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An Analysis Of Aircraft Exterior Lightin Indicator Control System Based On Arduino Atmega 256

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Beacon light,
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ABSTRACT

With the development of technology, there are some basic things that must be known and learned about airplanes, one of which is the exterior lighting system where the functions and uses vary. Exterior lighting plays an important role in airplanes on land and in the air and is a basic thing in knowing this exterior lighting system such as the layout, color and function of the lighting. For this reason, research and the creation of exterior lighting indicators on airplanes based on Arduino Atmega 2560 were conducted. In the research and creation of this tool, the main input from this tool is an adapter that produces a voltage of 5 V. Then there are 8 toggle switches that function as switches for each LED. In general, when the toggle switch is in the ON condition, the current and voltage have been sent to the system as a whole. Then the Arduino Atmega 2560 will process the inputted data. Furthermore, the Arduino Atmega 2560 sends the processed data to each LED so that the LED can light up according to its function and use. For the information generated such as each LED is on or not can be seen on the LCD. The results of functional testing show that the design is able to carry out the function of each LED. The design has a flash rate of beacon light of 45 times per minute and a flash rate of strobe light of 60 times per minute. Taxi light, Logo light, Landing light, Navigation light, Takeoff light, Runway light and Wing light do not have a flash rate or are steady. There is a time difference or delay between the wings strobe light and the tail strobe light of 1 second. The indicator can display information if there is damage to the LED.

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INTRODUCTION

In general, aircraft have main parts, namely fuselage, empennage, wing, engine, and landing gear (Cejpek, 2018). The landing gear section functions for all aircraft movements on the ground including take off, landing, taxing, parking and holding the aircraft load while on the ground (Yasa Utama et al., 2012). With one of the landing gear components in the form of a nose wheel assy which is provided to hold the aircraft's nose load and maneuver while on the ground (Susana, Albayumi and Triadhy, 2014). This nose wheel assy is a component that functions for the landing gear on the aircraft. So it can be concluded that this component must be on the aircraft and must be in good condition (Nendra et al., 2019). Maintenance is carried out to maintain the reliability and availability of the components that support the overall performance of the aircraft (Rismayanti et al., 2019). Calculation of reliability is carried out as a reference for the performance of a system and also to evaluate the effectiveness of the aircraft, so it is necessary to calculate to determine the level of reliability of the nose wheel assy component on the aircraft because basically flight safety is the main factor in operating an aircraft, by carrying out aircraft maintenance starting from preparation, implementation and certification process (Malendes, Tangkuman and Arungpadang, 2016).

Aircraft maintenance can be defined as all activities carried out for the reliability of the aircraft, aircraft components and their equipment must be in airworthy condition including inspection, repair, service, overhaul and replacement of parts. Maintenance is defined as all activities aimed at the engineering system to maintain its condition (preventive) or restore its condition (corrective) which is needed to fulfill certain functions (Romero, 2021). The landing gear and nose damage identification system can use several methods and applications where the method can identify the type of damage according to the symptoms that occur, and is able to provide handling of the damage identified from the component. (Agung Fathona et al., 2021). All activities carried out to maintain aircraft, aircraft components and equipment in airworthy conditions including inspection, repair, service, overhaul, and replacement of parts.

The exterior lighting system on an aircraft has a crucial role in providing visual indications to outsiders, such as ground personnel and other aircraft, regarding the status of the aircraft. The success of this visual communication is very important to maintain operational safety on the airstrip and its surroundings. Therefore, a control system is needed that can regulate the exterior lighting indicators of the aircraft efficiently and accurately. It is expected that this study can provide an in-depth understanding of the implementation and impact of using an Arduino ATmega 2560-based aircraft exterior lighting indicator control system. The results of the analysis can be the basis for further development in improving the overall aircraft lighting system.

The development of science and technology plays an important role in the modern era like today, where technology has a significant impact on human life. Airplanes are one of the effective and efficient means of transportation but with high risks, for that researchers continue to develop security systems on airplanes. Airplanes can be used for all groups from lower to middle economic classes.

