



FINAL PROJECT REPORT DRAFT

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Head of Study Program

# **Automatic Railway Gate using Arduino with Infrared and Vibration Sensor**

**A final Project Report  
Presented to  
The Faculty of Engineering**

**By**

**Muhammad Arwin Renardi Widyoko  
002201600002**

**in partial fulfillment  
of the requirements of the degree  
Bachelor of Science in Electrical Engineering**

**President University**

**May 2020**



DEFENSE READY -  
FINAL PROJECT REPORT

**APPROVED**

Date:

Signature:

Final Project Supervisor

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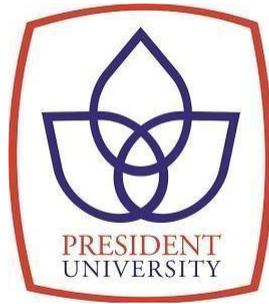
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## **DECLARATION OF ORIGINALITY**

I declare that this final project report, entitled “Automatic Railway Gate using Arduino with Infrared and Vibration Sensor” is my own original piece of work and, to the best of my knowledge and belief, has not been submitted, either in whole or in part, to another university to obtain a degree. All sources that are quoted or referred to are truly declared.

Cikarang, Indonesia, May 2020

A handwritten signature in black ink, consisting of a series of loops and a long horizontal stroke extending to the right.

**Muhammad Arwin Renardi Widyoko**

**AUTOMATIC RAILWAY GATE USING  
ARDUINO WITH INFRARED AND  
VIBRATION SENSOR**

By

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Alhamdulillahirabbil'alamin, praise to Allah SWT for all His guidance and smoothness so that I can finish this final project

I dedicated this thesis to people that I love, who always support my mental and financial, encourage me and always motivate me. Thank you, Mr. Jarot Widyoko and Ms. Arrosianti, my sister Bella Anamika. Who always support me every step and decision I made. Thank you very much

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## **ABSTRACT**

This project is created because in Indonesia there is still many railway crossing without any gate and person who supposed to guard the citizen from passing train. So author consider to create automatic railway gate prototype as the final project. the assumption of this project is to meet the needs in railway crossing in Indonesia. This prototype is using two types of sensor which Infrared sensors two pieces and vibration sensor one pieces. Those sensor are controlled using microcontroller Arduino and as an output the author is using two pieces of motor servo. Testing in this project has been done two session, each session the train looping for 30 times. For the result from this project is, the infrared sensors is working 100 % correctly and the vibration sensor have 36.67 % average rate of error from two session tests. The cause of that error is author using Styrofoam as base of this project and makes the vibration sensor can not receive the vibration properly.

*Keyword:* Arduino, Rail way crossing, Infrared sensor, Vibration sensor, Train, Automatic Gate.

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# CHAPTER I

## INTRODUCTION

### 1.1. Background

Railway history is the same as the history of public transport that starts with the wheel's invention. At first, it was understood that horse carriages consisted of only one carriage (series), then horse carriages were made that pulled more than one series and walked on certain iron (rails) tracks and named rails. This is especially used in mining areas where lorries are linked and pulled by a horse.[1]

Nicolas Cugnot made a three-wheeled steam-powered vehicle after James Watt invented the steam engine. People called the vehicle an iron horse. Then Richard Trevithick made a locomotive engine coupled with the train and used it in shows in front of the general public. The locomotive that won the locomotive race was invented by George Stephenson and used it on the Liverpool-Manchester line. The steam locomotive used to make locust at that time. Improvement after improvement to obtain a more reliable, more effective steam locomotive capable of pulling more trains.[1]

As an important infrastructure for the community, the railway system has again attracted interest, and new large-scale railway projects have begun in different regions of the world. One of the main reasons for this is that the environment is less affected by rail transport than other forms of transport. The unique advantages of trains, which can easily carry large numbers of people and objects, have also been rediscovered by people. Building the country's first separate railway system for high-speed rail services began in 1998 in the United Kingdom, where the railroad was first built. Superior environmental performance, safety, and comfort are required for this device.[2]

Nonetheless, the Indonesian people are still not ready for the involvement of the technology behind the technological developments that take place on trains. Data released by PT KAI, 35 accidents involving trains occurred in West Sumatra between 2016 and July 2017. Of these, 27 were accidents involving four-and two-wheeled vehicles, while the rest were accidents between trains and pedestrians. The total number of accidents represents eight people that died instantaneously on the scene. A total of 48 victims were killed and injured as a result of train accidents in West Sumatra within a year. [3]

The intersection between the railway lane and the actual road is not allowed, unless it is temporary, on the basis of Law No. 23/2007 on the railways listed. Conditions in the area, however, are not the case. There is still a fairly large number of level crossings. Level crossings are one of the most vulnerable to traffic jams, in addition to being prone to accidents. This is caused by the high train frequency, which affects the length of waiting time for road users. Note from PT Kereta Api Indonesia (KAI) Regional Division 2 (Divre II), there are 589 unlicensed crossings in West Sumatra along the Padang-Pariaman line There are only 43 official crossings and they are guarded by staff. While 131 other licensed crossings, they were official but not guarded by staff. Control of the railroad will be carried out by adding crossing signs, adding officers to the shutdown of unlicensed crossings. [3]

Due to the high number of rail transport accidents in 2016 -2018 that occurred due to the victim entering the railway crossing when the train was about to pass, and also due to the victim's violation of the laws enforced. With this, the author has an innovation in which the author will create prototype the automatic train door stop coupled with roadblocks due to the many accidents that have occurred, this prototype will be based on Arduino, which is connected to several vibrating sensors that will be installed under the railway tracks and that vibrating sensors will triggered the infrared sensor for detecting the train already passed or it stopped. Also the infrared sensor will connected to the servo module that used to close the railway door.

