International Journal of Advanced Technology in Mechanical, Mechatronics and Materials (IJATEC)

Vol. 02, No. 2 (2021) 87-92

Institute for Research on Innovation and Industrial System (IRIS)

Design of Prototype Aircraft Noise Monitoring System Using Microcontroller

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Abstract. This paper was presented a design of aircraft noise monitoring system using microcontroller. This system is for monitoring noise levels to make it easier to analyze and measure noise that can be accessed remotely. Noise monitoring has been carried out at the Soekarno-Hatta International Airport for the Boeing 737-800 aircraft type which is located in the line 11 hangar 4 area. Where the airport is located close to residential areas, therefore it requires a noise monitoring system. The noise measurement results can be accessed via a browser with IP address access (Internet Protocol) from a local server esp32 and also 0.96 inc OLED. Taking the noise value for 10 seconds with data samples every 1 second with aircraft noise sources consisting of APU (Auxiliary Power Unit), dual pack on and engine motoring. With each noise value of 61.5 dB, 75.6 dB and 82.5 dB.

Keywords: noise; aircraft; monitoring; microcontroller

DOI: 10.37869/ijatec.v2i2.49
Received 4 August 2021; Accepted 29 October 2021; Available online 18 November 2021

1. Introduction

Airplane noise impact is an important issue for main airports all over the world [1]. Aircraft noise continues to be an issue at many airports, especially where capacity expansions are under way or are being considered [2]. Noise pollution affects human health and well-being [3]. Noise pollution around airports continues to be the most significant cause of adverse community reaction towards airports [4]. Noise generating from landings and takeoffs at an airport remains critical issue for residents [5].

Airports encourage development but should also impose some restrictions on the use of residential land around airports and they are generally disturbed due to high levels of aircraft noise emissions [6]. The problem arises when aircraft noise nuisance and imposed land use restrictions overlap [7]. Aircraft noise disturbance is a subjective issue related to the perception or tolerance of nuisance and actual noise level [8]. The variation among individuals in response to effects of aircraft noise is often conceptualized as noise sensitivity [9].

Many studies to measure and analysis aircraft noise levels such as aircraft noise exposure maps using Integrated Noise Model, noise classification using artificial neural networks [10], noise classification using artificial neural networks [11], Neural Prediction of Aircraft Noise Levels [12], IoT-Based Technology [13], OpenSky Tracking Data [14].

Microcontroller has been used as a device for monitoring and control systems [15]. The monitoring system can be done with a microcontroller device with wireless communication [16]. This research focuses on designing an aircraft noise monitoring system using the NodeMCU esp32 microcontroller. To detect noise, a sound sensor is used to detect aircraft noise under maintenance and a 0.96" OLED is used to display the noise value in dB units. Noise detectors are applied in the hangar.

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ISSN: 2720-9008

2. Research Methodology

The system was designed by having several blocks, namely: input block, the microcontroller and output block. The whole system can be seen in Fig. 1. Detailed explanations of each block are as follows

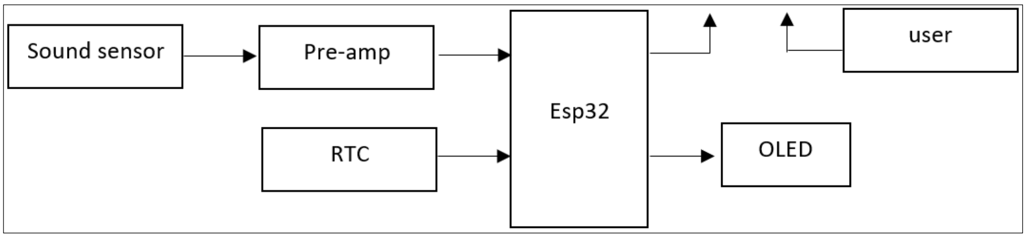


Figure 1. Block diagram of proposed system

The noise monitoring system device consists of a KY-037 sound sensor, NodeMCU esp32, op-amp IC LM358, 0.96 inch OLED display and RTC for timing. The signal from the sound sensor is amplified using IC LM358 and sent to pin A0 esp32 to be converted from analog to digital. Esp32 is connected to a computer with a USB connector. OLED is used to display noise measurement results. Esp32 transmits data signal via wifi to be accessed wirelessly by user.

