PROTOTYPE OF CONTROL AND MONITORING OF LAMP CONDITION, LUMEN AND BOX ANGLE PRECISION APPROACH PATH INDICATOR (PAPI) BASED ON GSM

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Abstract
Precission Approach Path Indicator (PAPI) is one of the visual aircraft landing aids in the form of lighting lamps that function to assist aviators when landing on the runway in order to land efficiently and safely. Precission Approach Path Indicator (PAPI) has an important role during the aircraft landing process, so a control and monitoring system is needed as an alternative way or another option in monitoring the condition, lumen and angle of the Precission Approach Path Indicator (PAPI) lamp. This research prototype uses the Arduino Mega microcontroller as data processing obtained from the ACS712 current sensor which detects whether or not the lamp is on the Precission Approach Path Indicator (PAPI), the BH1750 lumen sensor detects if the PAPI lamp has decreased light intensity past its minimum limit, and the MPU6050 angle sensor which detects if there is a change in the angle of the Precission Approach Path Indicator (PAPI) box and later the GSM SIM800L will send an SMS message to the technician's cellphone that a problem has occurred. This tool can also control the disconnection or connection of PAPI lights via SMS commands. The results of research on this prototype tool control system can work to turn on or turn off PAPI lights only by sending SMS messages via cellphone with an average delay time of 2 seconds after the message is sent. The monitoring system can also work well, namely when a trouble maker is carried out on each sensor, the cellphone receives an SMS message by displaying the sequence of PAPI lights that are experiencing problems. With the results of this research, it is hoped that technicians can be helped and flight operations can run well.

Keywords: Precission Approach Path Indicator, Lamp Condition, Lumen, Angle, GSM.

INTRODUCTION

Airports have a lighting system called the Airfield Lighting System (AFL). AFL is a visual landing aid that helps aircraft during takeoff, landing, and taxiways (paths to the apron) so that they can move in an efficient and safe way. Precision Approach Path Indicator (PAPI) is one of the visual aircraft landing aids in the form of lighting that functions to assist pilots when landing on the runway so that they can land efficiently and safely.

The Precision Approach Path Indicator (PAPI) lamphas several factors that can affect the lights including the absence of power from the Constant Current Regulator (CCR), broken primary or secondary cables,damaged series transformers, damaged lamps due to short circuits, and the age of the lamp and the density factor of the soil that can make the angle of the PAPI light box change. The process of monitoring the performance of PAPI lamps, technicians still do it manually going to the field directly, so the effectiveness is low and inefficient in terms of time. Technicians check the PAPI lights every night when the flight is over. In the morning or the start of the flight until the completion of the flight the technician standsby at the standby place, if the PAPI lamp is not on or off and when the angle of the PAPI light box changes during use there is no indicator that can inform the technician, so usually the technician waits for a report or info from the aviator through the ATC (Air Traffic Controller) officer that the PAPI lamp is not on (off) as well as when the slope of the PAPI angle is incorrect. And when the technician will replace the PAPI lamp that is not on, he must turn off the source from the technician's standby room and later all four PAPI light boxes will die.

This study deals with the monitoring system of electrical quantities such as current and voltage. The system uses AC current sensor SCT 013-000 and voltage sensor ZMPT101B to read the electrical quantities. Arduino Mega processes the data generated by the sensors and sends the data using SIM 800L to the mobile phone via SMS so that the user can monitor and control the use of electrical energy quickly and accurately. Voltage and current data are also stored in the data logger to be used as backup data if the system fails to function properly/system failure. The use of SMS is considered reliable because it only requires a minimal GPRS/Edge network to send data with characters long enough so that all voltage and current data information can be sent completely to the user's

device. The SIM800L module test showed a success rate of 80% (Adam, Hikmatul Amri, Miswan, 2019).