## **1.2. Problem Statement**

As mentioned by the BUMN, there are still many non-official crossing trains, but there is no attendant at the crossing of the train. Therefore, the author is creating a prototype of an automatic train door to overcome this problem. Because, according to the authors, trains are very dependent on their tracks, creating automatic doors is the most efficient solution..

## **1.3. Objective**

The objective of the author to create this prototype is the concern of the author himself, where the author often feels disturbed by citizens who violate railroad crossings and also sees the

number of railroad crossings that are not in accordance with standards and no guards at all. And also according to the opinion of the author, if we comply with existing regulations, we can reduce the number of accidents and also the level of congestion that exists in our country.

#### **1.4. Scope of Limitation**

This project's focus is on creating a smooth and safe transport in Indonesia. The automatic train doorstop prototype with the road blockade uses a vibration sensor that will be installed under the railroad tracks that will be connected to the Arduino UNO. The servo module will also be used to control the railroad bar and road blockade. The daily activity is inspired by this project. For the limitation in this prototype is still cannot measure the vibration that causes from vehicle that passing through the railway

#### **1.5. Final Project Outline**

##### **1.5.1. CHAPTER I**

There is a context, problem description, problem statement, sop and limitation in this chapter, the last is the final outline of the project. In the context, there is the content of why the author as mentioned above, made this project with the past. Problem analysis and problem statements must be clear where the problem statements must have the right answer to the problem so that they become the center of the conversation on this project. Scope and limitation explain a number of things related to the project. Lastly, the final outline of the project is to provide a brief explanation of each material in each chapter.

##### **1.5.2. CHAPTER II**

The aim of this chapter is to provide a review of the related materials applicable to the final project and to provide a concise summary of the content. Generally, this concerns the historical background of the ideas presented in the literature and the problems or ambiguities posed in these theoretical works. Sources for this section may be taken from books, journals and other written sources.

### **1.5.3. CHAPTER III**

In this chapter, for the implementation of the problem-solving method, the methodology used shall be explained in detail; the appendices shall contain mathematical derivations that are too long. For the design of synthetic hardware and software, a model and a detailed description of the techniques used and the implementation of the design mentioned above shall be provided.

### **1.5.4. CHAPTER IV**

The data should be organized and presented in tables, graphs or charts. A sample calculation can be included to show the correlation between the theory and the measured results. However, long calculations could also be included in the appendices. A discussion or interpretation of the results is an important part of this chapter.

### **1.5.5. CHAPTER V**

The conclusion section ends the document by presenting a description of the text. This demonstrates what the work shows, what its importance is, and what the advantages and weaknesses of the information presented are.

# CHAPTER II

## DESIGN SPECIFICATION AND LITERATURE REVIEW

### 2.1 Arduino

Arduino is an open-source microcontroller that can be programmed, removed and reprogrammed easily at whatever time [4]. The Arduino family of boards is chosen for their popularity resulting in a large number of users and a number of boards to choose from. In addition to boards that are more like general-purpose computer devices, there are boards called "shields" that expand the functionality of boards for uses such as Ethernet, Wi-Fi and GSM connectivity, SD card use, motor and relay power, spatial orientation and other functions.[5] Arduino boards are based on the Atmel microcontroller unit (MCU). On some more powerful devices, an additional microprocessor-based computer offers improved processing power and network connectivity.[5] Created with an 8-bit Atmel AVR microcontroller produced by Atmel or a 32-bit Atmel ARM, these microcontrollers can be simply programmed using the C or C++ language of the Arduino IDE [4].

#### 2.1.1. Arduino Types

Arduino boards are available with many different types of built-in modules. Boards such as Arduino BT come with an integrated Bluetooth platform for wireless communication. These built-in modules can also be made available separately, which can then be interfaced (assembled) to it. Such devices are known as Shields. Type of Arduino is shown on Figure 2.1 below.[4]



Figure 2.1 of Arduino types

**Table 2.1 Arduino Specification**

<b>Arduino Type</b>	<b>Microcontroller</b>	<b>Clock Speed</b>
Arduino Uno	ATmega328	16 MHz with auto-reset
Arduino Duemilanove / ATmega328	ATmega328	16 MHz with auto-reset
Arduino Nano	ATmega328	16 MHz with auto-reset
Arduino Mega 2260	ATmega2260	16 MHz with auto-reset
Arduino Leonardo	ATmega32u4	16 MHz with auto-reset
Arduino Mini	ATmega328	16 MHz with auto-reset
Arduino Fio	ATmega328	8 MHz with auto-reset
Arduino BT w/ ATmega328	ATmega328	16 MHz with auto-reset
Arduino NG	ATmega8	16 MHz with auto-reset

### 2.1.2. Arduino Uno

The Arduino Uno is an ATmega328 powered microcontroller module. It has 14 digital input/output pins (6 of which can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB interface, a power port, an ICSP header, and a reset button. It includes everything you need to help a microcontroller, just connects it to a device with a USB cable or power it with an AC-to-DC converter or a battery to get going. The Uno varies from all prior boards in that it does not use the FTDI USB-to-serial driver chip. It instead features the Atmega8U2 programmed as a USB-to-Serial converter [6]. Arduino Uno board is a standard example of MCU related boards, although efforts have been made for other boards to be pin-to-pin and software compatible [5].

