

# Automatic Control Based on Voice Commands and Arduino

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## ABSTRACT

Control that is widely used today was control by voice commands. This study aimed to determine the application of voice and Arduino-based control automation which had been developed from 2014-2020 based on 25 journals that would be studied. Journal assessments were carried out by taking into account the similarities or differences in each journal. The research method used in this research was literature review by reviewing 25 journals. The results obtained from the journal review showed that the developed voice control consists of 2 types, namely voice recognition and speech recognition. Voice recognition used an easy VR hardware device and a microcontroller, while speech recognition used an application installed on Android, controlling can also be done remotely using Bluetooth and the internet. The way the voice control system works was that the user given voice commands via a microphone, then the command would be converted by the voice control module on the EasyVR module or the voice recognition module. The conversion results were sent to the microprocessor and activate the controlled device. Whereas in remote control, the data resulting from the conversion was also sent to the bluetooth module or NodeMCU module which was sent to the microprocessor to activate the controlled device. The factors that affect the voice control system were clear pronunciation, pitch and sound, microphone distance, sound source, intonation and noise level.

**Keywords:** Automation, Voice recognition, Speech recognition

## 1. INTRODUCTION

The rapid development of technology has made it possible to control electronic devices using a variety of control methods such as controlling electronic devices automatically by utilizing sensors or by remote control. The existence of this technological advancement makes electronic device users not have to feel difficult in controlling their electronic devices. Control that is widely used today is control that is done by using sound. Like controlling a smartphone to run applications installed in it, controlling a smart home such as turning off or turning on lights, opening or closing doors, and controlling the robot. Control using voice is in great demand because it has a security system that utilizes the characteristic pattern of an individual by determining the specific physiology of the individual so that only individuals who meet predetermined characteristics can control the electronic device. Control of this electronic device is called a voice command.

Voice commands are divided into two, there is voice recognition and speech recognition. Voice recognition is a system to identifying someone through the voice characteristics of that person. Characteristics can be the intonation of the voice, the level of sound depth, and so on. Voice recognition works by analyzing each individual's voice features derived from anatomical and behavioral patterns such as tone of voice, style and speech accent. Thus, voice recognition can assist users in matching previously validated voices, and verifying voice match. Speech recognition is a technology that can be used to convert voice into text. Users simply say the word they want to write, then the system will convert the voice into text. The use of this technology can be found in instant messenger applications, google voice, Microsoft dictation and so on.

Therefore, this writing is done with the aim of knowing the application of voice-based and Arduino-based control automation which has been developed from

2014-2020 based on 25 journals to be studied. Journal assessments are carried out by taking into account the similarities or differences in each journal.

**1.1. Literature Review**

**1.1.1. Voice Command**

Voice command is control of electronic devices that is carried out through commands given to the system using the voice of the system user. Control using voice is a control that is in great demand today in smart home systems. This is because the operation of the system is very easy and does not require a lot of power, which is the main reason voice commands are suitable for smart home systems. This voice command consists of voice recognition and speech recognition with the speaker, for example by using a series resistor. The exact value of the resistor depends on the sensitivity of the headphones and the desired output volume (usually in the order of 1-10kΩ).

Software that can be used to connect the EasyVR module to a PC is EasyVR Commander. There is also SonicNet software that can be used to wirelessly connect the EasyVR module to a PC.

**1.1.2. Voice Recognition Module V3**

Voice recognition module V3 is a voice recognition module that can be used in voice recognition. This module has the ability to accommodate a maximum of 80 voice commands with a maximum of 7 voice commands that can be used at the same time. Each voice command can be given in 1500ms, which is one or two words.

This module has a voltage of 4.5-5.5V with a current of less than 40mA. The digital interface is a 5V TTL level for the UART interface and the GPIO, while the analog interface is a 3.5mm mono-channel microphone connector and a microphone pin interface. The size of this module is 31mm x 50mm with a speech recognition accuracy of 99% when used in ideal conditions.