Along with the development of technology, there are several basic things that must be known and learned about airplanes, one of which is the exterior lighting system. Exterior lighting plays an important role in airplanes on land and in the air, where its functions and uses vary. It is basic for students to know this exterior lighting system such as lighting layout, lighting color and the function of the lighting.

Since the British aviation authorities passed the law on airplane lights in 1848, every aircraft must have a red light on the left wing of the aircraft (port) and a green light on the right wing (starboard). Both lights must always be on both during flight and when the aircraft is landing. Because the function of the two lights is very important, just like in a spacecraft. In addition to the two lights on the aircraft wings, there are several other lights

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that also play an important role in the world of aviation, including taxi lights and landing lights that function when the aircraft takes off (takes off into the air) and taxis (moves on land). The position of the lighting placement, the color of the lights used and the function of the lighting, especially exterior lighting on an airplane, are basic things for an aviation student to recognize and learn about lighting on an airplane.

METHOD

This paper described model used Arduino Mega 2560 is an open-source microcontroller development board that features the main component of an AVR microcontroller chip from Atmel. This microcontroller is an integrated circuit (IC) programmable via a computer. The purpose of programming the microcontroller is to control how the electronic circuit reads inputs, processes these inputs, and generates outputs as desired. Thus, the microcontroller acts as the brain that manages input and output processes in an electronic circuit.

The Arduino Mega 2560 is equipped with the ATmega2560 chip and offers a variety of comprehensive features for electronic development. This board has 54 digital I/O pins (including 15 PWM pins), 16 analog input pins, and 4 UART (serial hardware) ports. Additionally, the Arduino Mega 2560 includes a 16 MHz oscillator, USB port, DC power jack, ICSP header, and reset button. All these features make it highly suitable for various microcontroller development applications.

Figure 1. Arduino Mega 2560

Table 1 specifications for Arduino Mega 2560:

Specification	Details
Microcontroller Chip	ATmega2560
Operating Voltage	5V
Input Voltage (recommended, via DC jack)	7V - 12V
Input Voltage (limit, via DC jack)	6V - 20V
Digital I/O Pins	54 (including PWM)
Analog Input Pins	16
DC Current per I/O Pin	20 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	256 KB (8 KB used by bootloader)
SRAM	8 KB
EEPROM	4 KB
Clock Speed	16 MHz
Dimensions	101.5 mm x 53.4 mm
Weight	37 g

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Arduino Mega 2560 Device Circuit Schematic

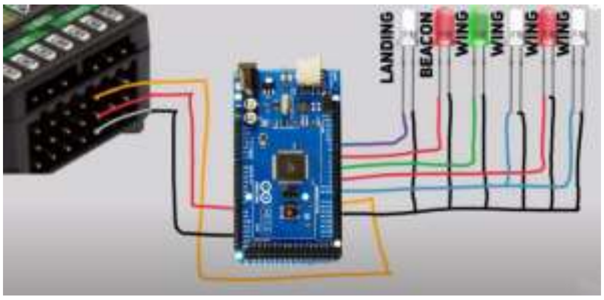

Figure 2. Arduino Mega 2560 circuit

To make an Arduino circuit as shown in the picture, here are the steps:

a. Required Components:
b. Arduino ATmega2560
c. Jumper Cables
d. LEDs
e. Resistor (220Ω or as required)
f. Power Source (such as battery or adapter)

Circuit Steps:

Connect Ground (GND):

a. Connect all ground pins from the LED to the GND pin on the Arduino Nano.
b. Connect Power (VCC):
c. Connect the power pin (VCC) to the positive line connecting all the LEDs.
d. Digital I/O Pins:
e. Connect the digital pin from Arduino Nano to each LED according to the function:
f. Pin for "LANDING" LED.
g. Pin for "BEACON" LED.
h. Pin for "WING" LED.