"Uno" means one in Italian and is named for the upcoming release of Arduino 1.0. The Uno and version 1.0 will be Arduino's reference models, going forward. The Uno is the latest in a series of Arduino USB boards and the reference model for the Arduino platform [6].

**Table 2.2 Arduino UNO technical specification**

#### *Arduino UNO specs*

Microcontroller	ATmega328
Operating Voltage	5V
Input Voltage (Recommended)	7-12V
Input Voltage (Limit)	6-20V
Digital I/O Pins	14(which 6 provides PWM outputs)
Analog Inputs	6
DC Current per I/O pin	40mA
DC current for 3.3V Pin	50mA
Flash Memory	32 KB of which 0.5 KB used by bootloader
SRAM	2 KB
EEPROM	1 KB
Clock Speed	16 MHz

### 2.1.3. Arduino IDE

IDE stands for "Integrated Development Environment": it is the official software introduced by Arduino.cc, which is mainly used for editing, compiling and uploading the code in the Arduino Device. Almost all Arduino modules are compatible with this open-source software and are easily available to install and start compiling the code on the go. In this article, we will introduce the software, how we can install it, and make it ready for the development of applications using Arduino modules [7].

The code of the program written for Arduino is classified as a sketch. This is where the simplified code can be written using a simplified C++ programming language format. It displays an error and also gives feedback regarding saving and exporting the code. The console displays the text performance of the Arduino system, including complete error messages and other information.[4]

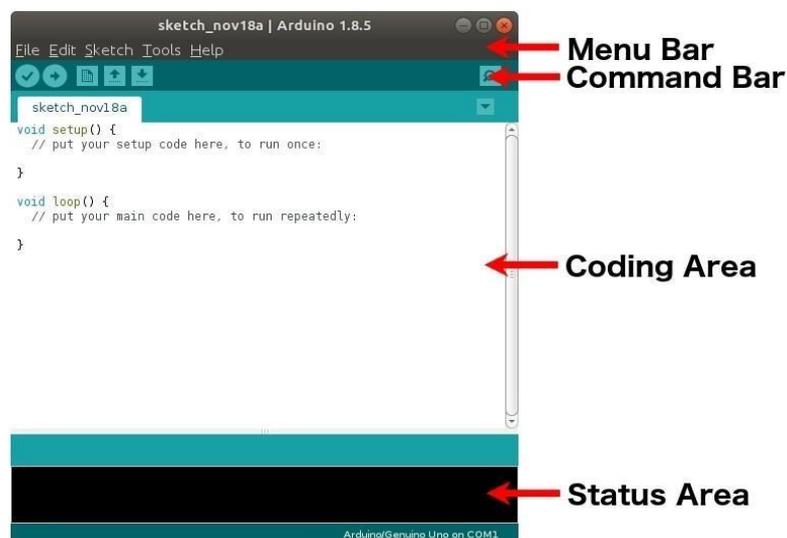


Figure 2.2 of Arduino IDE software

### **2.1.3.1. Void Setup**

It is the first routine that begins when the Arduino starts working. This role is performed only once in the entire program. The setup function involves the initialization of each pin that we plan to use for input or output in our project. This also involves the initialization of the Serial Monitor. A serial monitor is used to recognize the data that is being sent to every peripheral computer on a serial basis. Until using any variables for programming, this is important to define them above the "void setup()" function.

### **2.1.3.2. Void Loop**

This is the next important function in the sketch. This consists of that part of the code that needs to be continually executed, unlike that part of the code written in the setup function. Digital Write is a function that writes a high or low value to a digital pin. If the pin has been configured as an OUTPUT with pin Mode), (its voltage is set to the corresponding value: 5V (or 3.3V on 3.3V boards) for HIGH, 0V (ground) for LOW. Similarly, if there is a need for delay in the sketch, there is another feature that causes a pause in the execution of the code. This creates a delay in the execution of the program for the specified time period (in milliseconds).

## **2.2 SW-420 Tilt Sensor**

The SW-420 sensor is a vibration sensor that responds from different angles to vibrations. In static conditions / no vibration, electronic components function as a switch that is normally closed and conductive in nature, otherwise if shaken the switch opens/closes at a speed proportional to the frequency of shocks. Diversion This rapid change is similar to how PWM (pulse width modulation) works, which is a pseudo-analog signal in the form of a voltage level, compared to LM393 integrated circuits (Voltage Comparator IC) with a high threshold value of the voltage comparator, which is regulated by an external resistor [8].



