Jurnal Scientia
Volume 13, Number 04, 2024, DOI 10.58471/ scientia.v13i04
ESSN 2723-7486 (Online)
https://infor.seaninstitute.org/index.php/pendidikan

# A Communication System Design Use Voice Over Internet Protocol (VOIP) Based On Arduino Nano ESP32 At Medan Aviation Polytechnic

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**Article Info**
**Keywords**:
Communication tools,
Voice Over Internet Protocol,
and Arduino Nano,
ESP32.

**ABSTRACT**
A good communication tool must convey information clearly and be well received by the recipient. Currently, communication between units at the Medan Aviation Polytechnic still uses the Public Switched Telephone Network (PSTN) telephone network. This communication system has disadvantages, such as high maintenance costs and dependence on cable instructors. Therefore, in this research, the author created an alternative VOIP transmission media design based on Arduino Nano dan ESP32 aimed at reducing maintenance costs and making it easy to integrate with the sophisticated and flexible technology of the PSTN. Arduino Nano dan ESP32 is used as the main controller connecting software and hardware. This type of design and development research aims to create a product and test it using functional methods to ensure this communication tool works well to convey information to the recipient. The test results show that this communication tool effectively conveys more accurate information from one unit to another. Thus, this Arduino nano dan ESP32-based communication tool can be a useful tool for providing information quickly, effectively, and efficiently.



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## INTRODUCTION

Technology has become a primary need in this modern era. The rapid development of information technology has brought significant changes in the world of telecommunications. Supported by the rapid advancement of internet technology, various new innovations have emerged and greatly assisted humans in communicating. One of these innovations is voice telephone technology that utilizes the internet network, known as Voice over Internet Protocol (VoIP). Voice over Internet Protocol is a technology that enables voice transmission over the internet network. This technology converts voice into digital signals which are then sent over the internet and converted back into voice on the receiving end. VoIP offers lower costs compared to conventional telephone services.

At the Medan Aviation Polytechnic campus, communication between units still uses the Public Switched Telephone Network (PSTN) telephone network. The inter-unit

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communication system is a system consisting of components that interact with each other between two or more units to send and receive messages. PSTN is a voice telecommunications network based on circuit-switching or often called a cheap telephone network. PSTN has several disadvantages such as high maintenance costs and dependence on cable instructors. Based on the background that has been described above, an alternative VOIP transmission media design based on Arduino Nano and ESP32 can be made to reduce maintenance costs, easy to integrate with advanced technology and more flexible than PSTN. Arduino Nano The advantage is that even though its size is small, it can store many facilities. Then ESP32 is suitable for use in this tool because it has advantages, namely ESP32 supports Wi-Fi for IoT applications, has a large RAM. The call success test using the Arduino nano and ESP32 programs is to conduct a test from a distance of 250 M.

## Literature Review

### Voice Over Internet Protocol (VOIP)

VoIP is a technology that sends voice in the form of data over the internet or IP network. This technology allows telephone calls to be made over the internet by converting analog voice into digital data and sending it over the internet network. VoIP sends voice data packets from one location to another over the internet network.

The advantages of using VoIP include lower costs for long-distance calls. When two locations are connected via the internet, the cost of the conversation becomes very low. VoIP takes advantage of existing data network infrastructure for voice transmission. The way VoIP works involves converting the user's voice from analog audio signals into digital data. Once converted, the data is sent to another user over an internet network such as LAN or WiFi.


**Figure 1.** VOIP System.

### Arduino Nano

Arduino Nano is a small and flexible microcontroller board designed for electronics projects and programming. Arduino Nano is equipped with various digital and analog input/output pins, and can be programmed using the Arduino IDE. This board is suitable for various DIY projects, robotics, and prototype development because of its ability to be integrated into smaller and more complex circuits. Arduino Nano functions as a tool to create a microcontroller circuit prototype. By using this development board, assembling microcontroller-based electronic circuits becomes easier than having to assemble a minimum system of ATMega328 microcontroller from scratch.

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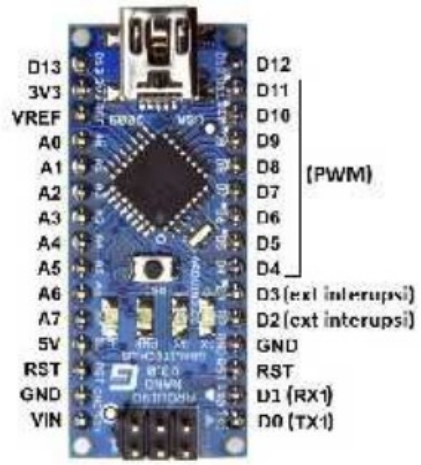


**Figure 2.** Board Arduino

## ESP32

ESP32 is a series of low-cost, low-power microcontroller systems with integrated Wi-Fi and dual-mode Bluetooth. ESP32 can be programmed using Arduino and supports various programming languages such as C++, C and Lua. This chip is commonly used in projects involving home automation, smart devices, and remote sensing. It operates at a voltage of 2.2V – 3.6V. ESP 32 has the ability to support direct Wi-Fi connection. This chip is quite complete, there is a processor, storage and access to GPIO.

