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Design and Development of An Automatic Door Gate Based on Internet of Things Using Arduino Uno

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ABSTRACT

This study aims to design a prototype of an automatic gate drive by utilizing a DC motor in order to be able to control the house gate automatically and be able to open the door or close the door by using an application on a Smartphone. The drive system uses a DC motor with a supply voltage given from a 12 V battery installed on the prototype turnstile. so that the DC motor can open and close properly it requires serrations on the gate according to the size of the teeth (gear). Besides that, the components are arranged in the Arduino uno circuit using the HC-05 Bluetooth module, Motor Driver l298n as a polarity reverser for the DC motor, the fence as a load, and the Bluetooth RC Controller application to be able to input so that the DC motor can move according to the commands given.

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1. INTRODUCTION

The existence of rapid technological advances allows the formation of various efforts in order to provide convenience and comfort for humans. One form is the development of a system that can be implemented in the home gate environment, namely a system that can open house gates automatically with assistance through the android system. Through this system it is expected can simplify the application user and provide time efficiency with no need for direct interaction with the gate because it is quite accessible via android.

In the previous research conducted research in the form of control pintu is the gateway to using Arduino and Smartphone. In this research, a circuit design consisting of the L298N motor driver was carried out to drive a DC motor. Arduino is used as a CPU and Bluetooth as a communication tool [1]–[3].

As for another research entitled " Door-automation system using bluetooth-based android for mobile phone". In his research, he discussed the use of the Arduino microcontroller by utilizing Bluetooth technology on Android which is connected to Bluetooth on the Arduino, as an input to open and close the gate automatically in this study. the method used to make a sliding gate is to use an android application created through the Inventor app software [4].

Application users with the aim that users no longer need to issue an android or interact with the Reuleut campus gate to open it with Arduino Uno which functions as a data processing center or can be said to be a microcontroller and a Bluetooth HC-05 module which functions as a

tool for communication media between android and microcontroller Arduino uno. Bluetooth itself has a range that is not too far to function in order to minimize errors in opening the gate via an android smartphone [3], [5]. The formulation of the problem in the research is as follows: How to determine the appropriate motor on the prototype? How to apply the system on the gate device automatically? The results of this research are as follows: 1. Using motor in order to control the gate of the house Automatic. Can open the door or close the door using the application on the Smartphone.The problem boundaries in conducting this research are as follows:

1. The microcontroller used is the Arduino uno
2. Give permission to run the application automatically
3. Availability of Bluetooth on the smartphone
4. Does not discuss data transmission on smartphones
5. Just open the automatic sliding gate

2. Basic Theory

2.1 Automatic doors

According to the Big Indonesian Dictionary (KBBI), the automatic word itself means that it can work by itself. In its application, the meaning of being able to work alone must be accompanied by certain treatments or changes to something that is automatic so that the work is carried out as intended.

The use of something that is automatic is often relied on to facilitate various human activities. The meaning of an automatic door is of course not much different from the description above. An automatic door must be able to open or close the door by itself. In order to do this, a fence must be connected to a control system that can give instructions to the fence about when to open the fence and when to close the fence [2], [6], [7].

2.2 Arduino

Arduino Uno can be said to be a platform for physical computing that is open source. Arduino is not just a development tool. Arduino is a combination of hardware, programming language and a sophisticated integrated development environment (IDE) so that it can be used to realize electronic circuits from simple to complex, with the addition of certain components, this tool can be used for remote monitoring via the internet such as smartphones. Arduino specifications can be seen in Table 1 and the shape of Arduino can be seen in Figure 1 [8]–[10].

