Design the Implementation of Monitoring Approach Light Runway Based Microcontroller and SMS A Gateway on the International Airport

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Abstract. Their technician in monitoring approach light at the international airport, because the approach light far from power house and the location is difficult to reach especially on approach light. Their final task, it uses Microcontroller as a media control and sms the gateway as communication media, methods to display results of monitoring using wonderware to be shown on a computer or a pc and for communication between pc or computer with Microcontroller using cable usb to serial. The results showed for monitoring flame light die approach could use pc or computer and technicians this method performance becoming more efficient.

Keywords: Approach light, Microcontroller, sms gateway

1. Introduction
The airport is one of the places where air transportation is located. This mode of transportation is increasing in demand because by using airplanes, the time traveled to distant places is faster than using land and sea transportation modes. With the increasing interest in this mode of transportation, certainly the safety and comfort of facilities both inside the airport and on the plane continues to undergo evaluation and improvement, especially in terms of passenger safety factors when using aircraft as a mode of transportation [1]. For comfort factors include internal comfort factors and external comfort factors. These technical factors include many things, including technical security of air pressure on aircraft tires, air pressure inside the aircraft cabin, availability of seats and a good safety belt for passengers and many more. One technical factor that has continued to increase in terms of safety is the monitoring of the approach lighting system. Approach light system or so-called ALS is a sign in the form of lights that is useful to guide the pilot to approach the runway in the landing process. By seeing this sign, the pilot will discover whether the plane is in line with the runway or not. Thus, if the plane is not yet in line with the runway, the pilot must take action to adjust the plane to be in line with the runway. The standard arrangement of approach lights follows the ICAIO standard by means of the installation of the PALS (Precision Approach Lighting System) category 1. This standard is used at the International Airport until now [2]. Flight traffic is very heavy every day. Almost every 15 minutes, there will be planes that fly away from the airport or toward the airport. In this case, the continuity of work of the approach lighting system must be very considered, given the function of the approach lighting is very important for flight safety and comfort. Currently, technicians working in the field monitor the approach lighting system manually. Manual here means that the technician checks the approach light by directly reviewing where the lamp/light is located. Based on observations that the
writer has done, technicians will have difficulty when checking the condition of the approach lights due to the location of the approach lights that are far from the power house.

1.2. Approach Light Theory

Approach light system or so-called ALS is a sign in the form of lights that is useful to guide the pilot to approach the runway in the landing process. By seeing this sign, the pilot will discover whether the plane is in line with the runway or not. Thus, if the plane is not yet in line with the runway, the pilot's action is to adjust so that the plane is in line with the runway. Approach Lighting is located at the end of the runway. This sign emits continuous white color with an intensity of 20,000 cd during the daytime. Based on the number of each lamp/light unit used, the Approach Lighting System can be distinguished as follows:

a. Single Source
b. Barrete (several lights arranged in a row)

From the existing light units can be arranged in such a way to facilitate the clear vision of the runway for the pilot. The way of arranging the lamp units is known as the Approach Lighting System. The ICAO standard distinguishes the Approach Lighting System as follows:

a. SALS (Simple Approach Lighting System) this system is commonly used in the Non Instrument category runway.
b. MALS (Medium Approach Lighting System) this system is used by the Non Precision category runway which has codes numbers 3 and 4.
c. PALS (Precision Approach Lighting System)
   2. PALS category I used for category I Precision Runway.
   3. PALS category II used for category II Precision Runway.
   4. PALS category III used for category III Precision Runway.

![Approach Light configuration](Fig. 1. Approach Light configuration)

2. Planning and Manufacturing Tools

2.1. Present condition

Until now, the installation of approach lighting units uses ICAO standards with the PALS (Precision Approach Lighting System) installation method category 1. Because the location of the approach lights are far from the power house and there are many, the source of electricity used to supply the approach lights as a whole from CCR substation with 380 V current input voltage of 45 A and a frequency of 50/60 HZ, while the output of CCR is 15 Kw and the maximum current at the highest brightness is 6.6 A. The voltage per lamp is only 50 V because it has entered CCR.
Fig. 2. Current Block Diagram.

Each approach lights, equipped with isolating transformers which are used to protect the lamp from problems with interference in the electric power system, such as over voltage transient interference, noise or other interference that can cause damage to the approach lights. In its implementation, the technician had difficulty in conducting monitoring due to the presence of Approach lights which were in the ponds owned by residents who lived around the Juanda airport.

2.2. Desired Condition

Fig. 3. Desired Block Diagram.

