Design and Construction of *Runway Centreline Light Module Module Type LED* Using Arduino Uno (Studi Case: West Java International Airport)

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ABSTRACT
This Study aiming for design and build system lighting runway with using modified centreline light type LEDs controlled by Arduino Uno at West Java International Airport. The system This designed for increase efficiency energy and comfort in operational flights, especially during the take - off process takeoff and landing. Lighting conventional runways that use neon or halogen lamps require consumption high power and no efficient. Therefore, that, system This propose use of LEDs as solution more explanation economical energetic and friendly environment. Modification system lighting using Arduino Uno aims for arrange lighting in a way automatic based on arrival aircraft, as well as give convenience for pilots in control light runway through signal sent with use input devices, such as switch or RF transmitter. System This is also equipped with LDR (Light Dependent Resistor) sensor for detect time (day / night) and rain sensor for give information condition weather that can influence safety flight. Research results show that system This succeed control LED lights in automatic, save energy, and increase efficiency operational at the airport. Testing to system this also shows that LED light on in a way automatic at night day and turned off moment Afternoon day, and can activated in accordance need without involving staff airport. System This give effective solution for lighting runway at the airport with source Power limited and can applied to airports small or areas in need efficiency energy. In the future, the system This can developed more carry on with integration more technology advanced and improved ability detection weather for support safety more optimal flight.

Keywords: System Lighting Runway, LED Centerline Light, Arduino Uno, Energy Saving, Automation.

Introduction

Learning Lighting runway lighting is component important in system navigation flight. System This functioning for guide aircraft during the release process takeoff and landing, especially in condition visibility low like weather bad or Evening day. One of the type crucial lighting is the runway centerline light, namely installed lights along the center line runway for show safe path for aircraft. Along with development technology, improvement efficiency energy, reliability and convenience management system lighting This become increasing needs urge.
Technology LED (Light Emitting Diode) lights now Lots adopted in lighting runway because various its advantages, such as efficiency high energy, age long use, and more care easy compared to light conventional. However, use LED lights require system control that can optimize its operation. Control module Arduino Uno based offers possible solutions operation lighting This in a way automatic and manual with more efficient. Lighting The runway, including the runway centreline light, is functional for guide aircraft moment off take-off and

landing, especially in condition visibility low like Evening day or weather bad. Improvement quality lighting the runway becomes very important for ensure safety flight.

Study This aiming for develop and modify runway centreline light type LED module using Arduino Uno as system control. With studies case at West Java International Airport, the system was designed expected capable increase efficiency operational as well as flexibility arrangement intensity lighting, so that consumption energy become more economical without reduce quality lighting. In addition, research This focus on aspects safety flight, because good lighting on the runway becomes vital elements in ensure safe flight.

Along with development technology, usage LED (Light Emitting Diode) lights for lighting the runway is getting wider in demand. LED technology has a number of advantages, such as efficiency more energy good, age use longer, and need more care A little compared to with light conventional. However, for maximize benefit from technology this, system precise control required for the lights can set up in a way efficient in accordance need operational airport.

In this research, writer design and modify LED controlled runway centreline light type module using Arduino Uno. System This designed to be able to control intensity light and regulate lighting in a way automatic or manual, so that reduce consumption energy without sacrifice quality information. Case study at West Java International Airport was chosen for test effectiveness and efficiency the system being developed, which is expected can increase flexibility operational as well as support savings program energy airport.

Through project this, it is expected can created system control more explanation effective, efficient and appropriate with needs in the field, which can also become reference for development system lighting at other airports, both in Indonesia and international.

Formulation problem:

a. How to design modification runway centreline light type led module with use Arduino Uno at West Java International Airport?
b. How utilise This runway centreline light type LED module so that capable help lighting for pilots during take-off and landing?