The technicians in monitoring the approach lightat the international airport have a little difficulty, because the approach light is far from the power house and the location is difficult to reach, especially at the approach light. In this research using a Microcontroller as a control medium and sms gateway as a communication medium, the method for displayingmonitoring results using wonderware to be displayed ona computer or pc and to communicate between the computer and the Microcontroller using a usb to serialcable. The results showed that monitoring the on or offof lights can use a PC or computer and technician performance with this method becomes more efficient (Kustori, Fiqqih Faizah, Suhanto, 2020).

The purpose of this research is to design a controland monitoring system for Short Message Service (SMS) based lights that can control and check the statusof lights remotely. Regarding feedback, this tool uses LDR as a sensor, GSM 900 shield as an information link with a cellphone, and Arduino Uno as a data processing and control center, which will later give commands to relays and will be forwarded to turn on and off the lights. Based on the results of tests that havebeen carried out both on hardware and software that have been carried out and considering the objectives ofthe study, it can be concluded that this tool has been tested and can be used to control lights remotely. Thistool helps users to control and monitor the status of the home electric lighting system remotely via cell phone.There is an SMS reply that the lights can be controlled.This proves that the feedback works perfectly (Budi Novianto, Slamet Winardi, Tubagus Purwo Rusmiardi, 2016).

The Precission Approach Path Indicator (PAPI) lights need to be maintained in terms of reliability by actively preparing the facility by checking or monitoring the condition of the lights on the PrecissionApproach Path Indicator (PAPI). With the problems faced by technicians, there is a way to try to solve the problem by means of other options in monitoring the condition of the lights on or off and the tilt angle of thePrecission Approach Path Indicator (PAPI) box remotely. Based on this background, the title Prototypeof Control and Monitoring of Lamp Condition, Lumenand Angle of Precission Approach Path Indicator (PAPI) Box Based on Gsm can be chosen.

METHODS

Research Design

In the process of designing control and monitoring of lamp conditions, lumens and angles of the GSM-based Precision Approach Path Indicator (PAPI) box refers to the research and development method.

The research and development method is a research method used to produce certain products, by testing the effectiveness of certain products. The following is a tool design plan using a block diagram:

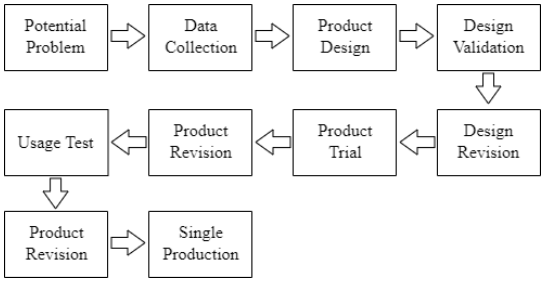

Figure 1. Tool Research Design

Tool Design

Based on the completed tool design block diagram, this process is the beginning of the tool's work.In this tool using Arduino Mega 2560 as a microcontroller. The PAPI lamp here gets an AC source which is passed through the ACS712 current sensor asa detector of whether or not the PAPI lamp is on and isparalleled with the ZMPT101B voltage sensor to detect the voltage whether or not there is voltage from the source, then passes through the relay as a switch connecting or breaking the electricity when replacing the PAPI lamp. SIM800L GSM module as aninformation link from arduino mega to cellphone. Arduino Mega is a microcontroller that will receive datafrom the ACS712 current sensor, BH1750 lumen sensor and MP6050 gyroscope angle sensor which is then channeled to the LCD, GSM, and relay. Red Dot Laseras an alternative media if GSM is having problems andwill turn on if there is a PAPI lamp that is not on or broken, the lumen of the PAPI lamp has decreased fromthe minimum limit and when the PAPI box has a changein its angle. LCD as a display of the results read by theACS712 sensor and MP6050 gyroscope angle sensor inthe form of a PAPI lamp number that is off or a PAPI box number that changes its angle. Adapter as a sourceof power from Arduino Mega. Push button functions toset each sensor to work at the minimum value limit. Mobile phone as a device used by technicians to controland monitor the tool. For the DC source comes from anadapter with 12 VDC output which is used as a relay source, then paralleled with a buck converter XL4016 to be reduced to 5 VDC which is used to provide sourceinput to all components above except GSM SIM800L which can source 4VDC input from LM2596.