RESULTS

Simultion Proposed

Navigation Light Assembly and Simulation

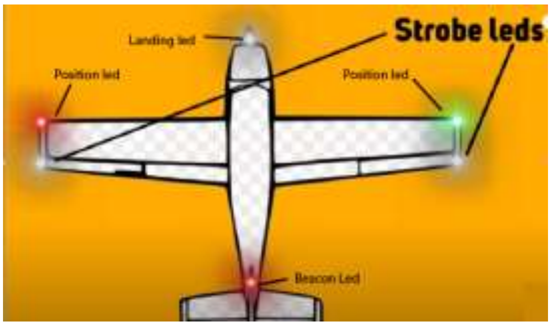

Figure 3. Simulation Navigation Light

In this simulation, navigation lights and anti-collision lights are controlled using relays to operate LEDs, with switches for powering them on and off. The author identifies a need for developing a simulation tool for navigation lights, anti-collision lights, and strobe position

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lights to aid in the learning process of students in the Aircraft Engineering Program who struggle with understanding these systems on actual aircraft. Previous setups for anti-collision and strobe lights had deficiencies, particularly in accurately reproducing the flash rate compared to real aircraft. Therefore, adjustments are necessary to ensure that the simulation's flash rate matches that of real aircraft.

The author proposes using Arduino for the navigation, anti-collision, and strobe position light circuits to simplify the setup. Additionally, the designed LED display must accurately replicate the flash rate of real aircraft. This LED display will be positioned on a miniature aircraft to correspond with its actual locations on real aircraft.

Developing a simulation tool for navigation lights, anti-collision lights, and strobe position lights using Arduino is crucial to support the learning process of students in the Aircraft Engineering Program. This simulation utilizes relays for LED control and switches for power control, demonstrating the practical operation of these lighting systems.

Previously, the setups for anti-collision and strobe lights had some shortcomings, particularly in replicating the flash rate accurately compared to real aircraft. Hence, adjustments are necessary to ensure that this simulation reflects the appropriate flash rate standard for real aircraft. By employing Arduino, the system control becomes simpler and more efficient. The LED display designed for this simulation will feature a flash rate that matches that of real aircraft and will be accurately positioned on a miniature aircraft to reflect the actual locations of the lights on real aircraft.

Through this development, it is expected that students can gain a better understanding and mastery of how navigation lights, anti-collision lights, and strobe position lights work on aircraft, enabling them to apply this knowledge more effectively in practical situations.

Wiring Diagram

A wiring diagram is a visual representation that illustrates each component in an electrical or electronic circuit using specific symbols. The main purpose of this diagram is to provide a clear and easily understandable illustration of how electronic components are connected and interact within the circuit.

In a wiring diagram, each component such as resistors, capacitors, transistors, LEDs, switches, and more, is represented by internationally agreed-upon symbols. These symbols facilitate understanding of the functions and relationships between components without needing to detail the physical appearance of each component.

Additionally, wiring diagrams include information about the direction of electrical flow, component values (such as resistor values), and the types and specifications of cables used to connect these components. This is crucial in the design, development, and troubleshooting of electronic circuits, as it allows engineers or technicians to plan, analyze, and repair circuits more efficiently.

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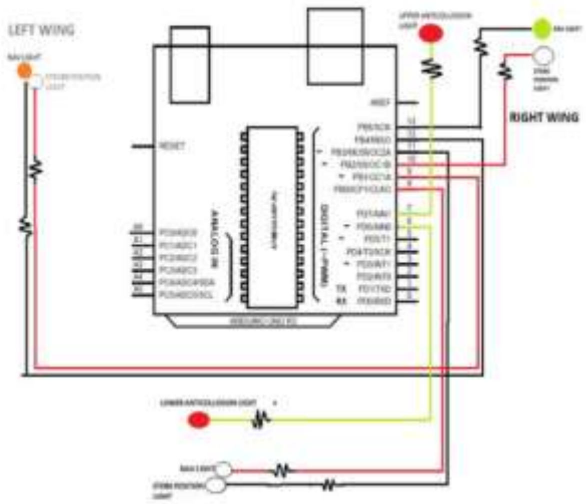

Figure 4. Arduino code circuit

Arduino IDE.