**1.1.3. Arduino**

Arduino is an electronic device designed to facilitate the use of electronics in various fields in the form of an open-source single-board micro controller. Arduino uno is one of the Arduino products with an ATmega328 microcontroller. This tool is used to realize electronic circuits ranging from simple to complex.

In its use, Arduino is combined with Integrated Development Environment (IDE) software. IDE is a program that can be used in designing or sketching programs for Arduino boards. Arduino source code is made using the C programming language called sketch. Sketch that has been completed in the IDE can be immediately decompiled to find out where the program

error is. If the program has no errors then the program can be uploaded directly to the Arduino board.

**2. METHOD**

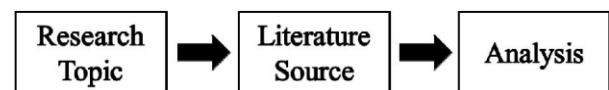
The research conducted was a literature research based on the results of written works such as the results of research that has been done. In library research, literature search was not only for the first step in preparing a research framework (research design) but at the same time utilizing library sources to obtain research data [1]. The data collection technique was carried out by conducting a study of books and a number of articles on controlling using voice commands and arduino. The data analysis technique used was to describe data and information in the form of easy-to-understand sentences as an effort to get answers to the problems studied [2], related to several studies on controlling using voice commands and arduino.

The steps taken in conducting literature research were divided into 3 steps. The first was to determine the title of the research to be carried out, what literature sources would be used, how much literature was used and so on.

Furthermore, the literature search was carried out in accordance with the matter to be reviewed. Finally, a content analysis of the easyvr 3.0

Easy vr 3.0 is a voice recognition module that can be used easily and is compatible with almost all applications. Easy vr 3.0 can be used with all uart (universal asynchronous receiver-transmitter) at a voltage of 3.3v- 5v.

Easyvr 3.0 audio output interface can be connected directly to an 8 ohm speaker or connected with an external audio amplifier for low impedance sound. In addition, it can also be connected to high impedance loads such as headphones, provided that the power output is in accordance literature that has been obtained was carried out related to how the relationship between the literature obtained was. The block diagram of literature research steps can be seen in “figure 1”.



**Figure 1** Block diagram of literature research steps

The literature review in this study was conducted by examining 25 journals from 2014-2020 which discussed controlling using voice commands and arduino. Journal assessments are carried out by paying attention to the similarities or differences in each journal based on the application of voice commands to the electronic device to be controlled, the voice command used in the form of voice recognition or speech recognition, the hardware used, the tests carried out, the test results, the system operation and the factors involved affected by system.

### 3. RESULT AND DISCUSSION

#### 3.1. Implementation

Based on the results of the studies that have been done, the research that many researchers have developed was the development of a smart home prototype. The control developed in a smart home was in the form of controlling electronic devices so that they can be controlled automatically by using voice commands from the user or smart home owner. The development of controlling using voice on this smart home could make it easier for users to carry out daily activities. Sound-based control of electronic devices in a smart home could be applied to lights, fans, air conditioners, TVs, bells, alarms, windows and doors as research conducted by almost all researchers. The control was carried out on lights, fans and air conditioners, namely by turning on or off the lights, fans and air conditioners automatically by giving commands according to predetermined codes. For controlling that is carried out on the TV, namely by controlling the TV turn on or off, turning off or turning on the TV sound, displaying the TV menu, and making the TV sound in mute mode. Control of the bell and alarm was done by giving commands to the system to turn off or turn on the bell and alarm. Control of windows and doors was done by giving orders to open or close windows and doors with a predefined code.