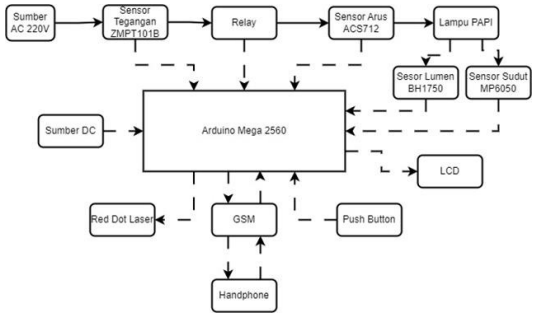

Figure 2. Block diagram of tool design

Testing Technique

The testing technique is carried out with the aim of knowing the performance of the designed tool whether it is working properly in accordance with its function. So it is necessary to do testing in accordancewith the tools made. The test method used in thisresearch is a direct testing method used to test certain functions of the designed tool.

Relay testing aims to ensure that the relay modulecan control the flow of electricity correctly based on the commands given by Arduino via cellphone.

Testing Method:

1. Prepare the necessary tools and materials
2. When the lamp is ON, send the PAPI lamp OFF command message along with the PAPI lamp number that you want to OFF via SMS with a cellphone.
3. Start counting with the stopwatch from the start of sending the command message.
4. When the light is OFF stop the count on the stopwatch and record the results.
5. If the lamp is in OFF condition then send thePAPI lamp ON command message.

Testing the SIM800L GSM module is carried out to determine the ability of the SIM800L GSM module to send and receive SMS correctly when the sensor sensor detects an error or disturbance in the PAPI lamp.

Testing Method:

1. Prepare the necessary tools and materials.
2. For the first test, disconnect one of the input wires from the PAPI lamp.
3. If the mobile phone displays the message "current... error=..." then the GSM SIM800L can function normally.
4. Second test, change the angle of one of the PAPI light boxes (lowered).
5. If the phone displays the message "angle.. error=.." then the GSM SIM800L can function normally.
6. The third test, cover the LED light with plastic or paper to reduce the intensity of the Light.
7. If the phone displays the message "lumen.. error=.." then the GSM SIM800L can function normally.

Testing the 5mw red dot laser aims to find out that the laser can work when the GSM SIM800L is experiencing network interference and cannot send SMS messages.

Testing Method:

1. Prepare the required tools and materials.
2. Remove the SIM Card installed in the GSM.
3. If the red dot laser emits red light then the laser is working according to its function.

Data Analysis Technique

From the previously described problems, a data analysis technique will be made to analyze whether or not the performance is good, then data analysis can be carried out according to the system through performance & data issued by the factory. The data analysis activities used are as follows:

1. Ensure that the components to be applied are functioning properly and normally.
2. Comparing the readings from the sensor with several measurement tools such as lux meter and multimeter.
3. Comparing the readings on the LCD screen with those displayed on the SMS message.

RESULTS AND DISCUSSION

Relay Testing Data

This relay module is used as a control of this prototype which works when the technician sends a command message for lights on or lights off via cellphone. In this test, testing is done using a stopwatch to find out how many seconds it takes for the relay module to work after the technician sends a command message.

Figure 3. Testing the Relay Module

The following table shows the results of the relay module sensor test:

Table 1. Testing Data of Relay module

PAPI Lamp	Command	Relay working Condition	PAPI lamp Condition	Time (S)
A	OFF	Yes	OFF	2,16 s
	ON	Yes	ON	2,5 s
B	OFF	Yes	OFF	2,7 s
	ON	Yes	ON	2,4 s
C	OFF	Yes	OFF	2,5 s
	ON	Yes	ON	2,4 s
D	OFF	Yes	OFF	2,3 s
	ON	Yes	ON	2,6 s

From the table data of the relay module test results,it is found that the time required for the relay module to respond to SMS commands from the technician is fast enough to turn off and turn on the PAPI lights again. In this case it can be concluded that the relay module can work according to its function properly.

