Conceptual Study and Design of Vehicle Alarm Notification System Using GSM Network

by

Sofea Azrina bt Azizan

Dissertation submitted in partial fulfilment of
the requirements for the
Bachelor of Technology (Hons)
(Information and Communication Technology)

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CERTIFICATION OF APPROVAL

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A dissertation submitted to the

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Approved by,

_____

(Dr Izzatdin Bin Abdul Aziz)

UNIVERSITI TEKNOLOGI PETRONAS

TRONOH, PERAK

MAY 2015

CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

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SOFEA AZRINA BT AZIZAN

ABSTRACT

This project focuses on studying and designing of vehicle alarm by using GSM device as well as to provide the user with information via SMS on whether an intrusion or some other possible factors have triggered the alarm. Nowadays, all vehicles are equipped with an alarm system that will alert the vehicle owner if there is any intrusion detected. However, when the vehicle alarm is triggered, the vehicle owner will not make aware of the siren. They might be somewhere far away from their vehicle parking and sometimes there is no intrusion instead there is a false alarm. Alarm trigger for a long time will cause the vehicle's battery to decrease and will annoy by passers.

This project is subdivided into two phases. First, the study on how to integrate GSM devices to send SMS to the vehicle owner's mobile phone. The second phase of this project is to design and develop a mechanism that can alert the vehicle owner from remote using GSM.

As a proof of concept, the proposed mechanism is then validated through a lab scale experiment. This project is expected to enhance the existing alarm system to benefit all users in order to protect their vehicle.

ACKNOWLEDGEMENTS

It would not have been possible to write this dissertation without the help and support of the kind people around me. First and foremost, I offer my sincerest gratitude to my supervisor, Dr. Izzatdin bin Abdul Aziz, who has supported me throughout my dissertation with his patience and knowledge whilst allowing me the room to work in my own way. His invaluable constructive comments and suggestions throughout the whole eight (8) months duration of the Final Year Project have contributed to the success of this research.

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I would like to take this opportunity to dedicate my deepest appreciation to the technician staffs Mr Paris Said and Mrs Siti Hawa for the continuous support, guidance and encouragement. Not to forget Mr Muhd Al Amin for his help also to all my friends and colleagues. Thank you for being there through thick and thin.

Last but not least, I would like to thank the most important people in my life, my parents and siblings for the endless love, support and patience. Thank you for always believing in me and for making me become what I am today. I cannot find words to express my gratitude to my family for everything that they have given me. I owe all of my achievements to them.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1
INTRODUCTION

1.1 Background of Study

Vehicle alarm is an electronic device installed in a vehicle to identify an intrusion. Since long, car or any other vehicle is being aimed by the thief. The alarm system is an imperative feature in order to make aware people nearby that the vehicle is in trouble. It might be an attempt by the thief to snip the car, someone broke into the owner's car and many other reasons that can trigger the alarm. However, if the alarm's sensitivity is fixed too high, it may turn out to be an annoyance more than a convenience towards people surrounding. If the vehicle alarm is triggered unnecessarily such as from lightning, someone hit the side mirror or a cat jumps on the car roof, reducing the sensitivity of the alarm system might be a good decision. Usually, the owner will not notice the sound of the alarm when they are far away from their vehicle. The commercially anti-theft vehicle alarm in today's market is very expensive. In this project, we would like to propose a conceptual design of a simple and low-cost vehicle alarm system that is integrated with a microcontroller. The significance of our purpose of this project is that, the system is able to notify the vehicle owner through text notification via mobile phone.

Occasionally, the owner is not aware that the alarm is coming from their vehicle. At a point of time, the sound of an alarm will annoy the surrounding community. Subsequently, the surrounding community will just ignore the alarm without knowing that someone is trying to steal or illegally force entry to a vehicle as a

false alarm happened too common. Therefore, there is an opportunity for thieves to steal the vehicle easily.

In today's world, thieves are getting more aggressive and they are well-versed on how to unlock the alarm system. Thus, there is a need for a better security system for each vehicle. In 2012, it was reported by Asia News Network, in average, 150 vehicles were stolen in Malaysia with Perodua and Proton models topping the list of 112 and 503, respectively [1]. According to Datuk Seri Mohd Bakri Zinin the Federal Criminal Investigation Department (CID) director, the high number of burglaries was because of the interest for new as well as old vehicles for their parts [1]. He also mentioned the statistic of vehicle theft were accounted in 2010 was 57,462 while the number was 55,041 as of September 2011 [1]. Based on the statistics collected by the Royal Malaysian Police, they also had affirmed that Proton cars are the most well-known focuses for car thieves, followed by Perodua vehicles as it referred to the demand and supply principle [2].