In addition to developing a prototype on a smart home, there were researchers who develop it with the aim of helping users with disabilities and smart hospital rooms. Controls developed to help with disabilities were controlling the wheelchair and controlling the printing of documents using braille. Control on smart chairs for physically disabled people who couldnot move a wheelchair by hand developed by Aktar [3]. This wheelchair was also equipped with a GPS module that can be used to track and send information to smartphone applications via firebase. Controlling the printing of documents using braille is done with the aim of developing a voice-controlled braille printer developed by Manigiri [4]. This printer would help users with disabilities print a spoken voice into a document in braille format. For controlling the prototype smart hospital room, the application was carried out in controlling the patient bed in the hospital and controlling the device to call nurses developed by Agustin [5]. The patient's bed could be adjusted using voice commands in the sitting, intriguing and sleeping position, while the buzzer is used as an assist button to call the nurse. Thus controlling the prototype smart hospital room would make it easier for patients.

#### 3.2 Voice Command

The differences in research that was conducted were at the voice command used, namely using voice

recognition or speech recognition. Researchers used voice commands in the form of voice recognition with the hope that the smart home prototype being developed can have a better level of security. This is because voice recognition identifies the user's voice based on intonation, accent, or speech style according to the stored voice. So that if other users given orders to the smart home, the system will not function like research conducted in reference [3], [6], [7], [8], [9], [10], [11], [12], [13], [14], [15]. Meanwhile, researchers in reference [4] and [5] chose to used speech recognition because researchers focused more on developing research on the success of the system in capturing words uttered by users due to each accent. different regions, testing the sensitivity of the system better in which language, or testing whether the system could recognize words that do not match the structure of the language.

#### 3.3 Hardware Used

The difference in the research conducted also were at the choice of hardware used by researchers in voice control or microcontrollers. The voice control module that can be used was the EasyVR module or the voice recognition module. This module was mostly chosen by researchers. But there were researchers in reference [9], [11] who used applications developed on Android connected by bluetooth. As for the microcontroller, most researchers used Arduino Uno and others used Arduino Nano, Arduino raspberry pi3 (Arbaus and Aryani) and wemos (Prakoso). Arduino Uno has been chosen because it maked it very easy in rapid prototyping, trial and error, the upload process is faster, and safer because it had an internal regulator and fuse. Meanwhile, raspberry pi3 is used because it can be used in projects involving high-level software using the widely known C language, and wemos is used because it had ESP-8266-based Wireless Fidelity (Wifi) which makes it easier to develop devices that used Wifi.

Remote voice control is done by combining software that can be developed on Android and connected with a Bluetooth module or a NodeMCU module. Control that adds a bluetooth module can be carried out in an intermediate distance with a maximum distance of 10 meters. The drawback was that if there is a barrier, it can make the system unable to catch the command given. Meanwhile, control that adds a NodeMCU module can be done from anywhere with an internet connection. The drawback was that if the internet speed was low, the system couldnot catch the command given.

#### 3.4 Testing

Testing on voice-based control systems consists of voice command testing, program testing, circuit testing, distance testing, environmental testing, response time testing and delay testing. Voice command testing was

used to determine whether the system could recognize voices and perform commands according to the voice given. This test was done by giving voice commands from the same person, other users, different accents, and age ranges. For program testing, it was carried out to determine whether the program was in accordance with the planned system and whether there was an error. Program testing was related to the programming language and programming software used. Circuit testing was carried out to test whether parts of the circuit, namely inputs such as microphones, processes such as microcontrollers, and outputs (related to actuators) can operate properly or not. The distance test was carried out to test whether the microphone can pick up sound at a specified distance. Meanwhile, for remote control, distance testing was carried out to test whether the transmitter and receiver can communicate properly. Environmental testing was carried out to measure the noise level whether it affects the system or not. Testing of response time and delay was carried out to test the response of the system when given a voice command, whether the system would immediately execute the command or there was a pause to carry out the command.