SIM800L GSM Testing Data

This GSM SIM800L is the most important component in this tool prototype. This GSM is used for media connecting information from Arduino to cellphones. In this test, testing is done by doing a trouble maker on each sensor. If the GSM SIM800L works, it will send an SMS message to the cellphone that there is an error.

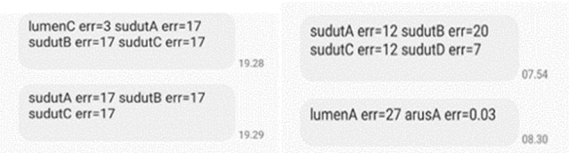

Figure 4. SIM800L GSM Testing

The following is a table of GSM SIM800L test result data:

Table 2. GSMSIM800L Test Result Data

Tests	PAPI Lamp	*Trouble Maker Done*	Sending SMS
Current Sensor ACS712	A	Yes	Yes
	B	Yes	Yes
	C	Yes	Yes
	D	Yes	Yes
Angle Sensor *Gyroscope* MPU6050	A	Yes	Yes
	B	Yes	Yes
	C	Yes	Yes
	D	Yes	Yes
Lumen Sensor BH1750	A	Yes	Yes
	B	Yes	Yes
	C	Yes	Yes
	D	Yes	Yes

From the data table of GSM SIM800L test results above, it is found that GSM is able to send SMS messages equipped with PAPI lamp numbers that occur errors. With this, it can be concluded that GSM SIM800L can work sending SMS properly.

5mw Red Dot Laser Testing Data

This 5mw red dot laser is used as an indicator and will emit red light when GSM is experiencing signal problems or cannot send SMS messages. In this test, testing was carried out by removing and installing the SIM Card.

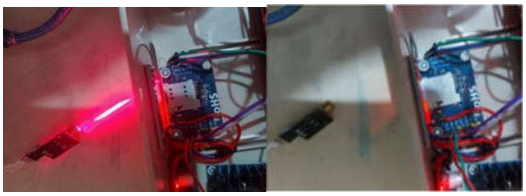

Figure 5. Testing the 5mw Red Dot Laser

The following is a table of data on the results of the 5mw red dot laser test:

Table 3. Testing Data of 5mw Red Dot Laser

Testing to-	SIM Card	Laser Conditions	SIM Card	Laser Conditions
1	Installed	Off	Released	On
2	Installed	Off	Released	On
3	Installed	Off	Released	On

From the data table of 5mw red dot laser test results, it is found that when the SIM Card is installed, the laser condition will turn off and when the SIM Card is removed, the laser condition will turn on. In this case it can be concluded that the 5mw red dot laser is able to work properly when there is interference with GSM.

CONCLUSION

From the whole research trial, it can be concluded as follows:

1. In the final project report there are componentsused to create a GSM-based Prototype Control and Monitoring of Lamp Conditions, Lumen and Precision Approach Path Indicator (PAPI) box angle and also accompanied by a series of tools.
2. The control system for on or off PAPI lights can be via SMS commands and the PAPI lamp condition monitoring system can detect whether the lights are on or not, because when a PAPI lamp breaks there is an SMS message on the cellphone in accordance with the order of the broken PAPI.
3. The PAPI lamp lumen monitoring system can detect if the light intensity emitted by the lamp has decreased and at that time there is also an SMS message on the cell phone according to the PAPI lamp command that has decreased the lumen.
4. The PAPI box angle monitoring system can detect if there is a PAPI box that has changed from its original angle and there is an SMS message on the cellphone in accordance with the order of the PAPI box that has changed the angle.