- 4 GND: connect this module to the system GND
- 3 VCC: you can use 5V or 3.3V for this module
- 2 NC: none connected in this module
- 1 SIG: output the Vout voltage signal
- 5 Potentiometer: you can use a screwdriver to rotate the potentiometer which controls the sensitivity of this sensor.
- 6 GND: the GND pin of the potentiometer.
- 7 Vsen: the lower the voltage of Vsen, the higher the sensitivity
- 8 VCC: the VCC pin of the potentiometer.
- 9 SW-420: the Vibration Sensor

**Figure 2.3 of SW-420 sensor**

## 2.3 Servo Motor

The servo motor is an electrical device that can push or rotate the object with great precision. If you want to rotate an object at a specific angle or distance, use the servo motor. It's just a simple motor that runs through a servo mechanism. We can get a very high torque servo motor in small, lightweight packages. Similar apps are used in many applications such as toy cars, RC helicopters, and aircraft, robots, computers, etc [9].



**Figure 2.4 of Servo motor**

Servo motors are rated in kg / cm (kilogram %imeter) the majority of servo motors are rated at 3kg / cm or 6kg / cm or 12kg / cm. This kg/cm tells you how much weight your servo motor can lift at a certain distance. For example, a 6kg/cm Servo engine should be able to lift 6kg if the load is suspended 1cm away from the engine shaft, the greater the distance the lower the load capacity [9].

All motors have three wires coming out of them. Out of which two will be used for Supply (VCC and ground) and one will be used for the signal to be sent from the MCU. The servo motor is operated by the PWM (Pulse with Modulation) which is supplied by the control wires. There is a low pulse, a maximum pulse, and a repeat rate. The servo motor can be rotated 90 degrees from either direction to form its neutral position. The servo motor needs to see a pulse per 20 milliseconds (ms) and the duration of the pulse can dictate how far the engine spins. For example, the 1.5ms pulse will rotate the engine to a 90° position, such as if the pulse is shorter than 1.5ms and the shaft moves to 0° and if it is longer than 1.5ms the servo moves to 180°.

## **2.4 Infrared Sensor**

Throughout today's world, full of nanotechnology sensors robotics and automation play a critical role. Sensors make our life easier by automatically sensing and controlling the devices. One of them is an IR camera. The IR sensor is a popular sensor used in the Remote Control System, the Line Follower Robots and our proposed system, i.e. the Automatic Railway Gate Control System. The working principle of an IR sensor is based on an IR LED that emits IR radiation falling on a photodiode that is used to detect that radiation. The resistance within the photodiode varies with an increase in the amount of radiation. The key advantages of infrared sensors include their low power demands, clear circuitry, and compact functionality. The voltage comparator (LM358) the voltage shift can be sensed and the output can be produced accordingly. The basic concept of an Infrared Sensor used as an Obstacle Detector is to relay an infrared signal, the infrared signal bounces from the surface of the target and the signal are processed by the infrared detector. In the electromagnetic spectrum, the infrared component is

classified into three regions: the near-infrared area (700 nm to 1400 nm), the mid-infrared zone (1400 nm to 3000 nm) and the far-infrared region (3000 nm to 1 mm).

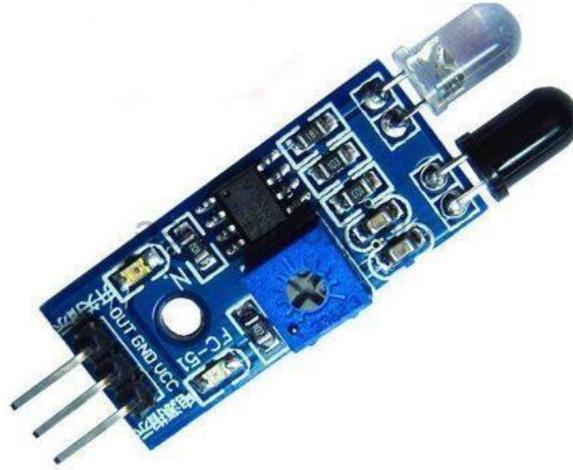


Figure 2.5 of Infrared sensor

## 2.5 Buzzer

A buzzer or beeper is an audio communication system that can be electronic, electromechanical or piezoelectric. Typical uses of buzzers and beepers include alarm devices, timers and user input confirmations, such as mouse clicks or keystrokes.



Figure 2.6 of Buzzer

## 2.6 Miniature of Train

Using conventional train toy with Rail King Brand. The box includes 14 pieces of tracks, one locomotive, 3 passenger car railway, and 1 boxcar. The locomotive is powered with two

batteries with AA types. If all the piece of track is installed, the dimension of the track will be 104 cm x 68 cm. and the train length is 62 cm.



**Figure 2.7 of Train toy**

## **2.7 Literature Study**

Many people have already made innovations at the railway gate. We can see it on [10][11]. In [11] they are trying to innovate the railway gate system using Arduino UNO with one input sensor which is infrared sensors. And the infrared sensor is connected to the buzzer and also servo motor. The workflow in this project is, if infrared sensors detecting there is an obstacle passing through, the sensor will give a signal to turn on the buzzer and close the gate with the servo motor. And the gate will opened again if the infrared sensor is not detecting any obstacle.

In [11] have different concept automatic railway gate with [10]. They innovate the railway gate using two input of sensors, which is ultrasonic sensor and infrared sensor. Ultrasonic sensors are used for detecting the train, trigger the buzzer and close the gate with a stepper motor. For the infrared sensor is used to make sure the gate is closed if the infrared did not read the gate was closed, so it will trigger an error and sent a message with GSM module

## CHAPTER III

### DESIGN IMPLEMENTATION

#### 3.1 Design System

In this project, the author will use two pieces of infrared sensors, two pieces of servo motors, one vibrate sensor, one unit buzzer and also using Arduino UNO as the microcontroller. We can see the prototype project in figure 3.1 below.