Arduino IDE stands for Integrated Development Environment, which is a unified environment used for developing hardware. It is called an environment because within this software, Arduino is programmed to execute embedded functions using programming syntax.

The installation process with Arduino IDE begins by downloading the Arduino IDE installer from the official Arduino website, accessible via https://www.arduino.cc/en/Main/Software. Choose the version that matches your operating system, such as Windows, macOS, or Linux. Once the download is complete, run the installer and follow the installation instructions displayed on the screen. The installation process is generally straightforward and does not require advanced settings.

After successfully installing Arduino IDE, open the application. The next step is to configure the Arduino board you will be using. Select the Arduino board from the `Tools > Board` menu. For example, if you are using an Arduino Mega 2560, choose the `Arduino Mega or Mega 2560` option. Next, select the serial port used by your Arduino from the `Tools > Port` menu.

Once the configuration is complete, you can start the programming process. Write your Arduino program code in the Arduino IDE workspace. To check for syntax errors in the code, click the checkmark icon or select `Verify`. If there are no errors, you can upload the program code to the Arduino board by clicking the right-facing arrow icon or `Upload`.

To monitor the output from the Arduino board, you can use the serial monitor. Open the serial monitor by selecting `Tools > Serial Monitor` or using the keyboard shortcut `Ctrl+Shift+M`. By following these steps, you can install and configure Arduino IDE easily and efficiently start programming for your Arduino board.

Figure 5. instal code Arduino IDE

To test this device, a 5 Vdc adapter is used to convert the electrical voltage from the household's original 220 Vac to 5 Vdc, which is then used as input for the Arduino Uno. Prior to testing, the Arduino Uno has been programmed using the Arduino IDE software. In this program, the Arduino Uno functions to control the flash rate of LEDs.

There are 3 LEDs used to simulate strobe position lights with a flash rate of approximately 60 times per minute, 2 LEDs for simulating anti-collision lights with a flash rate of around 45 times per minute, and 3 LEDs for simulating steady navigation lights. After being programmed as described, the output from the Arduino Uno controls the flash rate of these LEDs. Resistors are placed before the LEDs to prevent overload of electrical current entering the LEDs. These LEDs are positioned on a miniature aircraft according to the positions of the lights on real aircraft.

This simulation is developed for use by cadets in electrical practice, especially for avionics majors in the Aircraft Engineering Program. The aim is for cadets to understand the positions of lights on aircraft, such as navigation lights, anti-collision lights, and strobe position lights, and to comprehend how these lighting systems operate on aircraft.

Figure 6. Tool simulation test

This testing is to ensure that the circuitry functions properly as expected. The testing stages that will be conducted include: (1) Testing and analysis of the DC Adapter, (2) Testing and analysis of the Arduino program download process, (3) Testing and analysis of the Arduino microcontroller, and (4) Testing and analysis of the LED indicators.

The DC Adapter is used as a 5 VDC input source for the Arduino Uno. Before use, the author performs testing on the DC Adapter to ensure its proper functioning. Testing begins by measuring the input AC voltage, followed by measuring the output DC voltage.

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Subsequently, voltage measurements are taken at the microcontroller output.

CONCLUSION

A conclusion of this paper: A simulator for navigation lights, anti-collision lights, and strobe position lights is designed using the Arduino Uno microcontroller to control the flash rate of each light. This simulation sets the flash rate for strobe position lights at 60 flashes per minute, for anti-collision lights at 45 flashes per minute, while navigation lights remain steady without blinking. The control system for aircraft exterior lighting indicators based on Arduino ATMEGA 2560 is an effective solution for simulating and controlling navigation lights, anti-collision lights, and strobe position lights. By utilizing the Arduino ATMEGA 2560, precise flash rates for each light can be set according to required standards for cadet training in avionics. This allows for flexible usage and adaptation for various educational purposes in aircraft engineering.

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