Design and Implementation Servo Motor Controlling with Android Smartphone using Sound Frequency based Raspberry PI

Arif Viardiman*, Chevy Nanda, M. Rendy, and Aner Yuweti

Electrical Engineering, Engineering, Andalas University, Universitas Andalas Street, Limau Manis, Pauh, Padang, 25163, Indonesia

*e-mail: viardimaranrif@gmail.com

Abstract— Door security is a very important thing because the door serves as access to a valuable things or privacy place. This led to the rise of crime rate and the more sophisticated system in breaking into or damaging the door security system in the form of a conventional key. This research was designed servo motor control system for a door security with android smartphone apps using voice frequency based raspberry pi. Process in the system is the raspberry pi will store our voice database when speaking on android smartphone, and then the frequency of our voice will be transmitted with the Bluetooth module connection HC-05 to the microcontroller. When the voice input same with the database stored in the microcontroller Raspberry Pi, the servo motor will spin according to the program that has been input and will open a key that has been installed on the door. The farthest distance that have been tested to send data by android smartphone to a Bluetooth module with the obstacle is 4 meters. While the longest Distance that have been tested to send data without obstacle is 7 meters. Mobile application displays data reading in real time. This research is expected to create door security technology that can be implemented widely in the community.

Keywords— Bluetooth HC-05, Microcomputer, Raspberry PI, Servo Motor, Smartphone Android

I. INTRODUCTION

Security is one of the various cases are often spread through the media such as that mention murder which was originally from a place like bank break-ins as well as places that can invite the incidence of crime in the form of robbery. Robbery is not only from among the underprivileged, but also come from intellectual circles but with the crime rate is also different. This makes the security system to be one of the important factors in the development of current technologies. But as the development of technology development happened also in crimes committed to damage the security system that has made the owner of the room.

From a wide variety of problems that arise due to technological developments, then it should be also done development against security systems that are easily monitored and with a more efficient system to reduce the sense of worry about the owner of the place related events that will occur. So, that development in this technology needs to be done to resolve the problem that is described in the previous case.

Current advances in technology have already intensified. One such technology is the technology Android which has been epidemic in various countries using them. Android technology development can be combined with other technologies, such as combined with Microcontroller technology. Raspberry Pi is one of the modules of microcomputer which also has a digital input output port as on board Microcontroller.

Thus, by combining technology with android microcontroller, the author seeks to design and create a servo motor Control system with the latest Android Smartphone using the voice-frequency Based Raspberry Pi. Devices used include the Bluetooth module type HC-05, later the Bluetooth module is used to connect between authors Android Smartphone with a microcontroller Raspberry Pi. This tool will be controlling a servo motor used to open and lock the door which placed on the door. Servo motor is a DC motor that moves a thing to a series of mechanical, such as open closed valves, robotic arm, and open closed doors and so on.

The process is done in the system's is the microcontroller will store data base our voice when speaking on android smartphones and will then be transmitted to the frequency of the sound module Bluetooth connection we have with HC-05 to the microcontroller. When the voice input being entered in accordance with the data base stored in the microcontroller Raspberry Pi, then the servo motor will spin according programs already input and will open a key that has been installed on the door, and when the different sound input with data base stored in the microcontroller Raspberry-Pi, then the servo motor will not move and unlock any rang alarm indicator used, useful for making
usually in combination with PID control algorithm, always run at full speed. Both of these enhancements, can also control the speed of their motorcycles, rather than measure the position and speed of the shaft output. They control models. More sophisticated Servomotor good the basis of a simple and inexpensive servo used for radio widely used in industrial motion controls, but they form spinning at full speed (or stop). Servomotor type not position sensing via potentiometers, motor is always ordered to. Paired with some type of motor encoder to provide position and speed feedback. In the simplest case, only the position of the measured. The position is measured from the output of the command positions, compared with external input to the controller. If the output position is different from that required, the resulting error signal which then causes the motor to spin in either direction, it is necessary to bring the shaft output to the appropriate position. As the approach position, signal error is reduced to zero and the motor stops.

Fig. 1. Standard Motor servos Hitec HS-311

B. The Working Principle of Servo Motor

As the name suggests, the servo motor is a servo. More specifically is a closed-loop servo feedback using the position to control the movement and final position. Input control are some of the signals, whether analogue or digital, that represents the position of the output shaft is ordered to. Paired with some type of motor encoder to provide position and speed feedback. In the simplest case, only the position of the measured. The position is measured from the output of the command positions, compared with external input to the controller. If the output position is different from that required, the resulting error signal which then causes the motor to spin in either direction, it is necessary to bring the shaft output to the appropriate position. As the approach position, signal error is reduced to zero and the motor stops.