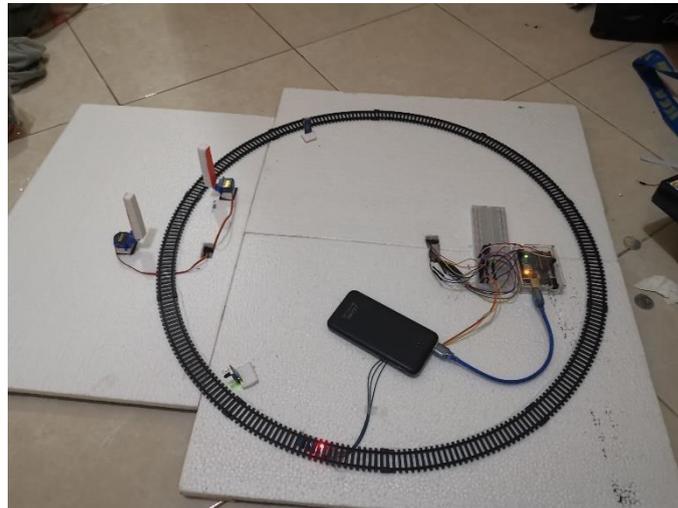


Figure 3.1 of Prototype railway gate design

In this project, the infrared sensor and vibrate sensor is used as an input. The output of the vibrating sensor will trigger the buzzer on and to set up the servo motor. And the infrared sensor is directly connected to the servo motor. But in this case, the servo motor will not move if the vibrating sensor does not detect any vibration. We can see the block diagram in figure 3.2 below

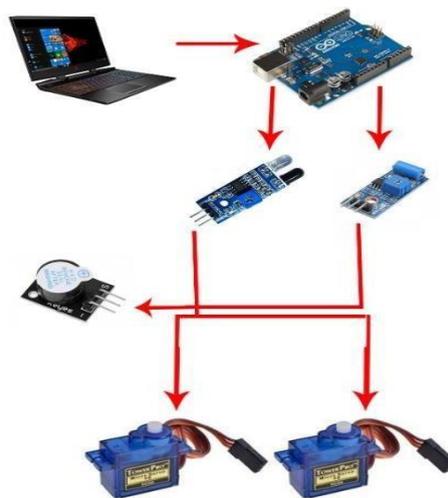


Figure 3.2 of Block diagram

And this overall flowchart of the project can be seen in figure 3.3 with the assumption there is no obstacle between the sensor beside the train.

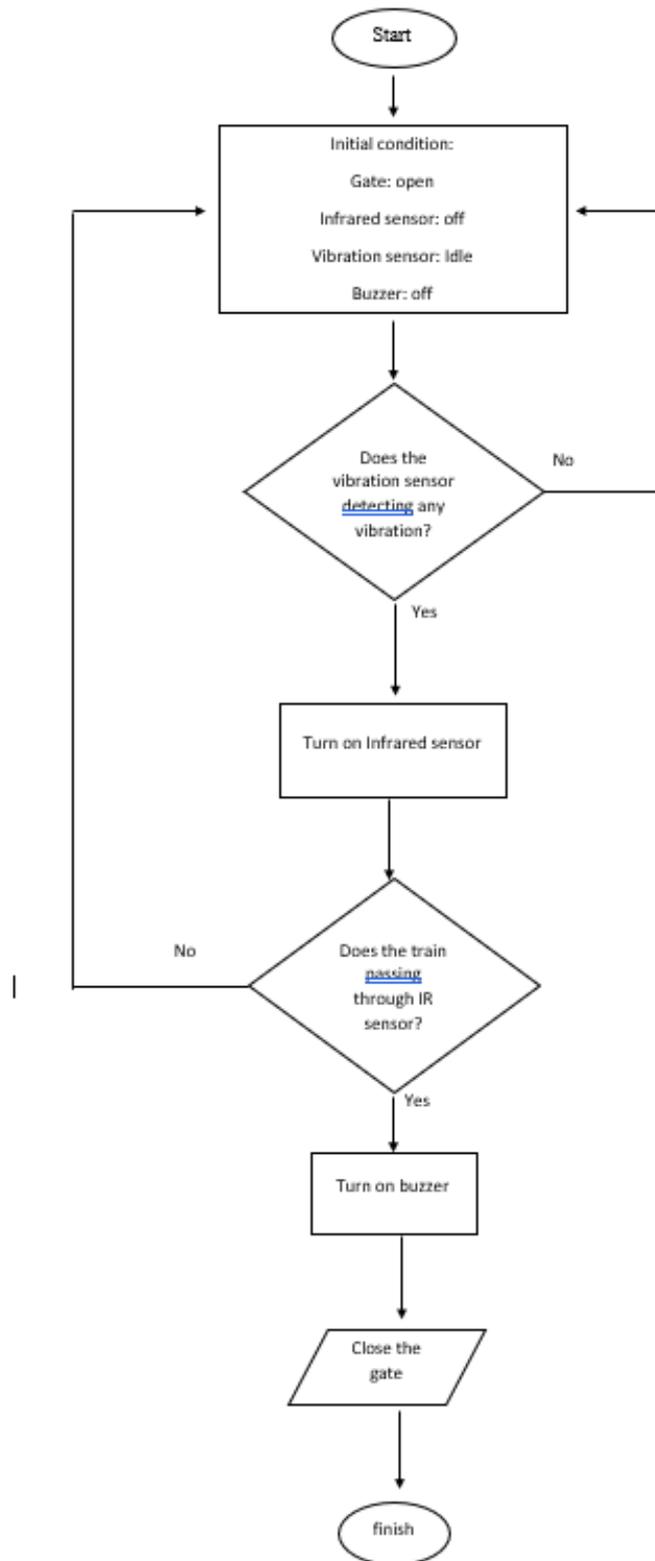


Figure 3.3 of Overall flowchart project

## 3.2 Hardware Implementation

This section will be explaining all of the hardware used to build this project.