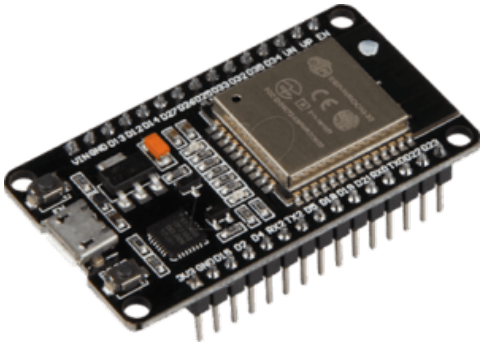

**Figure 3.** Esp 32 Module

## METHOD

The research method used in this study is development research with a Design and Development (D&D) approach. This type of research involves the design, development, and evaluation processes to create products and tools that can be used in learning and non-learning activities. The main stages in D&D research include planning, production, and evaluation. D&D is used to develop procedures, techniques, or tools based on methodical analysis of specific cases. According to Thomas & Rothman, D&D research aims to produce innovative solutions to practical problems. In this design, the author expects several desired results, namely:

1. This tool can be used to communicate well
2. There is no noise in using this tool

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3. Can be used to communicate from a distance

The initial step in making it is collecting data and making a block diagram as a general description of the tool circuit. The following is a block diagram of the design:

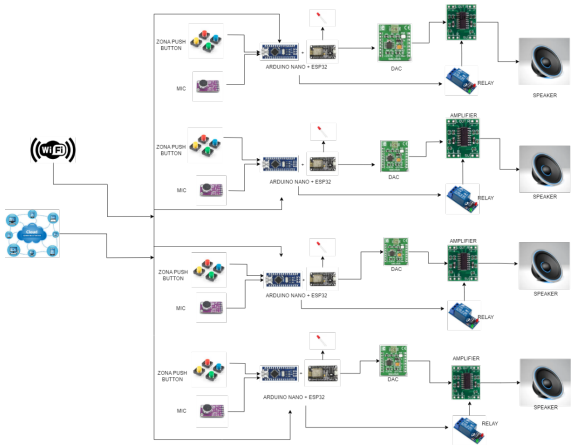

**Figure 4.** Flowchart of Tool Circuit

The Communication System Design using Voice Over Internet Protocol (VOIP) Based on Arduino Nano and ESP32 consists of several devices, namely Arduino Nano, ESP32, microphone, button, TPA3110 amplifier, Led, Relay, DAC, speaker, Arduino IDE software and Cloud Server. Laptop/PC that has Arduino IDE installed to create programs on Arduino, cloud server is a script that connects communication between station 1 to another station. How this equipment works is the Arduino IDE application gives a program to Arduino Nano and ESP32. Cloud server gives commands where to connect one device to another.

Then press one of the push buttons that will go to one of the stations, the microphone records the sound changes to digital audio and is forwarded to Ardunio Nano and ESP32, which already knows the command to one of the stations. When connected to the intended station the LED light will light up. The relay will also activate the amplifier, when the standby position the relay will switch the amplifier back to inactive or functioning. Then after that it enters the DAC, here the digital signal is converted into an analog signal, because the sound is still small and is forwarded to the amplifier which functions to amplify the sound, after that it is forwarded to the speaker and the sound is heard clearly.

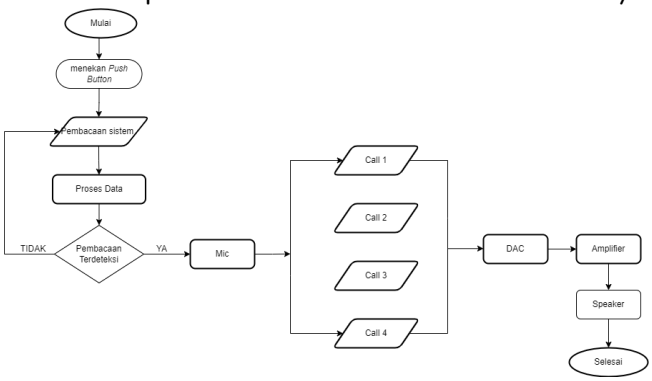


**Figure 5.** Flow chart System

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## RESULT

### Hardware Installation

Designing a mic system with ESP32 components, INMP 441 digital mic. Connecting the ESP32 pin to the INMP 441 DIGITAL MIC with the SCK pin configuration on the Digital Mic to D13 as a voltage source on other components used. The WS pin on the Digital Mic is connected to the D12 pin on the ESP32. The SD pin on the Digital Mic is connected to the D14 pin on the ESP32. The VCC pin on the Digital Mic is connected to the 3.3V pin on the ESP32. And then the GND pin on the Digital Mic is connected to the GND pin on the ESP32.