On the very simple servo motor that only using position sensing via potentiometers, motor is always spinning at full speed (or stop). Servomotor type not widely used in industrial motion controls, but they form the basis of a simple and inexpensive servo used for radio control models. More sophisticated Servomotor good measure the position and speed of the shaft output. They can also control the speed of their motorcycles, rather than always run at full speed. Both of these enhancements, usually in combination with PID control algorithm, allowing the servomotor will be brought to the position ordered faster and more accurately, with less overshoot.

C. Android

Android is a Linux-based operating system designed for mobile devices such as touch screen smartphones and tablet computers. Android was originally developed by Android Inc., with financial support from Google, who then bought it in 2005. This operating system is officially released in 2007, along with the founding of the Open Handset Alliance, a consortium of corporation’s hardware, software, and telecommunications that aims to advance the open standard mobile device. First Android phone went on sale in October 2008.

Android is an operating system with open source (open source), and Google released the code under the Apache license. Code with an open source license and permissions in Android allows the software to be freely modified and distributed by device makers, wireless operators, and application developers. In addition, Android has a large number of developer community applications (apps) that extend the functionality of a device, generally written in the Java programming language customization version.

Android also became the choice for technology companies that want low-cost operating system, customizable, and lightweight for a high-tech device without having to develop it from scratch. As a result, although initially this operating system designed specifically for smart phones and tablets, Android also developed into additional applications in television, game console, digital cameras, and other electronic devices. The open nature of Android has encouraged the emergence of a large number of communities of application developers to use open source code as the basis for project applications, by adding new features for advanced users or operating the Android devices that was officially released by using another operating system (Wikipedia, 2013).

The Android platform is regarded as the future of a complete, open and free as follows (Safaat, 2012):

- Complete Platform: the designers can do a comprehensive approach when they are developing the Android platform. Android is an operating system that is safe and provides many tools in building software and allows for application development opportunities.

- Open Source of the Android Platform are provided through open source license. Developers can freely to develop applications. Android itself uses the Linux kernel 2.6.

- Free: Android is a free application platform or develop. There are no licensing or royalty fees to be developed on the Android platform. There is no membership fee is required. The test fee is not required. No contract is required. App for android can be distributed and traded in any form.

D. Raspberry-Pi

The Raspberry Pi is a low cost, credit-card sized single board developed at United Kingdom. It was designed and
manufactured by Raspberry Pi Foundation from UK with the intention of stimulating the teaching of basic computer science in school’s students and every other person interested in computer hardware, programming and DIY (Do-it Yourself) projects. It acts like a computer when plugs into a computer monitor or TV, and uses a standard keyboard and mouse.

Raspberry Pi is a microcomputer module that also has a digital input output port as on board microcontroller. Among the advantages of Raspberry Pi than any other microcontroller board namely has the Port/connection to display either a TV or a PC Monitor as well as the USB connection for Keyboard and Mouse. Raspberry Pi is a microcomputer module which has a digital input output port as on board microcontroller. Raspberry Pi board is made with 2 different type i.e. type A Pi and Raspberries Raspberry Pi type b. the difference between Ram and the other on the LAN ports. Type A = 256 Mb RAM and without port LAN (Ethernet), type B = 512 Mb Excellence Raspberry Pi i.e. his RAM memory is larger and can store a lot of data base on microcontroller to another, so that in the draft this time can eventually keep a data base of sounds input as a data base for the opening and closing of the valve lock the door later.

The Raspberry Foundation provides Debian and Arch Linux ARM distributions for download. Tools are available for Python as the main programming language, with support for BBC BASIC (via the RISC OS image or the Brandy Basic clone for Linux), C, C++, Java, Perl and Ruby. The video controller is capable of standard modern TV resolutions, such as HD and Full HD, and higher or lower monitor resolutions and older standard CRT TV resolutions. Below figure shows advance specification of RASPBERRY PI.