### 3.2.1. Arduino UNO

In this project, Arduino UNO is the microcontroller. The function is to save the code that has written in the laptop and connected to all the sensors that connected to Arduino UNO pins. For this project, all the port used by the author is digital pins. Besides the digital pins used by the author, the author also uses the power pins such as ground (GND) pin and 5Volt pin. For all digital pins that used is shown on the table below

**Table 3.1 of Digital Pins**

<b>Pin</b>	<b>Detail</b>
<b>3</b>	Servo 1
<b>4</b>	Vibrating Sensor
<b>5</b>	IR sensor 1
<b>6</b>	Servo 2
<b>7</b>	IR sensor 2
<b>8</b>	Buzzer

### 3.2.2. Vibrating Sensor

Vibrating sensors have three pins for each device. First is Voltage at the Common Collector(VCC), VCC pins are connected to the 5Volt pin in the Arduino UNO board. Second, the GND pin also must be connected to the GND pin in the Arduino UNO board. And the last one is the OUTPUT pin which connected to the digital pin in the Arduino UNO board.

The vibrating sensor is a digital input sensor. So the output will only be shown as 1 or 0. But vibrating sensors have a potentiometer to control the sensitivity. In this project, the author considers using only one vibrating sensor because the railway is circular, because of the circular railway design it makes the vibrating sensor still detecting vibration while the train is at the longest distance from the sensor. The installation of vibrating sensor can be shown in figure 3.4 below.



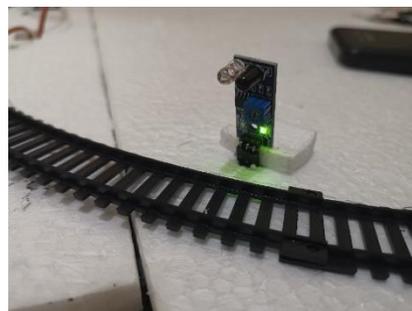
**Figure 3.4 of Installation vibrating sensor**

In this project vibration sensor is used as an input. If the vibration sensor detects there is a vibration nearby. It will trigger the buzzer on and set up the servo motor to get ready. This vibrating sensor is combined with an infrared sensor as an AND gate as input and the servo is the output. AND gate means the output will not work if vibrating sensor or infrared sensor did not detect anything.

### **3.2.3. Infrared Sensor**

The infrared sensor is the same as the vibrating sensor. It has three pins for each device. The first one is the VCC pin which must be connected into the 5Volt pin in the Arduino UNO board. Second, is the GND pin which also connected to GND in the Arduino UNO board. And the last is the OUTPUT pin which connected to the digital pin in the Arduino UNO board.

As a digital input sensor, the infrared sensor only shown 1 and 0 for the input. But the infrared sensor also the same with the vibrating sensor it has a potentiometer each device that used to control the range of detecting an obstacle. In this project, the author considers using two devices of the infrared sensor. Two sensors are used to overcome the arrival of trains in a different direction. The installation of infrared sensor will be shown in figure 3.5 below.



**Figure 3.5 Installation infrared sensor**

The infrared sensor installed at the edge of the railway and only programmed to detect close obstacles from the sensor. It supposed to not detect any obstacles across the other side of the railway.

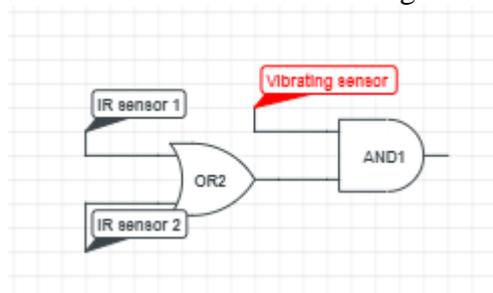
### 3.2.4. Servo Motor and Buzzer (Output)

The servo motor is the same as the infrared sensor and vibration sensor. It has three pins that have been used to connect to VCC, GND and also OUTPUT as a digital input to the Arduino UNO board. And Buzzer only has two pins in which the first one is connected to the digital pin on the Arduino UNO board and the last one is connected to the GND pin.

Both have the same function, which is used to receive signals from the sensor above and to process the signal to the output moves. In this project, the author considers the use of two servo motor parts and one buzzer unit.

## 3.3 Arduino IDE Program

The code must be written and combined to create an automated rail crossing with Arduino UNO using a vibrate and infrared sensor. Code used to merge vibrate sensors and infrared sensors. The combined circuit of the sensor is shown in Figure 3.6 below.



