to obtain current and voltage parameters. The difference lies in the purpose of using these parameters, namely, this study uses them as indicators of disturbance conditions in a runway edge light model.

Putra et al.'s research is closely related to *airfield lighting* facilities and the use of the ESP32, ACS712, and ZMPT101B. However, this study focuses more on utilizing current and voltage changes to identify *fault* conditions in runway edge lights and presenting the results through an IoT dashboard.

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Meanwhile, Andeni's research implements *airfield lighting monitoring* using current sensors and IoT, while this study integrates current and voltage parameters as the basis for classifying system conditions.

Radwitya and Alkadri's research shares similarities in the use of ACS712, ZMPT101B, LCD, and Blynk in a current and voltage *monitoring* system. The difference lies in the research object, because that research was applied to household electrical installations, while this study applies the *monitoring* concept to a runway edge light model. Thus, the contribution of this research lies in the application of a combination of current and voltage parameters and IoT technology to provide an indication of *fault* conditions in a prototype-based runway lighting system.

Conclusion

Based on the results of the design and testing of the current and voltage *monitoring* system as an indicator of disturbances in IoT-based runway edge lights, it can be concluded that:

1. The results of the current and voltage *monitoring* tests show that the system is able to read the electrical parameters on the runway edge light model. From 15 tests, the voltage values read are in the range of 203.0–220.5 V, while the current values are in the range of 1.90–2.03 A. These results indicate that the ACS712 and ZMPT101B sensors can be used to obtain current and voltage data as system *monitoring* parameters.
2. The *fault* detection test results show that the system is able to identify conditions based on predetermined threshold values. Under normal conditions, the voltage is in the range of 209–231 V with a current of 1.8–2.0 A. Voltage values below 209 V are successfully identified as *undervoltage*, currents above 2.0 A as overcurrent, while a current of 0 A is identified as an indication of a Electrical Circuit Interupption or non-operating load. Thus, changes in current and voltage parameters can be used as condition indicators in the runway edge light model.
3. The results of the *real-time* data transmission test showed that all 10 test data points were successfully received by the Blynk platform, resulting in a 100% success rate. The transmission *delay* ranged from 1.1 to 1.4 seconds, with an average of 1.22 seconds, enabling the system to transmit *monitoring* results from the ESP32 to the dashboard in real time under test conditions.
4. The results of the *monitoring* dashboard test show that the current, voltage, and condition status values can be displayed on Blynk according to the data processing results on the ESP32. Normal conditions are displayed as NORMAL, while *undervoltage*, *overcurrent*, and Electrical Circuit Interupption are displayed as *FAULT*. This shows that the dashboard can be used as a medium for monitoring the electrical conditions of the runway edge light model in real-time.
5. Overall, the developed system successfully integrates current and voltage measurement, condition classification, data transmission, and visualization of *monitoring* results into a single IoT-based system. The system is still a prototype and cannot yet be directly implemented in runway edge light facilities at airports due to the need to comply with applicable licensing, safety, and standard operating procedures (SOPs). Furthermore, the dashboard does not yet have a data storage or *history* feature, so the information displayed is still focused on conditions at the time of the monitoring.

Reference

Andeni, A. N. (2025). *Prototype IoT-Based Airfield Lighting On/Off Monitoring System* (ALMOS) Using ESP32 Microcontroller. Journal of Airport Engineering Technology (JAET), 6(1), 25–33.

Al-Fuqaha, A., Guizani, M., Mohammadi, M., Aledhari, M., & Ayyash, M. (2015). Internet of Things: A survey on enabling technologies, protocols, and applications. IEEE.

Amri, S., Fajrul, R., & Custer, J. (2026). IoT-Based Smart Energy Management System for Air-Conditioning Energy Efficiency in Mosques. Journal of Embedded Systems, Security and Intelligent Systems, 33-48.

Anugrah, I. (2017). Pengukur daya listrik menggunakan sensor arus ACS712-05A dan sensor tegangan ZMPT101B (Proyek Akhir). Universitas Negeri Yogyakarta, Yogyakarta, Indonesia.

Ashish, K., & Singh, R. (2021). Design and implementation of smart airport infrastructure using Internet of Things. Sensors, 21(18), 1–20

Bolton, W. (2015). Programmable Logic Controllers and Industrial Automation . Oxford: Elsevier.

https://doi.org/10.61536/ambidextrous.v5i02.833

Fachrul Ramadhan, Deni Satria, Ratna Aisuwarya. 2013. "Rancang Bangun Implementasi Sistem Pencuci Tangan (Hand Washer) dan Pengering Tangan (Hand Dryer) Otomatis". Jurusan Sistem Komputer, Fakultas Teknologi Informasi, Universitas Andalas. Padang.

Hafizur Rizki, Wildian. 2015. "Rancang Bangun Sistem Wastafel Otomatis Berbasis Mikrokontroller Atmega8535 Dengan Menggunakan Sensor Fotodioda". Jurusan Fisika, Fakultas FMIPA, Universitas Andalas, Padang.

Haryadi, Gatot. 2012. "Pencuci Dan Pengering Tangan Otomatis Berbasis Mikrokontroler ATMEGA8535". Jurusan Sistem Komputer, Universitas Gunadarma.

International Civil Aviation Organization (ICAO), Aerodrome Design and Operations, Annex 14, Volume I, 8th ed. Montreal, QC, Canada: ICAO, 2018 L. Da Xu, W. He, and S. Li, "Internet of Things in Industries: A Survey," IEEE Transactions on Industrial Informatics, vol. 10, no. 4, pp. 2233–2243, Nov. 2014.

Mada, Jimmy. 2014. "Belajar Pemograman Mikrokontroler Arduino".

Pedoman Penulis Skripsi, Fakultas Teknik, Universitas PGRI Adi Buana, 2020.

Perusahaan Umum Listrik Negara. (1978). SPLN No. 1:1978 tentang Tegangan- Tegangan Standar. Jakarta: Perusahaan Umum Listrik Negara.

Putra, I. G. D. A., Kartika, R. B. B., & Suprihartini, Y. (2020). Sistem monitoring operasional lampu runway threshold identification light (RTIL) di laboratorium *airfield ground lighting* Sekolah Tinggi Penerbangan Indonesia. Jurnal Ilmiah Aviasi Langit Biru, 13(2)\

Radwitya, E., Alkadri, S. I., dkk. (2026). Perancangan alat monitoring tegangan dan arus listrik berbasis mikrokontroler untuk *monitoring* real-time. Jurnal Simetrik, 16(1) Sugiyono. (2022). Metode Penelitian Kuantitatif, Kualitatif, dan R&D. Alfabeta.

Solikin, A., & Wijaya, W. S. (2025). Implementasi Data Logger Menggunakan Sd Card Pada Pembangkit Listrik Tenaga Surya Di Tambak Udang Banjarasri Kecamatan Tanggulangin Kabupaten Sidoarjo Jawa Timur. Jurnal Qua Teknika, 15(02), 130- 140.

Solikin, A., & Rochman, S. (2025). Artificial Intelligence System for Face Detection to Identify Passenger Identity at the Airport. Best: Journal of Applied Electrical, Science and Technology, 7(1), 11-16.

Wardhana, Lingga. 2006 . "Belajar Sendiri Mikrokontroler AVR Seri ATMega8535 Simulasi, Hardware, dan Aplikasi". Penerbit Andi. Yogyakarta.

Zhang, L. et al. (2021). Intelligent Climate Control Using IoT and Cloud Integration. Sensors Journal.

https://doi.org/10.61536/ambidextrous.v5i02.833