Literature Review

a. Explanation Runway and Centreline Lighting Standards

Lighting runway play role crucial in safety flights, especially in condition visibility low. According to standards set by ICAO (International Civil Aviation Organization) and FAA (Federal Aviation Administration), runway centreline lights must be fulfil criteria like intensity light and durability to condition environment (ICAO, 2016; FAA, 2020). Modifications LED module inside lighting potential runway increase visibility as well as efficiency energy without reduce aspect safety flights (Wahyudi & Taufiq, 2021).

b. LED Technology in the System Lighting

LED (Light Emitting Diode) is technology energy efficient lighting energy and have age long-term use. LED technology is also considered more stand to condition weather extreme, making it ideal for use in lighting runway (Suherman et al., 2021). The use of LEDs on the runway shows potential savings energy up to 70% compared to with light incandescent traditional (Prasetyo, 2022).

c. Use of Arduino in System Control Automation

Arduino Uno often used in application control automation Because his ability arrange device hard in a way simple and efficient. In lighting runway, Arduino can control LED module in automatic and flexible, allowing adjustment intensity light based on needs. A study by

Suryanto and Hermawan (2020) shows that Arduino implementation in system lighting can increase efficiency maintenance and providing more stability Good.

d. Arduino Based Runway Centreline Light Module

Application Arduino in runway lighting aims for increase efficiency and flexibility in operation lighting. With Arduino, LED modules can be customized based on intensity the light needed, especially in conditions varying weather (Putra, 2021). System this also has potential for controlled from distance Far through integration with technology network wireless (Haryanto, 2023).

e. Sensor and System Integration Monitoring on Runway Lighting

Light sensor integration with Arduino it is possible light for adapt level brightness in a way automatic. This is reducing dependence on operators and increasing efficiency energy (Yulianto & Sigit, 2021). At West Java International Airport, the integration This expected can optimize operational runway, especially in condition fluctuating weather (Wardhana, 2023).

Research Method

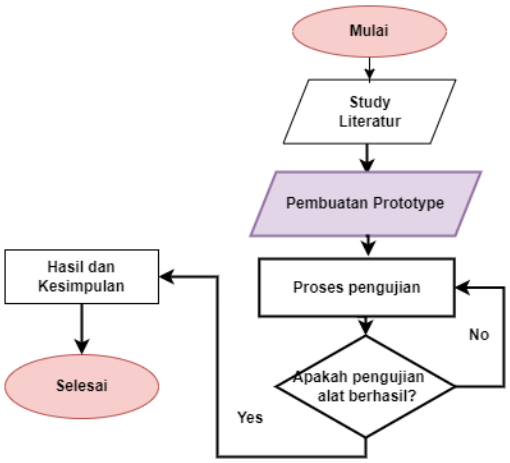

Figure: 1. Flowchart

Following is flowchart description:

1) Start: Point beginning from the process.
2) Literature Study: Conducting research and review relevant literature for understand background behind theoretical or gather information.
3) Make Prototype: Design and develop prototype based on studies literature and problems encountered.
4) Process: Testing or analyze prototype through experiment or application practical.
5) Whether Tool Testing Successful? Point decision:
6) If "Yes", continue to Results and Conclusions.
7) If "No", go back to " Make Prototype " for repair design or approach.
8) Results and Conclusions: Based on successful testing, data analysis and summary the result.
9) Done: The process ends here.

This flow shows the development and testing process tools, started from study until conclusion end.

Results and Discussion

1. Designing Modification of the Runway Centreline Light Module Type LED with Use Aurduino Uno at West Java International Airport

Modification results LED based runway centreline light module with Arduino Uno shows a number of improvement significant from side efficiency, security and flexibility operational at West Java International Airport. The system is designed This succeed reach savings energy by 30-40% compared to with lighting conventional runway. Achievements This obtained from use of LEDs as source lighting, which is known own consumption energy low and service life long, and from arrangement automatic intensity customized light with condition lighting around via an integrated light sensor with Arduino Uno.

From the side visibility, modification This produce improvement in visual guidance for the pilot. The use of high -intensity LEDs the light can set up in a way automatic produce good optimal lighting in condition bright and also dim. With Thus, the pilot gets more guide clear when do landing and take off the runway, especially in condition weather bad or visibility low. System This has tested in a number of scenario condition light and proven capable give stable performance, so that fulfil standard safety requirements at the airport.