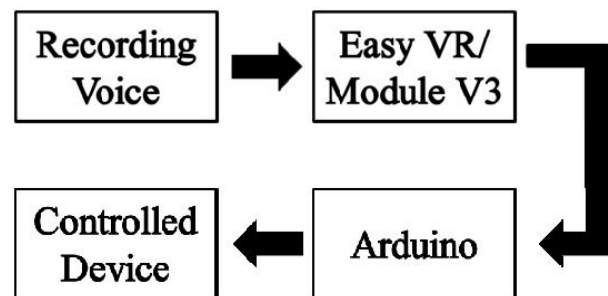
**3.5 Result**

The results were obtained from the testing process, in the voice command test, the following results were obtained when voice testing with the same person had high results of more than 80%, while for testing other users had low results of less than 25%, while for testing different accents and age obtained accents of kelantan, trengganu and kedah are the worst accents and age 60 years and over give a lot of error commands. The results of program testing as a whole did not experience problems, this can be attributed to all research that shows the system could work in accordance with the instructions given. For the results of the circuit testing as a whole there were also no problems, because the circuit could work according to the instructions given, for example in research using the L298N motor driver, in this study it was known that the motor driver could function properly. The results of the distance test showed that the best distance between the sound source and the microphone was 3 cm - 10 cm, while for remote testing using bluetooth and wi-fi, the best distance was between 1 - 20 m. Apart from distance, the remote control system was also affected by the baud rate and internet speed. The higher the baud rate, the lower the results, and the higher the internet speed, the higher the results. The results of environmental testing show that a noisy environment would give many errors. This can be seen from an example of a study which states that the room noise level of 34.5 dB gives a success of 86%, while the 62 dB room noise level gives a success of 79%, another example was in another study which states that the best environment for testing was in the library and the worst environment was located at the cafe. In the test results, the response

time and delay were influenced by the distance between the sound source and the microphone, the farther the distance between the two would make the response of the system longer.

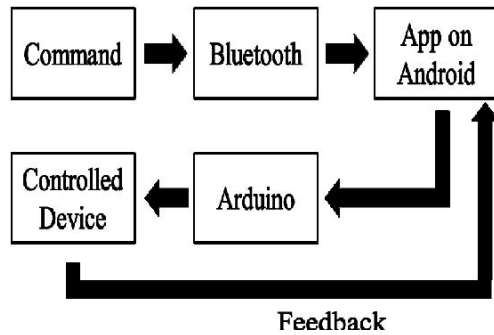
**3.6. System Procedure**

The way the voice-based control system works when using voice recognition was that the user records their voice to be stored in the database as a sample to be used in verifying the voice input later. Input in the form of voice commands given through the microphone, was forwarded to Easy VR as voice recognition which will match the voice sensor output data that had been sampled. The microcontroller was Arduino which will process the output from EasyVR and activate the controlled device as in “Fig. 2”. If the voice command used was in the form of speech recognition, the system works by utilizing speech to text on the Web Speech API, the input was then converted into text. Users must connect to the internet for intermediary data exchange in order to access the Speech API Web server. The input that was processed will be responded by the server by sending a switch on or switch off command. The microcontroller would then run the relay according to the command received.



**Figure 2** Block diagram of how the system works

Remote control can be done using bluetooth and NodeMCU. Controlling using bluetooth, the system was run by opening an application that has been made on Android. Then given the command to activate the controlled device. This command would then be converted and sent via bluetooth to android using a voice and speech detector. The next command was processed by the Arduino Uno microcontroller and will be executed to turn on or turn off electronic devices and send feedback to Android as in “Fig.3”. In controlling using NodeMCU, the system worked by giving voice commands as input through an application that has been designed on Android which would then be converted and processed in Arduino and the data was sent to the NodeMCU module.



**Figure 3** Block diagram of how the system works using Bluetooth

### 3.7 Factors

Factors that could affect the sound-based control system include clear pronunciation, sound pitch, microphone distance, sound source, intonation and noise level. If there was a change in the sound, the system would not work. This was because the voice is not identified in the database that had been created. Whereas in remote control, things that needed to be considered when using bluetooth are distance, obstacles, and signal strength. If you used an internet network, you needed to pay attention to the internet speed level. The greater the internet speed, the greater the success rate.