Table 1. Specifications for Arduino Uno

Microcontroller	ATmega328
Working voltage	5V (depending on model)
Voltage input	5 - 12 V (5V model)
Digital I / O pin	14 (6 of them are used as PWM output with 8 bit resolution)
Analog Input Pin	6 (A0-A5) with a resolution of 10 bits
DC current per I / O pin	50 Ma
Flash Memory	32 kB (0.5 kB used as bootloader)
SRAM	2 Kb
EEPROM	1 Kb
Clock Speed	16 Hz

Figure 1. Arduino Uno

2.3 Smartphone

Smartphone is a linux-based operating system that is used as a hardware resource manager, both for cellphones, smartphones and tablet PCs. In general, Android is an open platform (open source) for developers to create their own applications for use by various mobile devices The first phone that uses the Android operating system is the HTC Dream, which was released on 22 October 2008. Android has come with version 1.1, which is an operating system that is equipped with aesthetic updates to the application, such as an alarm clock, voice search, sending messages by Gmail, and email notification [3].

The features and benefits available on Smartphones are:

a. The application framework allows the use and removal of the available components
b. Optimized virtual machines for mobile devices
c. Graphics in 2D and 3D based on open GL library
d. Sqlite to store data.
e. Supports various media such as audio, video, and various image formats (MPEG4, H.264, MP3, AMR, JPG, PNG, GIF)
f. Has a lot of application support

2.4 Bluetooth HC-05

Bluetooth HC-05 is an easy-to-use Bluetooth spp (serial port protocol) module for wireless serial communication that converts the serial port to Bluetooth. The HC-05 uses Bluetooth ver.2.0 modulation + EDR (Enchanced Data Rate) 3 Mbps with utilizing radio waves with a frequency of 2.4 GHz. this module can be used as a slave or master. HC-05 has 2 configuration mide, namely AT mode and Communication mode [5], [11]. AT mode functions to make configuration settings of the HC-05. Meanwhile Communication mode functions to perform Bluetooth communication with other devices. for the Bluetooth HC-05 form can be seen in Figure 2.

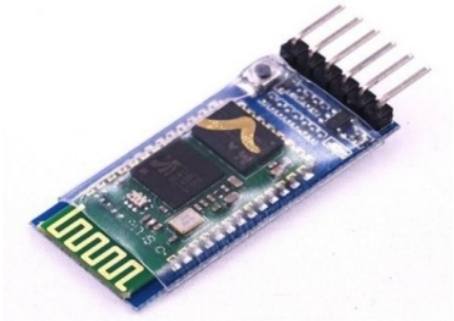

Figure 2. Bluetooth HC-05

2.5 L298 Motor Driver

A driver is a circuit composed of transistors used to drive a DC motor. The motor can indeed rotate only with DC power, but it cannot be adjusted without using a driver, so a series of drivers is needed which functions to regulate the work of the motor. It can be seen that the motor driver used is the L298 motor driver. The L298 motor driver is a type of motor driver IC that can control the direction of rotation and speed of a DC motor or stepper motor [12].

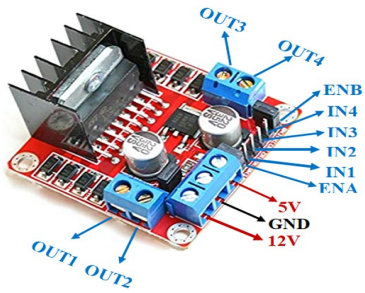

Figure 3. L298 Motor Driver

2.6 DC Motor

A DC motor is an electric motor that requires a direct current voltage supply to the Field coil to be converted into mechanical energy. The field coil in a dc motor is called the stator (non-rotating part) and the armature coil is called the rotor (rotating part). Direct current motors, as the name suggests, use direct indirect current / directunidirectional [13].

DC motor is an electronic device that converts electrical energy into mechanical energy in the form of rotational motion. In a DC motor there is an anchor with one or more separate coils. Each coil ends in a split ring (commutator). With the insulator between the commutators, the split ring can act as a double pole switch (double pole, double throw switch). DC motors work on the principle of the Lorentz Force, which states that when a current conductor is placed in a magnetic field, a Force (known as the Lorentz Force) will be created orthogonally between the direction of the magnetic field and the direction of current flow.

Figure 4. DC motor

2.7 Bluetooth

Bluetooth is a wireless personal area network (PAN). Bluetooth can be used to exchange information between devices. Bluetooth specifications are developed and distributed by the Bluetooth Special Interes Group. Blueetooh operates in the 2.4Ghz frequency band using a frequency hopping traceiver that is able to provide real-time voice and data communication services between bluetooth hosts with a limited distance in the form of radio transceivers, baseband link controllers, and link managers [1].