<table>
<thead>
<tr>
<th>SoC:</th>
<th>Broadcom BCM2835 (CPU, GPU, DSP, SDRAM, and USB ports)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPU:</td>
<td>700 MHz ARM1176JZF-S core (ARM11 family)</td>
</tr>
<tr>
<td>GPU:</td>
<td>Broadcom Video Core IV, OpenGL ES 2.0, MPEG-2 and VC-1 (with license), 1080p30 h.264/MPEG-4 AVC high-profile decoder and encoder</td>
</tr>
<tr>
<td>Memory (SDRAM):</td>
<td>512 MB (shared with GPU)</td>
</tr>
<tr>
<td>USB 2.0 ports:</td>
<td>4 (via integrated USB hub)</td>
</tr>
<tr>
<td>Video outputs:</td>
<td>Composite RCA (PAL and NTSC), HDMI (rev 1.3 &amp; 1.4), raw LCD Panels via DSI,14 HDMI resolutions from 640×350 to 1920×1200 plus various PAL and NTSC standards.</td>
</tr>
</tbody>
</table>

E. Bluetooth Module HC-05

Bluetooth is a wireless communication protocol which works on radio frequency 2.4 GHz for data exchange on a mobile device such as a PDA, laptop, HP, and other lain1. One of the results of the example module Bluetooth is the most widely used type HC-05. Bluetooth module HC-05 Bluetooth module is one that can be found over the counter with a relatively inexpensive price. Bluetooth module HC-05 consists of 6 pin connector pin connectors, which each have a different function. Bluetooth module for the image can be seen in Figure 3 below:

![Fig. 3. Module Bluetooth HC-05](image)

Bluetooth module HC-05 with a supply voltage of 3.3 V and pin 12 of it’s as the VCC. Pin 1 on the Bluetooth module as a transmitter. Then pin 2 on Bluetooth as a receiver. The following is a configuration pin Bluetooth HC-05 shown in Figure 4 below:

![Fig. 4. Pin Configuration Bluetooth HC-05](image)

Bluetooth module HC-05 is a Bluetooth module that could be a slave or master. This is proven by the notification could give for pairing to others, as well as other devices are pairing to a Bluetooth module CH-05.
To set the Bluetooth devices it takes command AT which will in response by a Bluetooth device if the Bluetooth module is not in a state to connect to other devices.

III. METHOD

A. Research Flowchart

On the research of a system designed to drive a servo motor to open and close the door using the frequencies of the voice as an input. There are several stages in the design of this system, as shown in Figure 5 about program flowchart design.

![Flowchart of Research](image)

B. Designing System Algorithm

At this stage author, have done the design algorithm of the system. The algorithm of the system is as follows.

![Flowchart of System Algorithm](image)

As seen in the flowchart that to run the system do the voice input using android smartphone then the voice input will be translated by Google Voice into data in the form of characters which will then be transmitted using HC-05 Bluetooth module to the microcontroller Raspberry-Pi. Then the data is transmitted earlier will be matched with data stored in Raspberry-Pi.

C. Preparation of Program Design

Preparation of program design is to analyze the performance of the hardware required, collect drivers and libraries needed in the making of the program, and install the software that will be used in the program design.

In this study, author use software such as python and Linux operating system which is Raspberry-Pi for the camera and software programming python-language C, as well as using software Arduino IDE for connecting between android smartphone and Arduino microcontroller via Bluetooth module HC-05 as a data transmission medium.

D. Main Program Design

At this stage, it will be discussed on the program design of motion control servo motor for opening and closing the door with a voice input using a microcontroller raspberry-Pi. The program is a program that made communication between the Raspberry-Pi with Servo Motor, Raspberry-Pi with Bluetooth Module HC-05 and the HC-05 Bluetooth module with Android smartphones. At this stage, also author calibrates servo motor’s torque so that servo motors turn the corner as the desired. Therefore, when the servo motor has gained a high logic instruction (1), the servo motor’s hinge will rotate to open or close the door.

E. System Evaluation

In this stage testing of the system is to perform voice input and see the response of the system. The parameters of the success of this system is that it operates without error, the suitability of servo motors in open, closed and locked the door as well as the system's response time to drive the servo motor is not too long.

IV. ANALYSIS AND TESTING RESULT

A. Testing and Analysis

Based on the system has been successfully created, author have done some testing of the system's response time in the form of servo motor control with android smartphone using voice frequency-based Raspberry Pi. Testing the time taken of the output of the servo motor will move to open the door since the input of voice input on Android smartphones. As in this test there are two variables. The first is the distance between Android Smartphone with a system of opening and closing the door and the second is the quality of internet signal contained in the Regional systems. So, testing done is how long the system response at particular internet signal at a certain distance. From the results of experiments conducted for the simulation tool, the author gives an analysis based on the submission and design systems.
1) **Step-by-Step Testing**

In conducting the testing system was created, then there are steps system test as follows:

a) Declaring the words that would be the password for controlling the servo motor in the program.

b) Activate the system by connecting the devices used, the Raspberry PI, HC-05 Bluetooth module, the servo motors on doors and power modeling bank as a source of electric current, then activate the voice inputting application on android smartphone.

c) Once the system is activated, the system is ready to be tested by means of voice input into a password in order to drive the servo motors on the door.

d) Evaluating the system with a certain signal conditions and the distance between android smartphone and modeling of different doors.

e) Noting how long the system response time to drive the servo motors on modeling the door.