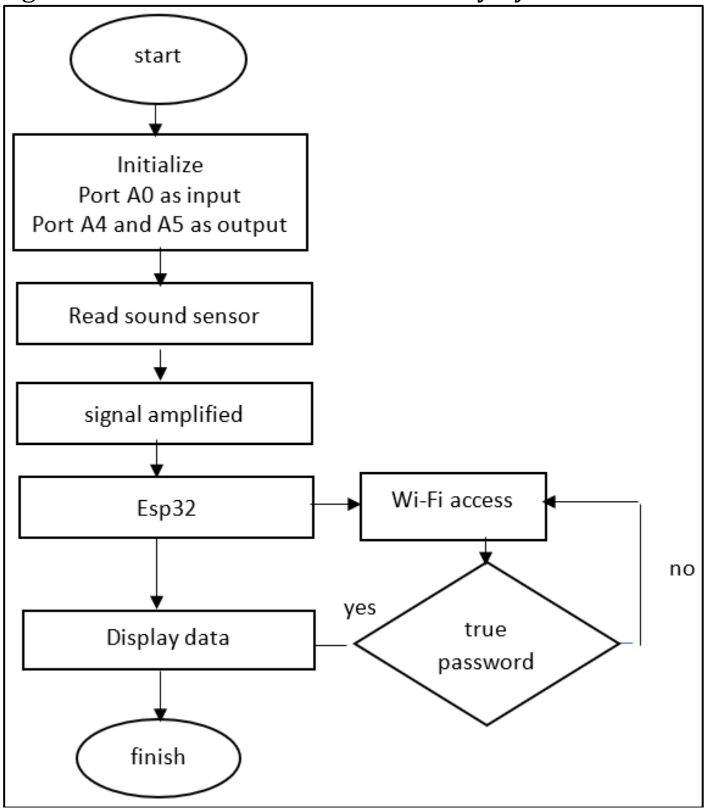


Figure 2. Flowchart of Proposed System

The program for the monitoring system on the microcontroller uses C language with Arduino IDE software. The data program for the esp32 has the following functions:

1. Reads input data from the sound sensor and pre-amp amplifier
2. Process analog to digital input signal
3. Displays the output data and displays it on the OLED and also devices connected to wifi for data access via the local web.

The sound signal that has been detected by the sensor is amplified by a pre-amp circuit using the LM358 IC. The amplified signal is connected to the ADC via pin 34 esp32. OLED displays the noise value in dB. To display the noise value remotely by accessing the IP address in the browser by opening index.html as esp32 webserver.

3. Results and Discussions

3.1Sound sensor test in hangar

Sound sensor testing to obtain accuracy values by comparing sensor data with standard measuring instruments. The graphic data shown in Figure 3 is the average value for 6 seconds of data collection with 1 data per second.

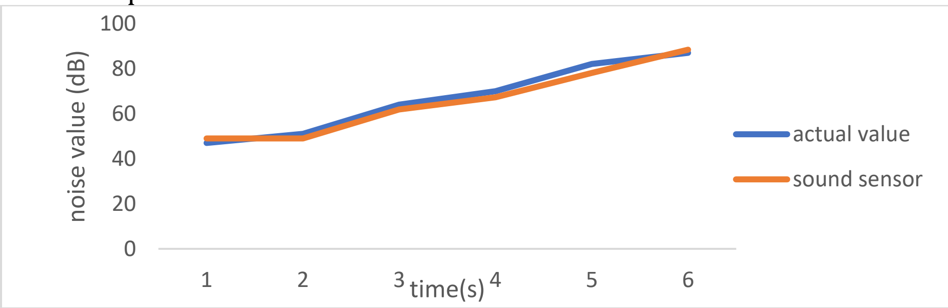
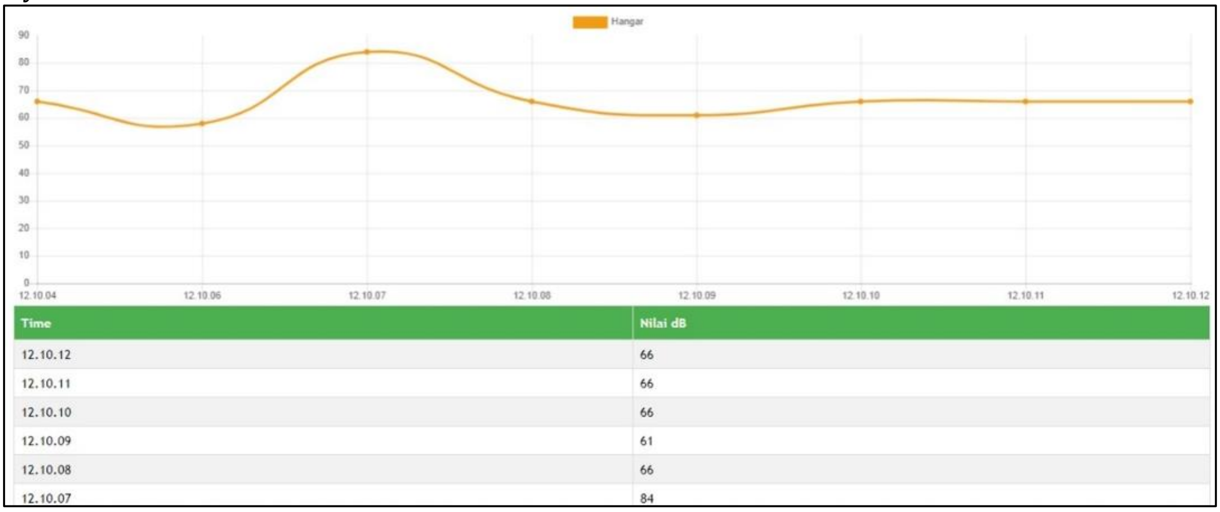