**Figure 3.6 Block diagram circuit**

By writing code to Arduino IDE, the sensor would look like the sensor is functioning like the figure above. AND Gate means that no output will be activated if one of the inputs is not active. On the other hand, the OR gate means that the output will be activated as long as one input is active. But in this case the sensor will only receive vibration that causes from the train only. For the code is shown in Figures 3.7 below.

```

void setup() {
  myservol.attach(6);
  myservo2.attach(3);
  pinMode(sensorir1, INPUT);
  pinMode(sensorir2, INPUT);
  pinMode(vibrate, INPUT);
  pinMode(buzzer, OUTPUT);
  Serial.begin(9600);
  // put your setup code here, to run once:
}

void loop() {
  val = digitalRead(sensorir1);
  val2 = digitalRead(sensorir2);
  val3 = digitalRead(vibrate);

  Serial.println("ir1");
  Serial.println(val);
  Serial.println("ir2");
  Serial.println(val2);
  Serial.println("vibrate");
  Serial.println(val3);
}

```

```

if(val==0 && val2==0 && val3==1)
{myservol.write(90);
myservo2.write(90);
digitalWrite(buzzer,HIGH);
delay(2000);
}
if (val==0 && val2==1 && val3==1)
{myservol.write(90);
myservo2.write(90);
digitalWrite(buzzer,HIGH);
delay(2000);
}
if(val==1 && val2==0 && val3==1)
{myservol.write(90);
myservo2.write(90);
digitalWrite(buzzer,HIGH);
delay(2000);
}
if (val==1 && val2==1 && val3==0)
{myservol.write(180);
myservo2.write(180);
digitalWrite(buzzer,LOW);
delay(200);
}

```

**Figure 3.7 of Arduino program**

As can be seen in Figure 3.7 above. In the void setup, is used to declare all that is attached to the Arduino UNO board. And in the void loop section "Val" is a variable that stands for value, used to track the input sensor is working well or not. In Figure 3.8, we can see if the servo writes for 90 degrees that means closing the gate in this case the infrared sensor has unique input data. Which has a value of 0 when detecting an obstacle and a value of 1 while not detecting any obstacle.

# CHAPTER IV

## RESULT AND DISCUSSION

### 4.1 Result

There will be two sections to discuss in this segment. First, calculating the error rate of the sensor when the train is going from point A to point B. Hence the INPUT sensor stated in this project will be included in the calculation. With this calculation, the author will use one of the locomotives and run the locomotive 15 times on the line, as well as the locomotive and one of the cargo containers with the same 15 times on the line. Second, it will be the same as the first section. The difference is the direction of the train coming from point B to point A. This measurement test is carried out to obtain an effective place for the location of the sensor and the quantity sensor to be used for this project.

#### 4.1.1. Point A to B

In this section will be shown two tables that obtain data from the author project. The first one will be locomotive only that running looping for 15 times and the second one is locomotive plus cargo container.

**Table 4.1 One locomotive running**

<i>No</i>	<b>IR-1</b>	<b>IR2</b>	<b>Vibration</b>
1	v	v	v
2	v	v	v
3	v	v	v
4	v	v	x
5	v	v	x
6	v	v	v
7	v	v	v
8	v	v	v
9	v	v	x
10	v	v	x
11	v	v	v
12	v	v	v
13	v	v	x
14	v	v	v
15	v	v	v

As we can see from the table above, there is no error on the infrared sensor. On the other hand, the vibration sensor has an error rate calculation  $5/15 \times 100\% = 33,3\%$ , means that in during test period, the error happen 5 times out of 15 trial which can be said that it has 33,3% error rate. During testing the error usually happen when the locomotive already passes the IR-1 sensor and before the train passes the IR-2 sensor. And sometimes the vibration sensor still reading if there is a vibration after the train passing the IR- 2 sensor.

**Table 4.2 locomotive and cargo containers running**

<i>No</i>	<b>IR-1</b>	<b>IR-2</b>	<b>Vibration</b>
1	v	v	v
2	v	v	v
3	v	v	v
4	v	v	v
5	v	v	x
6	v	v	x
7	v	v	v
8	v	v	v
9	v	v	v
10	v	v	v
11	v	v	x
12	v	v	x
13	v	v	v
14	v	v	v
15	v	v	v

As we can see from Table 4.2 above. There are no major differences in the result when one locomotive is working on a cargo container. The effect of running the cargo container is less error than just one locomotive. Calculation of the percentage of error with freight containers is  $4/15 \times 100\% = 26,7\%$ , this means that in during test period, the error happen 4 times out of 15 trial which can be said that it has 26,7% error rate.

#### **4.1.2. Point B to A**

Two tables that collect data from the author project will be shown in this section. The first one is a locomotive, and the second one is a locomotive working with a shipping container. It's going to be the same for every test running 15 times.

**Table 4.3 B-A Locomotive only running**

<i>No</i>	<b>IR1</b>	<b>IR2</b>	<b>VIB</b>
<i>1</i>	v	v	v
<i>2</i>	v	v	x
<i>3</i>	v	v	v
<i>4</i>	v	v	v
<i>5</i>	v	v	x
<i>6</i>	v	v	v
<i>7</i>	v	v	x
<i>8</i>	v	v	v
<i>9</i>	v	v	v
<i>10</i>	v	v	v
<i>11</i>	v	v	v
<i>12</i>	v	v	v
<i>13</i>	v	v	x
<i>14</i>	v	v	x
<i>15</i>	v	v	x

Table 4.4 indicates that it is the same with test A-B that the IR sensor works 100% without error. But the vibration sensor has more errors in this test than before. The result showed that the vibration sensor in this test had an error calculation  $6/15 \times 100\% = 40\%$ . Means that in during test period, the error happen 6 times out of 15 trial which can be said that it has 40% error rate.