2) **Based on the results of testing the system, it will get data such as response time of the system.**

That time is time servo motor for open or closed as from the sound input through android smartphone. In the following tables show data on the state of the signal system response is different and also the distance between android smartphone and modeling door.

### TABLE I. SYSTEM RESPONSE IN E+ SIGNAL CONDITION

<table>
<thead>
<tr>
<th>Distance (m)</th>
<th>Time taken(s)/Trial</th>
<th>Average time taken(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2.1 2.2 2.1 2.3 2.2</td>
<td>2.18</td>
</tr>
<tr>
<td>2</td>
<td>2 2 1.9 2.3 2.2</td>
<td>2.08</td>
</tr>
<tr>
<td>3</td>
<td>2.1 2.1 1.9 2.1 2</td>
<td>2.04</td>
</tr>
<tr>
<td>4</td>
<td>2.3 2.2 2.1 2.1 2.1</td>
<td>2.16</td>
</tr>
<tr>
<td>5</td>
<td>1.9 2.4 2 2.2 2.2</td>
<td>2.14</td>
</tr>
</tbody>
</table>

### TABLE II. SYSTEM RESPONSE IN H+ SIGNAL CONDITION

<table>
<thead>
<tr>
<th>Distance (m)</th>
<th>Time taken(s)/Trial</th>
<th>Average time taken(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.8 1.8 1.9 2.1 2.1</td>
<td>1.92</td>
</tr>
<tr>
<td>2</td>
<td>1.8 2.1 1.7 2.1 2.1</td>
<td>1.96</td>
</tr>
<tr>
<td>3</td>
<td>2.2 1.8 2.1 2 1.9</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>1.8 2 1.8 2 2.2</td>
<td>1.96</td>
</tr>
<tr>
<td>5</td>
<td>1.9 1.9 2 2.1 1.9</td>
<td>1.96</td>
</tr>
</tbody>
</table>

### TABLE III. SYSTEM RESPONSE IN 3G SIGNAL CONDITION

<table>
<thead>
<tr>
<th>Distance (m)</th>
<th>Time taken(s)/Trial</th>
<th>Average time taken(s)</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>1.8 1.7 1.7 2.1 2.2</td>
<td>1.9</td>
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<tr>
<td>2</td>
<td>1.9 1.6 1.8 2 2</td>
<td>1.86</td>
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<td>3</td>
<td>1.8 1.9 1.8 2.1 2.1</td>
<td>1.94</td>
</tr>
<tr>
<td>4</td>
<td>1.9 1.8 1.8 2.3 2.2</td>
<td>2</td>
</tr>
<tr>
<td>5</td>
<td>1.8 1.8 2 1.9 2.4</td>
<td>1.98</td>
</tr>
</tbody>
</table>

V. **RESULT ANALYSIS AND DISCUSSION**

These systems are a simulation of a servo motor control to close, open and lock the doors using the modeling android smartphone for voice input and raspberry Pi as a microprocessor. Based on the results of experiments conducted, the author gives an analysis based on the results of testing and designing the system, which are:

a) Condition of the signal affect response time, it appears that the system response time to the signal E+ is the longest and the fastest time on 3G.

b) The distance between Android smartphone with Raspberry-Pi did not significantly affect the response time of the system, it is shown in the table that the response time not too different in the distance was tested.

VI. **CONCLUSION**

From this research the author concluded as follow:

a) Servo motor control systems with voice input on Android Smartphone has gone well and the response time is appropriate.

b) The results of the testing system response in moving motor servo signal condition seen that affect system response time.

c) While the distance between android smartphone and Raspberry Pi not too affect system, response time.

d) Maximum Distance system response is no more than 7 meters, so the distance above the system is not running properly.

### ADVICE

a) On the development in the future to use another communication module that has more transmission distance, for communication between android smartphone and raspberry pi

b) The future is developed by using a database to store data, so that the sound is better security level
REFERENCES