2.8 Proteus

Proteus is a useful software for PCB design which is also equipped with a Pspice simulation at the schematic level before the schematic circuit is upgraded to a PCB so that before the PCB is printed, the user will know whether the PCB that has been made is correct or not. Proteus can also combine the ISIS program to create a circuit design schematic with the ARES program to create a PCB layout from the schematic that has been made. Proteus software is suitable for designing microcontroller circuits and can be used as a basic learning tool for electronics to applications about microcontrollers [14], [15].

3 RESEARCH METHOD

3.1 Research Stage

The first stage is to create a flow chart to help make it easier to analyze and implement an active and inactive automation system. The following is a form of the flow chart that has been created shown in Figure 5 below.

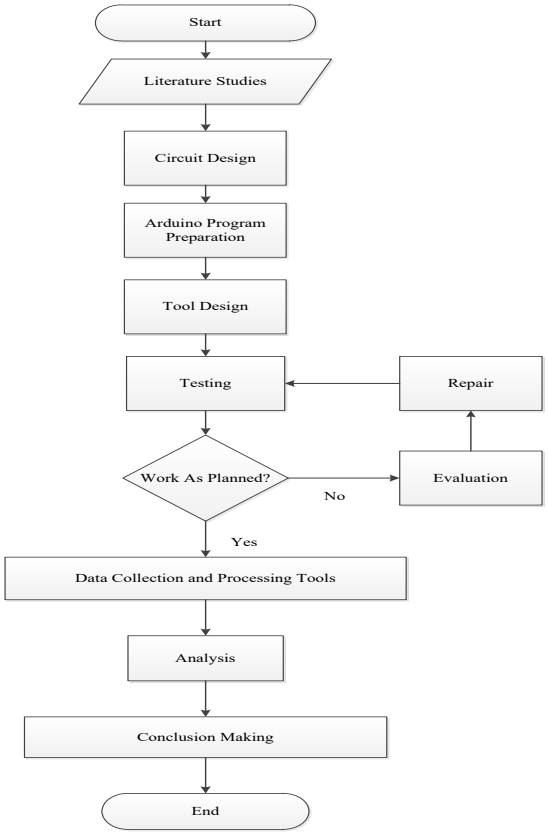

Figure 5. Research Flowchart

From the research process the flow chart above can be described:

1. Doing the design with a literature study, namely by conducting a literature review related to the issues discussed. Which is expected to provide confidence that this research can be carried out and provide direction to reduce errors in research.
2. Furthermore, designing the circuit, namely the selection of components that are in accordance with the design, the mechanical design of the miniature gate using acrylic and the drive system using a DC motor attached to the prototype of the gate besides that the components inside the prototype are connected by cables and plugs so that the stepper motor can open and closing properly, it takes the teeth on the miniature gate in accordance with the size of the teeth (gear) installed on the DC motor. After designing the circuit, the next step is to design the program using the Arduino IDE software to be embedded in the microcontroller.
3. Compiling the Arduino program, then testing the tool by connecting or detecting devices that have been installed (paired) with Bluetooth HC-05, if no data has been received by Arduino, it continues to detect until there is a device or data. giving orders to the DC motor to move so that the gate opens until the next data is sent, namely data b, then the gate is closed again.
4. After the tool can operate properly, then we analyze the results of the work of the tool, then take data in the form of testing the DC motor rotation whether it can work properly and can be used as a driving force to open or close the prototype gate so that the components match the datasheet and does not damage the components in the circuit that will affect the work of the tool.