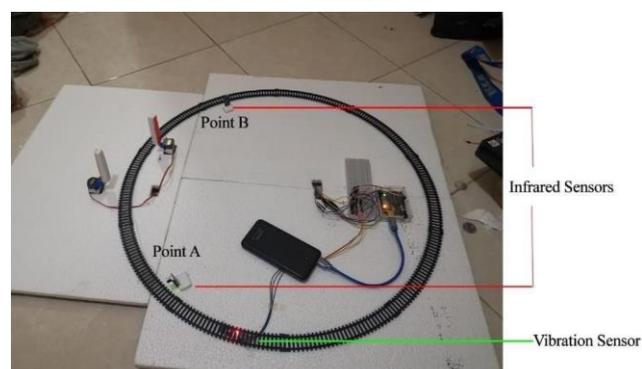
**Table 4.4 B-A locomotive and cargo containers running**

<i>No</i>	<b>IR1</b>	<b>IR2</b>	<b>VIB</b>
1	v	v	v
2	v	v	v
3	v	v	x
4	v	v	x
5	v	v	v
6	v	v	x
7	v	v	v
8	v	v	x
9	v	v	v
10	v	v	v
11	v	v	x
12	v	v	v
13	v	v	x
14	v	v	v
15	v	v	x

The data are shown in table 4.3 the IR sensor still working correctly but the vibration sensor has more error than running with locomotive only. It has an error rate calculation  $7/15 \times 100\% = 46,67\%$ . Means that during the test period, the error happen 7 times out of 15 trial which can be said that it has 46,67% error rate.

## 4.2 Discussion

In this section will be discussing about the weakness of author project and the reason for the error that happen while testing. The design of author project will be shown on figure 4.1 below.



**Figure 4.1 Design of project**

As can be seen in Figure 4.1, this is the location of the IR1 sensor, the IR2 sensor and also the vibration sensor. The measurement point A is located on the IR1 sensor and the point B is located on the IR2 sensor. Since the location of both IR sensors is on the edge of the track, and there is less than one centimeter of gap when the train moves in front of the sensor, and the author also considers using the cheap IR sensor because the range detecting the obstacle is less than 10 cm which is ideal for this prototype. So that's why the IR sensor is working 100% on every tests.

On this project, we can see that the author considers that the vibration sensor is mounted under the rail. This decision was taken because the author had already tried to install a vibration sensor on the edge of the rail as an IR sensor. As a result of the placement of the placement that near the IR sensor point A. the error rate from point A to B is less than the error rate on point B to A. The decision to use only one of the vibration sensors is because the rail system is circular. That often the vibration of the train could still be felt at the furthest point.

From the data we've got from the experiments.

Running from point A to point B has a lower error rate than running from point B to point A. As we can see from Table 4.1 and Table 4.2, we can see the error pattern. The error will be replicated after the first error, as the foundation in this project uses stereofoam and even the vibration sensor floats and is retained by the stereofoam itself. And the mistake in this project is normally that the vibration sensor does not sense any vibration when the train passes the sensor itself. Because of the system, if the vibration sensor does not detect any vibration, the gate will be opened.

We can see the error pattern comes randomly for the running check from point B to A. This will be triggered by the position of the vibration sensor. Since the vibration sensor is near the point A IR sensor, and when the train passes the IR sensor located at point B, the vibration sensor does not sense any vibration.

# CHAPTER V

## CONCLUSION

### 5.1 Conclusion

The conclusion for AUTOMATIC RAILWAY GATE WITH ARDUINO USING INFRARED SENSOR and VIBRATION SENSOR are:

1. The device work properly with all function
  - a. Infrared sensor A (100 % work without error rate)
  - b. Infrared sensor B (100 % work without error rate)
  - c. Vibration sensor (has 36.67 % error rate for overall)
  - d. Servo motor A (working properly as long as the vibration sensor detecting vibration)
  - e. Servo motor B (working properly as long as the vibration sensor detecting vibration)
2. The overall error rate for this project, as stated in point 1, is 36.65 %. This value is derived from the four-time running session test that the train loops 15 times each session. Each session shall run from A to B locomotive only, run from A to B locomotive with a cargo container, run from B to A locomotive only, and last run from B to A locomotive with a cargo container.

### 5.2 Feature Developments

There are a variety of improvements that can be developed by this final project in order to make the project even greater than before. Recommendations for this final project:

1. The most important to develop in this project is the vibration sensor placement. Because the vibration sensor is the only one that has a error while testing in this project. For developing the vibration sensor replacing the sensor is not the only thing to consider. Because of this project using Styrofoam as the base in this project, might be replacing Styrofoam with another things will concluded as developing the vibration sensor.
2. If this prototype will be implemented for real life. The author suggests replacing the IR sensor with the one that waterproof and can detect at a distance minimum one meter from the sensor standing
3. For the future development is redesigning the railway gate, because in Indonesia there are still many people passing through the railway gate while it is clos

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