## 4. CONCLUSION

The results of the study conducted by reviewing journals as described can be concluded that the design and implementation that has been done using voice commands in the form of voice recognition and speech recognition can facilitate human activities in everyday life. Control automation can be applied to a smart home by controlling electronic devices such as lights, fans, TVs, air conditioners and so on which are based on voice commands. It can also be applied as a security system such as automatic door control. In addition, the application of voice commands can also be applied to smart hospital rooms such as controlling the patient's bed in the hospital and assisting in calling for nurses. It can also help users with disabilities such as moving a wheelchair and printing documents converted to braille.

## REFERENCES

[1] M. Zed, *Metode penelitian kepustakaan*, Jakarta: Yayasan Obar Indonesia, 2014.

[2] Sugiyono, *Metode penelitian kuantitatif, kualitatif dan R&D*, Bandung: Alfabeta, 2017.

[3] N. Aktar, I. Jahan, and B. Lala, "Voice recognition based intelligent wheelchair and GPS tracking system," in *International Conference on Electrical, Computer and Communication Engineering*,

February 7-9, 2019.

[4] B. Manigiri, D. Maladewa, R. Panchal, S. Hakke, and S. Dicholkar, "Voice controlled braille embosser," *International Journal for Research in Applied Science and Engineering Technology*, vol. 8, no. 1, pp. 415-417, January 2020.

[5] E. I. Agustin, T. R. Yunardi, and A. A. Firdaus, "Voice recognition sistem for controlling electrical appliances in smart hospital room," *Telkommika*, vol. 17, no. 2, pp. 965-972, April 2019.

[6] A. Seppiawan, Nurussa'adah, and P. Siwindarto, "Sistem keamanan pintu pagar otomatis menggunakan voice recognition," *Jurnal mahasiswa TEUB*, vol. 2, no. 6, pp. 1-6, 2014.

[7] Y. Mittal, P. Toshniwal, S. Sharma, D. Singhal, R. Gupta, and V. K. Mittal, "A voice-controlled multi-functional smart home automation system," in *Annual IEEE India Conference*, 17-20 December, 2015.

[8] D. Arbaus, D. A. Prasetya, and A. P. Sari, "Kecerdasan buatan pada sistem pintu otomatis menggunakan voice recognition berbasis raspberry PI," *Jurnal ilmu-ilmu teknik-sistem*, vol. 12, no. 3, pp. 186- 196, 2016.

[9] C. S. Tyagi, M. Agarwal, and R. Gola, "Home automation using voice recognition and arduino," *Journal of Recent Trends in Engineering & Research*, vol 2, no. 7, pp. 1-6, July 2016.

[10] A. Asni, A. F. S. Rahman, and M. Mursid, "Rancang bangun buka tutup pintu otomatis menggunakan pengenalan isyarat tutur," in *Seminar Nasional Inovasi Teknologi Terapan*, 2017.

[11] D. Ariyani, D. Iskandar, and F. Indriyani, "Perancangan smart door lock menggunakan voice recognition berbasis raspberry PI 3," *Jurnal cerita*, vol. 4, no. 2, pp. 180-189, August 2018.

[12] S. Ariyanti, S. S. Adi, and S. Purbawanto, "Sistem buka tutup pintu otomatis berbasis suara manusia," *Electronics, Informatics, and Vocational Education*, vol. 3, no. 1, pp. 83-91, May 2018.

[13] L. D. W. Raj, K. Santhosh, S. Subash, C. Sujin, and P. Tharun, "Voice controlled door lock system using matlab and arduino," in *International conference on system computation automation and networking*, 29-30 March, 2019.

[14] D. Eridani, I. Sanusi, and E. D. Widiyanto, "Pengenalan dan analisis ucapan pada sistem control perangkat listrik menggunakan arduino uno," *Jurnal Teknologi dan Sistem Komputer*, vol. 6, no. 1, pp. 18-24, January 2018.

- [15] L. A. Dzulfikar, E. Haryatmi, and T. A. Riyadi, "Rancang bangun purwarupa sistem pengunci lemari dengan pengenalan suara," *Jurnal Ilmiah Teknologi dan Rekayasa*, vol. 24, no. 3, pp. 216-225, Desember