Based on the explanation in the previous chapter, the desired condition is for the technician to easily ascertain the condition of the approach lights without coming directly to where the approach lights are. To realize the desired conditions, the writer tries to make a tool design that is expected to be able to facilitate technicians in monitoring the approach lights in Juanda airport. This monitoring process can be fully carried out in a place close to the power house. When the approach light is on, it means that there is a current going to the load, this current is read by the current sensor. Then, Arduino sends
commands and then the results of those commands are displayed on a computer screen. This monitoring process is expected to make it easier for technicians to control the approach lights. The block diagram diagram above explains how to monitor the approach lights using the ACS 712 current sensor. With a diagramming process like this, it has the advantage that if one of the approach lights does not function properly according to the current value that should go to the load, then it can be known which lamp is currently malfunctioning, and monitoring can be done without heading to where the approach lights are located. Thus it will facilitate the control and monitoring.

2.3. Tool Design Concepts

a) Working Principle of the Tool

Overall, the desired monitoring system that is monitoring can be done computerized. Computerization here is in other words using the display interface, in the form of a display of current values on the load and lamp conditions using the ACS 712 current sensor. The output of the current sensor is then read by the ATMega 2560 microcontroller using an Analog to Digital Converter (ADC) reading. After the ADC reading, the results of the ADC reading are then sent to the ATMega 2560 microcontroller and processed so that it can be displayed on a personal computer digitally. At Juanda Airport, the approach lights used has a power of 150 W, the output of the CCR is 6.6 A and 15 kW with a voltage at the approach lights 50 V. If the reading of the current value on each approach light does not match the previous value, the technician can directly ascertain which lamp is not operating properly and can replace it with a new approach light. ACS 712 current sensor that is used has a maximum current capacity of 5 A because the writer uses consideration for a maximum brightness of 3 ie with a maximum current of 3 A, this has met the criteria of the maximum current passed by 3 A for each lamp approach. In fact, the distance between the approach light and the control center is approximately 3 km. In this case, sending data that is received by arduino 1 (for current sensor data receiver) and headed to arduino 2 using sms gateway communication using GSM module (SIM 900), in which sending between modem 1 to modem 2 in the form of sms gateway. The process of transferring data from Arduino 2 to a personal computer using USB to serial communication and to display the layout on a computer using wonderware.

b) System Flow Chart

In Figure 5 is a flowchart for the entire Approach Light Monitoring Design system. The order of how the program works for the whole system is as follows:
1. Start is when the program starts.
2. In Arduino Mega, there are 16 ADC pins, these sixteen ADC pins have the same characteristics, so which pins can be selected for the ACS 712 current sensor port. For this current sensor PORT PF0 (ADC0) - PK3 (ADC 04) can be selected because the number of ADC pins used is 5. In this case also the initialization of the GSM Module PORT (SIM 900)
3. Microcontroller reads how much current flows at the approach lights load.
4. In the conversion process, the current value reads in the form of data bits 0-1024 on the microcontroller.
5. Data from the microcontroller entered. The data is then processed and then the data is sent by the GSM module (SIM 900).
6. Data is received in the form of sms by another GSM module (SIM 900). And the data is parsed.
7. Data that has been parsed by the microcontroller, then displayed to the wonderware software using USB to serial.
8. The purpose of this program is to read the current value and then send the data via sms gateway "lights on" or "lights off" to the wonderware software that has been installed on the computer.

![Design Flow Chart](image)

**Fig. 5.** Design Flow Chart.

### 2.4. Microcontroller Design

This chapter will explain the microcontroller used in the final project entitled Approach Light Monitoring Design. Microcontroller is used as the control centre of this project, all commands and work carried out are designed in software design through a microcontroller. There are several types of microcontrollers that can be used, some are in the form of modules, some are in the form of an IC or chip which is strung together with several electrical circuits. The microcontroller used is the Arduino Mega module. Arduino Mega is a microcontroller board based on ATmega 2560. Arduino Mega has 54 digital input output pins, 16 analog inputs, a 16MHz Crystal oscillator, a USB connection, a power jack, an ICPS header and a reset button.

### 2.5. Design of Current Sensor Programs

The current sensor used in the final project entitled Design and Making Approach Light Monitoring in Juanda Airport is DT-Sense Current Sensor. The DT-Sense Current Sensor to be used is calibrated by using the program. In figure 6 above, it can be seen that the flow chart design for the process of reading the current through the current sensor (ACS 712) on Arduino. For the sequence of work flow charts are as follows:
a. Start is when the program starts.
b. In Arduino Mega there are 16 ADC pins, these 16 ADC pins have the same characteristics, so which pins can be selected for the current sensor port.
c. The data entered in Arduino in the form of current will be read and converted by Arduino, if the converted current is in accordance with what it should be, then the data will be displayed in digital form.
d. If the flow is not as it should be, then the data will be reprocessed until the data is as desired.

![Flow Sensor Calibration Flowchart](image)

Fig. 6. Flow Sensor Calibration Flowchart.

2.6. Connecting GSM SIM 900A Module
What is meant by connecting the GSM SIM 900A module is connecting the SIM900A module with the ATMega 128 microcontroller. The following is a schematic of the GSM SIM 900A Module:

![Schematic GSM SIM 900A Module](image)

Fig. 7. Schematic GSM SIM 900A Module.