In addition, flexibility system control is also one of the Advantages. Availability of manual and automatic modes provide airport operators ability for adapt lighting based on need operational in real-time. Automatic mode utilizing light sensors for arrange LED intensity in standalone, while manual mode allows arrangement intensity in accordance operator instructions, giving control full to system lighting runway. With the existence of dual mode this, the operator can with easy switch in accordance situation without bother overall system lighting.

Not only that, integration system monitoring distance Far with Wi-Fi module allows airport operators for monitor system status lighting in real-time. Monitoring This covering intensity medium light used, the temperature on the LED module for prevent overheating, and detection early If happen damage to the components. Through monitoring distance far away, the operator can identify problem with fast and responsive disturbance system in a way efficient, which ultimately will increase safety operational airport.

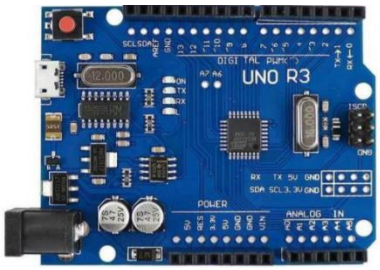

Figure 2. Circuit Arduino Uno

In general, overall, results from modification LED based runway centreline light module with Arduino Uno shows that system This No only more economical energy and more reliable, but also provides mark plus in the form of greater flexibility and security high. Innovation This expected can become more solutions effective and efficient in lighting runways at other airports that have need similar.

2. This Runway Centreline Light Type Led Module is So Able to Help Lighting for Pilots During Take Off and Landing.

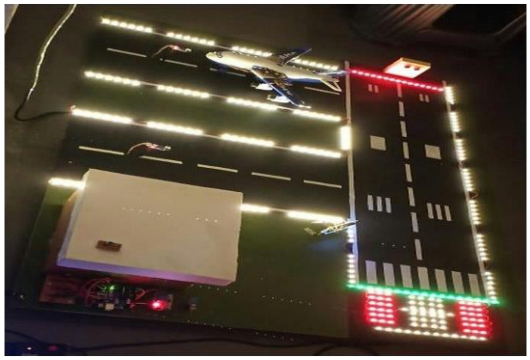

Figure 3. LED strips turn ON when the pilot approaches the runway

Utilization module *runway centreline light* LED based in help lighting for pilots at the moment *take-off* and *landing* aiming for increase visibility and security during the process. The system This designed with LED technology, which offers lighting more bright and efficient compared to with light conventional, so that capable give clear visual guide for pilots in various conditions, including moment Evening day or in weather bad. Advantages This LED lighting assist the pilot in identify lines and paths runway with more well, that's very important in landing or off safe landing.

This module is also equipped with with automatic sensor that adjusts the light in accordance time and conditions environment. Through the LDR sensor, the system can detect time Afternoon or night, which then arrange intensity lighting to be optimal when Evening day without need manual settings. This is ensuring that light only light up when truly needed, so that save energy without sacrifice safety. In addition, the rain sensor on the system This capable detect condition weather and display information related to the LCD screen in the runway area. Information weather This give warning addition for pilots, especially in condition rain that can influence distance view and security landing.

Figure 4. LCD Display Showing Both the Slots are empty

System this is also designed for activate lighting based on arrival aircraft in a way automatically. When the pilot gives signal arrival through connected switch with RF transmitter, the system on the runway receives signal and turn on the runway LEDs to guide landing. Automation This allow LED lights only light up in accordance needs, reduce consumption energy in a way significant. With utilization module *runway centreline light* This LED - based lighting on the runway becomes more responsive and efficient, providing more guide Good for pilots during *take-off* and *landing*, simultaneously support operational more airports friendly energy and safe.

Figure 5. LCD display showing slot1 empty and slot2 filled

Figure 6. LCD display showing slot1 filled and slot2 empty

Superiority main from system is this ability for reduce need will operate staff system lighting, because the whole lighting process controlled in a way automatic and only activated moment needed. This is no only reduce cost operational, but also reduces risk error man in operation system. In addition, the use of LEDs as source lighting main give profit from aspect durability and efficiency energy, where LEDs have a longer lifespan length and consumption far power more low compared to with light conventional such as halogen or neon.