3.2 System Block Diagram

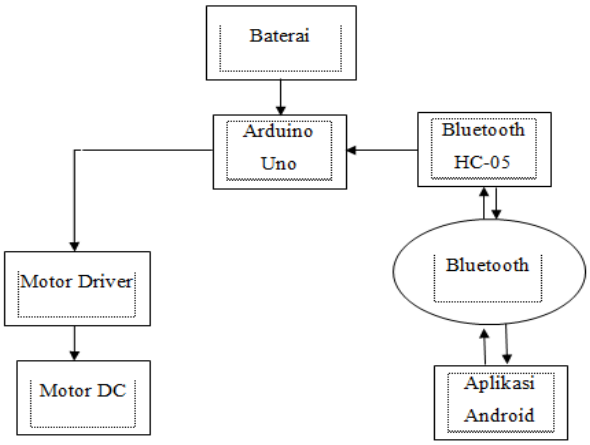

Figure 6. System Block Diagram

Each part of the block system diagram in Figure 3.2 will be explained as follows:

1. Input on Arduino Uno:
   a. Battery: Serves as a provider of voltage and electric current to other components and converts the voltage obtained from AC current to DC current.
   b. Bluetooth: used as a means of communication between Arduino Uno and applications on an android smartphone.
   c. Smartphone: The application is installed on a Smartphone to be able to input so that the stepper motor can move according to the command given.
2. Output on Arduino Uno:
   a. Motor driver: is an IC that is used to regulate the movement of the stepper motor after getting commands from the application on Android.
   b. DC motor: used to move the gate both in the condition of opening and closing after getting a command from a Smartphone.

3.3 Tools and Materials

a. Tool

The tools used or needed in designing an automatic gate can be seen in Table 3.1 as follows:

Table 2. Tools

No.	Tool's name	total
1	Screwdriver +/-	1
2	Soldering iron	1
3	Tin Vacuum	1
4	Multimeter	1
5	Cutting pliers	1
6	Laptops and Devices	1
7	Arduino IDE application	1

b. Material

The materials used or needed in designing an automatic gate can be seen in Table 3.2 as follows:

Table 3. Materials

No	Tool's name	Total
1	Arduino	1
2	Lead	1

3	Akrilic	Sufficiently
4	Adapter	1
5	Glue	Sufficiently
6	Smartphone	1
7	Motor driver circuit	sufficiently
8	Jumper cable	Sufficiently
9	Bluetooth HC-05	1
10	DC motor	1

4 RESULTS AND DISCUSSION

In this Chapter IV, we will discuss the testing and discussion of the automatic gate system. The first test starts with Bluetooth testing and the DC motor to make sure each part has worked so that it can be applied to the miniature. Furthermore, the gate miniature will be tested as a whole to find out whether the existing equipment on the miniature and the application on the smartphone has been running according to its function.

4.1 Automatic Gate Prototype

Automatic turnstile driving prototype Using acrylics and a drive system using a Dc motor with a voltage of 12 v attached to the prototype gate. In order for the DC motor to open and close properly, it takes serrations on the miniature gate according to the gear size. Other than that, the components arranged in the Arduino uno circuit using the HC-05 Bluetooth module, the motor driver L298 as a polarity reverser for the DC motor, the fence as a load, the battery and the connecting cable. The following is a miniature form can be seen in Figure 7.

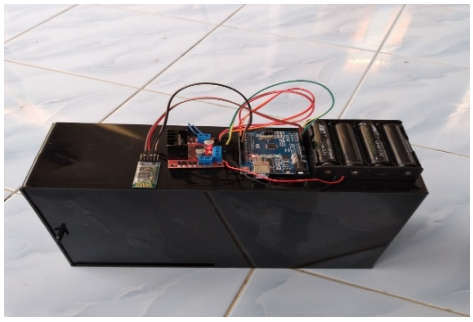

Figure 7. Automatic Gate Prototype

This automatic turnstile driving prototype only moves back and forth according to the command given to Arduino uno with a 5 cm diameter gear and a chain as a gear medium to move the fence having a length of cm with a kg fence load.

4.1.1 Testing Tool Components

The following is a test table for checking the main tool components in the design of an automatic turnstile using a DC motor.