2.7. HMI Display with Wonderware InTouch
Wonderware InTouch is software that is used in Human Machine Interface (HMI). In this software, there are many complete features about making lights and button shapes and lines for the main display on a PC. How to connect arduino with wonderware is explained, images below explain each item on the wonderware display.
a. Firstly, connect arduino OPC to wonderware, enter the selected OPC that will be used to add to wonderware
b. So if OPC has been selected and put into wonderware, then we just design the look we want

Credit status shows the number of credit on the modem

For on/off control function of the lights, on this tool using CCR so the on / off button is not needed

Error indicator works if there is a system error.
3. Analysis and Discussion

This test was conducted to discover the performance of this system and find out whether the system made has run based on the concept. There are several steps to carry out the test below: Receiver and transmitter test through sms gateway SIM 900 module. The steps of the test in reading current value from prototype of approach light are using HMI display with wonderware InTouch. The steps of the test to reading current value from prototype of approach light are manually using AVO metre. The test of power supply towards current sensor and prototype load are in the form of approach light.

3.1 The Test of Receiver and Transmitter Through Sms Gateway Module SIM 900

This test is conducted to ascertain whether the SMS gateway program that has been made both on the Receiver and the Transmitter side can run well. This process is important to carry out, because when the approach light does not work, then the transmitter side will send sms to the Receiver through the program that made previously. This Sms will present the valid information against the condition of approach light that does not function. Receiver will receive the sms, and can take the step to control over to be more effective and efficient.

Fig. 12. Wiring Connection Chart.

Furthermore, for testing the GSM SIM Module 900A is carried out using hyperterminal on a computer / laptop. The procedure of this test is GSM SIM 900A module using Bluetooth HC-05, where the communication used is serial communication with TTL voltage level.

3.2 The steps of the test in reading current value from prototype of approach light using HMI display with wonderware InTouch.

a. Connect the 220 VAC power to transmitter, if sim 900 module is ready then connect the Arduino power to the PC.

b. Open the system management console software on a PC that has been installed then open the wonderware InTouch software, open the file that we created earlier, we are runtime, then the monitoring flow will appear out of each light.

c. Attempt to turn off several lights to know the current value on each light when they are off.

d. And finally turn off all the lights on the switch that has been provided, then see the current changes in monitoring on the PC.

As explained in Chapter 3, that in the process of designing the approach light uses five prototypes light. Every light will be conducted the reading of current value by current sensor ACS712. The current value that has been read by the sensor will be displayed in the image visualization created by the researcher using wonderware InTouch software. Here is a display of current values using wonderware InTouch software:
Fig. 13. Current values display from approach lights using wonderware InTouch

Each approach lights will represent a different bias current value, depending on the conditions of approach lights at the airport. That is the greater current value (close to the current nominal value) from the actual approach light, so the function of the light is still good, and vice versa. In the program setting, when approach light has 0 current value (that means the light does not function), then in the visualization display that using visual basic will present 0 number, and from transmitter side will directly deliver sms to receiver side. So, the sms gateway only works when the current value from one of them, or all of the approach lights is 0.

3.3 The test of power supply towards current sensor and prototype load in the form of approach light

Power supply test to current sensor is needed, in order the current sensor can run well. The Mean, the sensor is able to read the value of ADC (Analog to Digital Converter) from current value that flowing to the approach light load. The following is a display of power supply design to the light load:

As pictures appeared above, that the current sensor design is in one place with the transmitter (sender) sms. Current sensor also requires 5 volt from power supply that obtained from power supply adjustable. From this acrylic box, it also appears that the design side of current sensor is also equipped with LCD 16x2, to facilitate the reading process of current value at load manually.

Fig. 14. The Test of Monitoring Tool Using PC

Fig. 15. The Test of Tool Using Approach Light.
Thus, in addition to current value test that flowing to approach light load can be observed through visualization display from wonderware Inouch software as well as this test of current value is displayed on the Lcd display 16x2 made by the researcher. Therefore, the technician just look from the PC to know the condition of approach light in the field, then if some problems appear in the field so the technician immediately know and take actions to repair or replacement. The complete list of tool components is explained in appendix 6.

4. Conclusion

By conducting the monitoring design of approach light, researcher has several conclusions as follow:

a. We can monitor the current that works on the approach light from 1-5 brightness with a current limit of 6.6 Amperes.

b. The display current change takes 7 seconds when changing brightness, because of the communication using sms gateway so it depends on the signal.

c. We can monitor the approach lights in real time and definitely figure out which lights are not functioning properly without controlling directly to where the approach lights are.

Several things need to be considered in the design and operation of the tool below,

a. It is needed to check periodically the amount of remaining balance and active period of GSM installed on the transmitter and receiver side so the sending information via sms is not interrupted, indicating whether the approach light is working or not.

b. It should be noticed that the laying condition of the acrylic box for control, to be safe and avoid excessive temperatures and avoid anything that can damage the controller.

References

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