Figure 3. Measurement comparison between sensor and actual

The KY-037 sensor has the ability to read noise values in decibels in the value range of 49-89 dB for monitoring software capabilities in the range of 47-87 dB, so beyond that value the sensor cannot read it. There is no significant difference between the actual reading and the proposed tool with error value < 5 %. Display noise software called sound meter which can be downloaded on playstore for free



Time	Nilai dB
12.10.12	66
12.10.11	66
12.10.10	66
12.10.09	61
12.10.08	66
12.10.07	84

Figure 4. Web monitoring display for hangar

3.2Noise Monitoring of Auxiliary Power Unit

APU (Auxiliary Power Unit) is a unit in an aircraft that provides electricity and pneumatic sources, especially when the aircraft is on the ground. When the aircraft is in the hangar, the APU can be operated only when the aircraft is nose in (the APU is facing out of the hangar). Even if the APU is pointing out of the hangar, it can still cause noise in the hangar. The following is data on the noise value in the hangar when the APU is operating

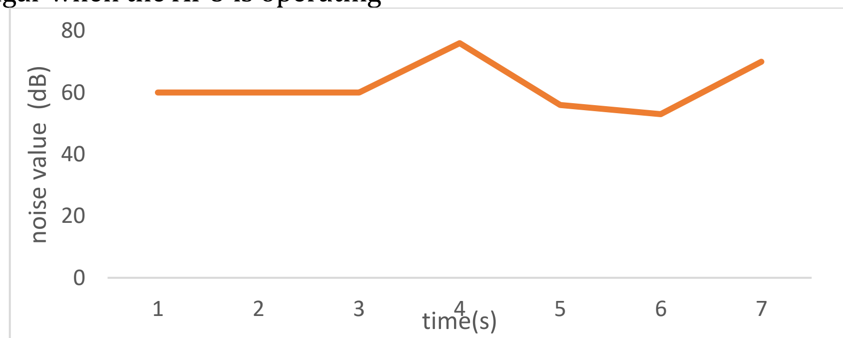


Figure 5. Noise monitoring of auxiliary power unit

3.3Noise Monitoring of Dual Pack ON

Dual pack provides air conditioning for IFE (In Flight Entertainment) maintenance, regulates cabin pressure and packs assessment during aircraft maintenance. When the dual pack on operates simultaneously with the APU on because the APU is the pneumatic source for ACM (Air Cycle Machine) operation. The following is the data on the noise value in the hangar when the dual pack on operates:

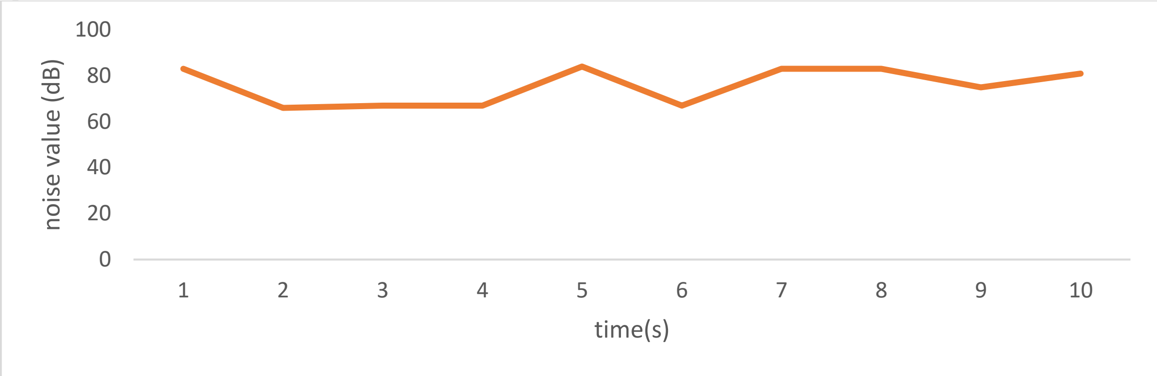


Figure 6. Noise monitoring of dual pack ON

3.4Noise Monitoring of Engine Motoring

Engine motoring during hangar which is the source of the highest noise because the engine rotates but there is no fuel supply and ignition in the combustion chamber so that combustion does not occur. The operation of the engine motoring coincides with the operation of the APU because the APU is the pneumatic source for the engine starter. The following is data on the noise value in the hangar when the motoring engine is operating:

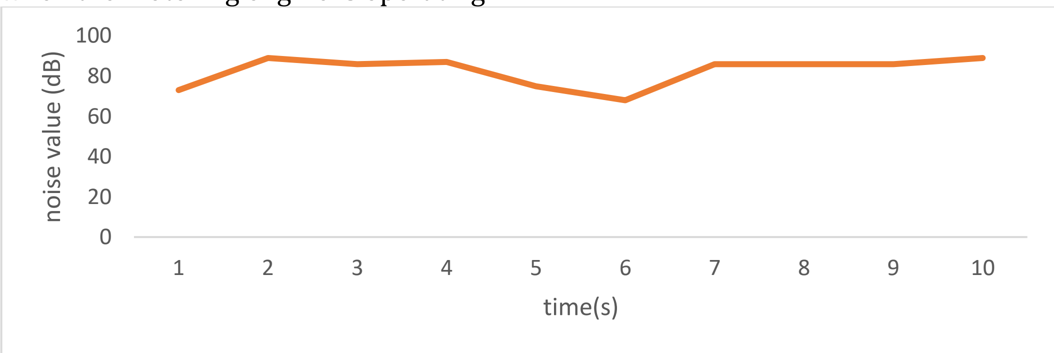


Figure 7. Noise monitoring of engine motoring

The comparison of the noise levels of the three parameters, namely APU, dual pack on and engine motoring, can be seen in Figure 8. In accordance with government regulations, the noise level for office areas is 65 dB.

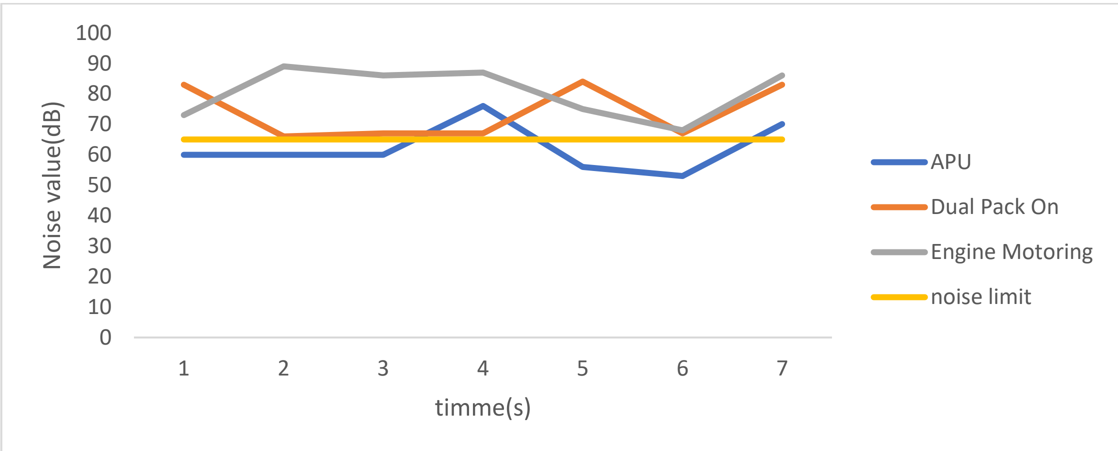


Figure 8. Noise level comparison

From the three data in Figure 8 shows that the noise value for dual pack on and engine motoring exceeds the noise threshold according to government regulations. To reduce noise exposure, it is recommended to wear PPE (Personal Protective Equipment) such as earmuffs or ear plugs when operating the motoring and dual pack on engines.

4. Conclusions

From the results of the analysis, it can be concluded that the aircraft noise monitoring device in the hangar works as expected. This device is capable of detecting and displaying noise values in decibels in the range of 49 dB to 89 dB and has an error of < 5% when testing the KY-037 sound sensor. According to the state minister for the Environment in 1996, it was stated that the noise for office areas was 65 dB and in this study, it was obtained when the engine motoring and dual pack on produce noise > 65 dB, so it is important to use PPE (Personal Protective Equipment) related to the ear such as ear plugs, and ear muff to reduce noise exposure.

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