Table 4. Testing Tool Components

Tool	Testing Method	Result	Status
Motor driver L298N	When the motor driver can drive the DC motor when the Bluetooth terminal application enters commands	Can move	Work
Bluetooth HC-05	Connected to a smartphone	Can be connected	Work
DC motor	Enter commands in the Bluetooth terminal	DC motor can drive	Work

The table shows the test results of the main tool components contained in the automatic gate design and analysis of the DC motor test results and tool status.

4.2 Testing Bluetooth

For testing the Bluetooth communication required is still very simple and does not require complex equipment. The tools used are still a laptop with a smartphone which will be used to provide input commands in controlling the gate with Arduino Uno and Bluetooth HC-05.

4.2.1 Bluetooth Testing Method

In this test, it will explain how the steps to be taken to test the accuracy level and also find out the error level of Bluetooth with Arduino and smartphones that have been given a Bluetooth connection program are as follows.

1. Connect the data cable on the Smartphone to the laptop and allow access to the smartphone data. Make sure the developer mode and USB debugging on the smartphone are active.
2. Configure the Java programming that has been configured then do the install process on the smartphone and load the C ++ programming for Arduino.
3. Search for the device with the Name HC-05 and carry out the Bluetooth Pairing process on the smartphone.
4. If Bluetooth is successful in the pairing process, it will automatically connect to the HC-05 module in the Miniature, marked by a notification on the smartphone.

4.2.2 Bluetooth Test Results

In Figure 8 is a request display on the Bluetooth HC-05 application from an Android smartphone that is used to connect the two devices and then the smartphone will automatically scan to detect what devices are installed and active on the Android smartphone then display it.

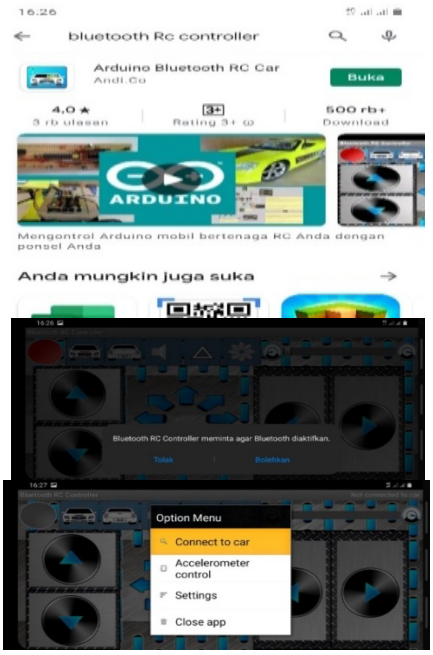

Figure 8. Display Bluetooth Application

Figure 9 shows the output of the Arduino uno in the form of an L298N motor driver and a DC motor when receiving commands from a smartphone, this proves that the HC-05 Bluetooth device can work properly and can be used as a medium for sending data to open or close the prototype gate. on the Arduino uno it will check whether the data is there or not then if it receives data in the

form of a then Bluetooth on the HC-05 will be connected and the motor will move and vice versa. if it receives data in the form b then Bluetooth on the HC-05 is disconnected and the motor will be in a dead condition.

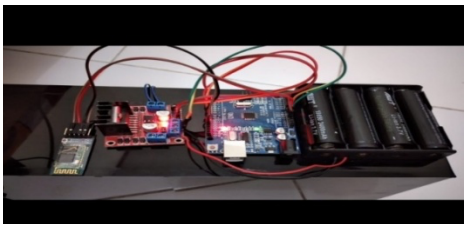

Figure 9. Bluetooth connected

4.3 Testing the Bluetooth Distance Connection

Testing the Bluetooth connection to determine the transmission distance between the bluetooth contained on the android smartphone and the Bluetooth HC-05 which has been integrated with the Arduino uno board. We can see a Bluetooth connection test in Table 5.