SUGGESTION

To perfect and develop this tool include the following:

1. The use of 5mw red dot laser as a backup system experiencing an error (unable to send SMS messages) can be replaced using lights such as rotating beacons.
2. The application of control and monitoring to be directly applied to the actual PAPI located in Lab.AFL 3rd floor.
3. The 16x2 LCD screen can be replaced with a 16x4 LCD or larger so that when an error occurs in each PAPI, it can display in one slide only.
4. To improve the data transmission system to technicians, this tool can be replaced from GSM using a radio system.

REFERENCES

[1] Agus, Faudin. (2018). Advanced tutorial accessing GSM Module SIM800L v.2. Jakarta.

[2] Adam, Hikmatul, A., & Miswan. (2019). Current and Voltage Monitoring System Using SMS Gateway. Politeknik Negeri Bengkalis.

[3] Adam, M., Hamka, Yusuf, Hermansyah, Randi, G., & Ahmad, A. (2017). Plastic Waste Shredding Machine Adapter. Muhammadiyah University of Parepare.

[4] Andrianto, M.T.D. (2022). Prototype Control and Monitoring of Backup Constant Current Regulator (CCR) of Precission Approach Path Indicator (PAPI) Lamp Based on Microcontroller. Airport Electrical Engineering: Aviation Polytechnic of Surabaya.

[5] Budi, N., Slamet, W., & Tubagus, W. (2016). Design of Control and Monitoring of Lights with Short Messege Service (SMS) Technology. Narotama University.

[6] Directorate General of Air Transportation. (2002). Decree of the Director General of Civil Aviation Number: SKEP/114/VI/2002 concerning Standard Drawings of Airport Lighting System Installation.

[7] Directorate General of Air Transportation. (2003). Decree of the Director General of Civil Aviation Number: SKEP/157/IX/03 on Guidelines for Maintenance and Reporting of Aviation Electronic and Electrical Facility Equipment.

[8] Directorate General of Civil Aviation. (2017). Regulation of the Director General of Civil Aviation Number: KP 262 of 2017 concerning Technical and Operational Standards of Civil Aviation Safety Regulations Part 139 (Manual of Standard CASR - Part 139) Volume I Airports (Aerodrome).

[9] Elga, A.P. (2019). Arduino Mega 2560. PT Teknolab Caraka Internasional.

[10] Gatot, S., Wiwik, H., Slamet, H., & Gani, H.B. (2019). Design of an SMS Gateway-based Electricity Usage Measurement and ControlTool. AKPRIND Institute of Science and Technology Yogyakarta.

[11] Inggih, P. (2022). Adapter: Definition, History, Function, How to Work, Types of Circuits. Idmetaphor.

[12] Imam, Roni, M., Purnata, Hendi, Aji, & Galih, M. (2022). Implementation of Buck Boost Converter on Mobile Charging Station with Solar Panel. Cilacap State Polytechnic.

[13] Kustori, Faizah, F., & Suhanto. (2020). Design the Implementation of Monitoring Approach Light Runway Based on Microcontroller and SMS A Gateway at the International Airport. Aviation Polytechnic Surabaya.

[14] Kevin, N.T. (2022). Prototype Gyroscope as a WEB-based Approach Light Angle Calibration Tool. Airport Electrical Engineering: Aviation Polytechnic of Surabaya.

[15] Pramana, Nusyirwan, P., & Nugraha, H. (2019). Arduino and SMS Gateway-based for ships emergency information system. Tanjung Pinang.

[16] Rijalullah, Faid. (2016). Implementation Design of Monitoring Approach Light Runway 28 Based on Microcontroller and SMS Gateway at Juanda International Airport Surabaya. Airport Electrical Engineering: Aviation Polytechnic of Surabaya.

[17] Yuana, Haris, & Yuswandari. (2020). Design ofa Lamp Remote Control System Using Thingsboard Based on IOT. Computer Systems: Polinema.