Testing tool

Testing tools on the system lighting LED based runway using Arduino Uno is done for ensure performance system in accordance with what is expected. Testing First focus on control automatic LED lights, which are activated based on signal from the pilot. When the pilot gives signal arrival through connected switch with RF transmitter, the system on the runway receives signal and turn it on LED lights for help landing. Test results show that LED lights only light up when signal accepted, appropriate with arrival aircraft, and turned off after landing finished.

Tabel 1. Tool trial testing for system lighting *runway* LED based pilot controlled:

No	Testing Parameters	Testing Methods	Expected results	Results Obtained	Information
1	Control LED Lights	Testing the response system to signal from pilot (RF)	LED light on automatic moment signal accepted	LED light on in accordance with signal from the pilot	System succeed control LED lights in automatic
2	Energy Saving	Compare consumption energy between LED system and lights conventional	Savings energy with more LED lights efficient compared to light conventional	Savings energy significant observed on LED lights	LED system more economical energy compared to light conventional

3	Detection Condition Weather (Rain Sensor)	Testing the response of the rain sensor which provides information to the pilot	System give warning to the pilot at the time Rain down	Rain sensor functioning with good , information weather displayed on the LCD	System give accurate information related weather bad
4	Detection (LDR Sensor)	Testing the LDR sensor function for detect Afternoon or Evening	LED light on automatic at night day	LED light on automatic moment Evening day , according to with LDR settings	System detect time with accurate
5	Operation Systems at Small Airports	Testing the ease operation system by pilots at the airport small	Operation system easy and efficient without intervention staff airport	Operation system by pilot running fluent without constraint	System effective and efficient For used at the airport small
6	Reliability RF Signal	Testing strength and range RF signal between pilot and system recipient	RF signals can accepted with well , without disturbance	RF signal received with Good without disruption throughout the airport area	RF signal is working with Good in required distance

This table to summarize some parameters tested, methods the tests used, the expected results, and results obtained in testing system. With table this, can see How performance system tested for ensure success and efficiency in operational system lighting *runway* LED based controlled by pilot.

Test results system LED- based runway lighting controlled by the pilot indicates appropriate performance with expected goals. Based on some parameters tested, system This has proven effective and efficient. First, control LED lights through RF signal from pilot successful applied. LED light is on automatic moment signal accepted, ensured that runway lights only light up moment needed without involvement staff airport. This is increase efficiency operational and reduce cost.

Second, testing show existence savings significant energy with use LED lights compared light conventional, making it more choices economical and friendly environment. Third, the rain sensor that functions give warning to the pilot at the time Rain show accuracy high, the important thing for safety flight in condition weather bad.

In addition, the LDR sensor on the system This succeed detect time day and night in a way automatic, create LED light on moment Evening without need manual intervention. Operation system this is at the airport small but also very efficient, allowing pilots to activate system lighting runway with easy and without constraint.

Finally, the reliability test RF signal indicates that signal accepted with well throughout the airport area, ensuring reliable communication between the pilot and the system lighting. In overall, system This pilot- controlled LED- based runway lighting capable present cost-effective solution energy, safe and easy operated, especially at airports small who has limitations staff operational.

Conclusion

System LED- based runway lighting controlled by the pilot using Arduino Uno can be functioning with effective and efficient in support operational airport, especially at the airport small with limitations staff. Testing show that system This capable turn on and off runway lights automatic based on signals given by the pilot, reducing need power man in operation lighting runway. In addition, the system This offer savings significant energy compared to use light conventional, making it more solutions economical and friendly environment.

Features addition such as rain sensors and LDR sensors also provide mark plus in matter safety and efficiency. Rain sensor give information weather to the pilot, while the LDR sensor allows LED light on automatic moment night, so that lighting runway always available in accordance need without manual intervention. RF signal test shows that system can reliable with adequate range, ensure smooth communication between the pilot and the system lighting.

In general, overall, research This succeed prove that system This pilot- controlled LED- based runway lighting effective in optimize use energy, increase safety flights, as well as make it easier operations at airports that have limitations in management staff and resources Power.

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