Table 5. Testing bluetooth distance connection

Distance between Bluetooth systems	Information
1 Meter	Smoothly take orders
1.2 Meters	Smoothly take orders
2 Meters	Smoothly take orders
2.5 Meters	Smoothly take orders
3 Meters	Smoothly take orders
3.5 Meters	Smoothly take orders
4 Meters	Smoothly take orders
4.5 Meters	Smoothly take orders
5 Meters	Smoothly take orders
5.5 Meters	Smoothly take orders
6 Meters	Smoothly take orders
6.5 Meters	Smoothly take orders
7 Meters	Smoothly take orders
7.5 Meters	Smoothly take orders
8 Meters	Smoothly take orders
8.5 Meters	Smoothly take orders
9 meters	Smoothly take orders
9.5 Meters	Smoothly take orders
10 Meters	Smoothly take orders
10.5 Meters	Smoothly take orders
11 Meters	Smoothly take orders
11.5 Meters	Disconnected

In Table 5, it can be explained that the results of sending data from a smartphone can be received well by Arduino uno at a distance of 1 meter to 11 meters. If the smartphone is at a distance of more than 11 meters, data transmission cannot be carried out and the connection will be lost. the data is by turning on Bluetooth on the smartphone.

4.4 Testing a DC Motor

The purpose of this test is to determine the success rate of the L298N motor driver to adjust the direction of rotation of the DC motor with commands given through the program.

4.4.1 Testing Method

This test will explain the steps that will be taken to test the success rate of the L298N motor driver to adjust the direction of rotation of the DC motor with the commands given through the step-by-step program for testing the DC motor connection, as follows:

1. Connect the cable on the Arduino Uno to the laptop and configure the c ++ programming with a predetermined number of steps via the Arduino IDE.
2. Provide power via the plug cable that is connected to the battery and make sure the Arduino is connected to the L298 driver as well as the DC motor.
3. Observe and make changes to the program for the desired number of input steps.

4.4.2 Test result

Table 6 can prove that the DC motor device can work properly and can be used as a driver to open or close the gate prototype. And also, the simulation of this automatic door gate simulation can be seen in the Figure 10 and 11.

Table 6. Motor rotation test

Step	Condition	Information
1	Move left	It works
2	Move left	It works
3	Move left	It works
4	Move left	It works
-1	Move right	It works
-2	Move right	It works
-3	Move right	It works
-4	Move right	It works

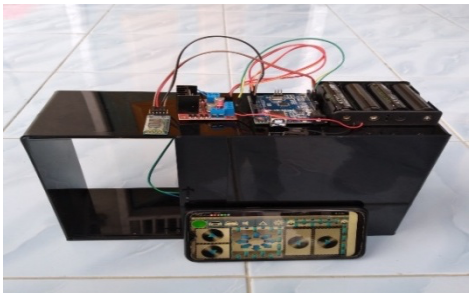

Figure 10. Position of the open gate

Figure 11. Closed gate position

4.5 Measurement of Voltage on the Battery

In measuring the voltage on the battery using a Digital multimeter, the voltage from a full wave rectifier circuit is in the form of a DC voltage. Testing the voltage on the battery to determine the input voltage and output voltage on the DC motor can be seen in the Table 7:

Table 7. Voltage on battery

Input voltage	Output voltage			Information
	Slow	Moderate	Fast	
16.10 V	4.74 V	5.64 V	6.27 V	Motor works
8.7 V	3.50 V	4 V	4.6 V	Motor works

The results of this measurement we can see that the output of the battery, namely the DC motor requires a constant voltage so that the rotation of the motor is more efficient, which in the

first data result is higher in value than the second data, because the first test uses 4 batteries and the second test uses 2 batteries. This indicates that the battery is in good condition so that the voltage that comes out does not differ much from the normal voltage.

5 CONCLUSION

From the results of the designs made and the discussion above, it can be concluded that:

1. It can be explained that the thrust generated by the door roller according to the design is more than 50 N so that it meets the thrust to move the sliding fence with the required voltage on the DC motor of 5 volts.
2. The command to move the door via this automatic switch can be carried out according to the command using the Bluetooth RC controller application on the smartphone, this design can occur when the smartphone and Bluetooth are connected.
3. By using an application on a smartphone, there will be an effect on the distance between the smartphone and the sliding door equipment, the farther the distance we test, the lower the Rpm speed value and the time is not short.

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