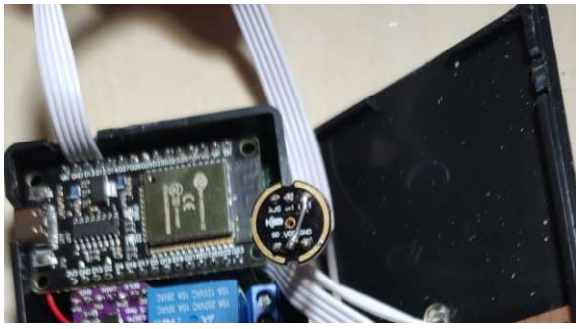

**Figure 6.** INMP 441 Digital Mic pin configuration with ESP32

Design of amplifier system with ESP32 components, DAC MAX98357a, amplifier TPA3110, speaker. Connecting the DAC MAX98357A pin to the ESP32 and TPA 3110 Amplifier with the configuration of the LRC pin on the DAC connected to pin D17 on the ESP32, the BCLK pin on the DAC connected to pin D16 on the ESP32, the DIN pin on the DAC connected to pin D4 on the ESP32, the VIN pin on the DAC connected to the 3.3V pin on the ESP32, and the GND pin on the DAC connected to the GND pin on the ESP32. The OUT+ pin on the DAC is connected to the IN+ pin on the amplifier and the IN- pin on the DAC is connected to the IN- pin on the amplifier. Then the OUT+ pin on the amplifier is connected to the IN+ pin on the speaker and the OUT- pin on the amplifier is connected to the IN- pin on the speaker.

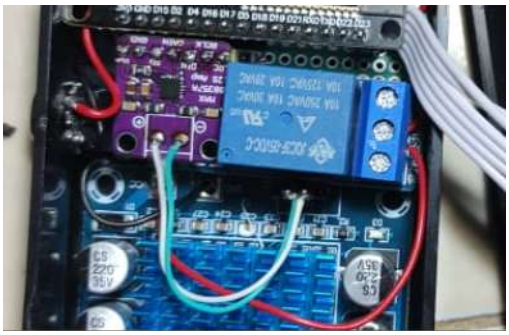

**Figure 7.** DAC pin configuration with ESP32 and amplifier, amplifier pins with speaker

The Relay system design includes ESP32 components, 1ch relay module, TPA3110 amplifier, jumper cables. Connecting the Relay module to the ESP32 and TPA 3110 amplifier with the VCC pin configuration on the relay connected to the VIN pin on the ESP32 as a power component, the GND pin on the relay connected to the GND pin on the

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ESP32, and the IN pin on the relay connected to the D19 pin on the ESP32. The NO pin on the relay is connected to the VCC pin on the TPA 3110 amplifier.

Design of power converter system with ESP32 components, DC Jack, step down converter, jumper cable. Connecting the step down module to ESP32 and DC Jack with the configuration of OUT+ pin on the step down connected to the VIN pin on ESP32, GND pin on the step down connected to the GND pin on ESP32, IN+ pin on the step down connected to the VIN pin on DC Jack and GND pin on the step down connected to the GND pin on DC Jack.

Design of button and indicator light control system with Arduino nano components, push button, jumper cable, ESP32, led. Connect Arduino nano to push button with GND pin configuration on Arduino nano connected to GND pin on push button. Pin D12 is connected to OUT1, pin D11 is connected to OUT2, pin D10 is connected to OUT2.

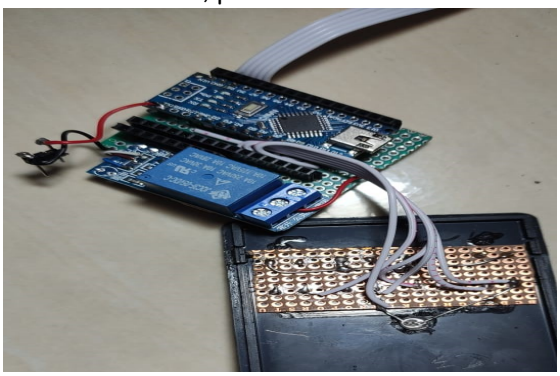

**Figure 8.** Arduino Nano pin configuration with Push Button and ESP32 pin configuration with LED

In the working system of this tool requires an internet network or Wi-Fi so it is necessary to ensure that there is an internet network and has been included in the Arduino IDE coding. The assembled equipment is connected to a power source, where the power source will flow to all components in the Arduino and ESP32 circuits. When the equipment is active, the communication tool circuit will work to communicate.

## CONCLUSION

From the research and discussion on the design of a communication system using voice over internet protocol (VOIP) based on Arduino Nano and ESP32 between units at the Medan Aviation Polytechnic, the following conclusions can be drawn: This design was created as a solution for communication which currently mostly still uses the Public Switched Telephone Network (PSTN) telephone network with expensive costs and uses many cables. This design uses Arduino nano and ESP32 which are connected to the DAC module, Led, Amplifier, Relay, speaker, push button and mic. In this process the mic receives sound or information which is then forwarded to the Arduino nano and ESP32 to be managed, then the sound is converted from digital to analog and amplified, after which the sound will be forwarded and outputted by the speaker to be heard by the recipient. This design is a communication tool between units which is useful for making it easier between

one unit and another to convey information or something urgent that must be conveyed to another party. This design is tested by conveying information from one station to another to ensure that the sound produced is clear and can receive information clearly.

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