Nowadays, there are numerous alarm system technologies that have been commercialized in the market. The common vehicle alarm system will produce alarming sound when there is any disturbance to the vehicle. We all recognize the sound of a vehicle alarm and it is not common to hear sounds alarm blaring anywhere and anytime. However, many people ignore the sound. Usually, the owner of the vehicle also does not notice of their vehicle alarm is turned ON as the sound does not reach the owner's location. The public is not able to inform the owner to the reason that they do not know who the owner of the vehicle is as well as they are not feeling responsible to make a report to the nearest police station. Thus, this siren alarm system is not much comprehensive to protect the vehicle from thieves as it just produces a sound without notifying the owner about the condition of their vehicle.

There are many major cases that thief breaking the glass of the window to steal all stuff inside the car instead of open the hook lock. The reason is that when someone is trying to crack or break the tempered glass, the car alarm will not be triggered unless they open the car door. The car window is the weakest link in the car security system because they can easily smashed [3]. Security windows tints are safe against blunt blows such as someone using a motorcycle helmet, baseball bat, or rock to smash the window [3]. However, these tints are rather vulnerable against sharp objects such as a screwdriver, ice pick, or any strong and harsh objects.

Based on the research of current technologies, there is an alarm system that sending a detailed message to the user by informing together the current location of the vehicle through GPS [13]. However, they are using 3G, which is only compatible with a smart phone and 3G or some advance generation (G's) of communication network does not provide coverage in rural areas. Besides, not all mobile subscriber's uses smart phones, which means that they are using 2G communication network. From the study of this project, 2G provides more network coverage as compared to 3G and the comparative study between these two communication technologies will be discussed further in Chapter 2.

Above all, a sophisticated vehicle alarm is important to safeguard our property. From the study, the existing alarm system is not enough since thieves are becoming tech savvy and they could learn on how to disable the alarm systems with only a few simple steps. With so many different off the shelf alarms available, this project will propose an alarm system that will text messages to your mobile phone to alert you of the condition of your car right after the sound alarm is turned ON by using GSM regardless of your location and whereabouts.

1.2 Problem Statement

In most cases, when vehicle alarm system is triggered, be it due to a false alarm or legitimate reasons, the vehicle owner are often not made aware of the situation. This is because, the owner is remotely apart from the vehicle. For instance, at a shopping centre, the vehicle that is parked at the basement is left unattended as the owner is in the shopping centre. If the vehicle alarm system is triggered, the owner will have no notification and is not made aware that his or her vehicle alarm system has been triggered. There is no information to differentiate whether an alarm was triggered due to intrusion or some other natural factors such as someone has accidently hit the car, vibrations due to passing vehicles or lightning.

Thus, existing vehicle alarm systems have taken for granted the need to notify vehicle owners whenever an intrusion happens, especially in cases when they are remotely away from their vehicles. Therefore, there is a need to propose and design an alarm notification system to alert vehicle owners remotely.

1.3 Objectives

i. To perform a study on existing vehicle alarm system that can alert the owner from remote location.
ii. To design and develop a prototype alarm system that can alert the owner from remote location.
iii. To provide the user with information via SMS on whether an intrusion or some other possible factors have triggered the alarm.

1.4 Scope of Study

This project will consist of studying the current vehicle alarm system that can send an alert message to the vehicle owner by using Global System for Mobile (GSM). This project will also cover on designing and developing a prototype alarm system that is capable of alerting the owner from a remote location only. In this project, we are using GSM, Arduino microcontroller, piezoelectric vibration sensor, C++ scripting language and mobile phone for the concept of validation.

CHAPTER 2
LITERATURE REVIEW

2.1 Statistics of Stolen Vehicles in Selangor and Penang

Vehicle theft is a common phenomenon nowadays. It has happened years ago and no one can stop from it occurring. However, we can equip ourselves with a better alarm system to protect our vehicle from intruder or theft. Based on a research, Petaling Jaya, Gombak and Shah Alam in Selangor, Malaysia recorded the highest number of cases in the state [19]. As a whole, Selangor recorded a total of 11,138 motorcycle theft cases in 2012. As indicated by DCP Tun Hisan the figures for bike robbery in Selangor in 2010 remained at 13,751 while it had dropped to 12,959 cases a year ago [4].

Table 1: Statistics of Vehicle Crimes in Penang [5], [20].

Crime Category	**Year**	
	2011	**2012**
Van Theft	35	77
Lorry/ Heavy Machinery/ Bus Theft	94	88
Car Theft	640	670
Motorcycle Theft	3, 760	3, 578
Total	**4, 529**	**4, 413**

Based on Table 1, in Penang, resource from Royal Malaysian Police Penang, they recorded 640 car theft, 3760 motorcycle theft and 35 van theft reported in the year 2011. In 2012, car theft increases a little bit to 670 cases, decreasing the number in motorcycle theft which is 3578 and growing number of van theft to the amount of 77 cases.

Providing that, Malaysia also recorded to have many cases of vehicles theft. Thus, in this manner, so as to keep the expanding number of stolen vehicles, a vehicle alarm system must be installed to save it from the thief.

2.1.1 Related Work

There are various method and system to protect vehicles from the thief. Below is the lists of existing security method that is being implemented nowadays. However, from the lists, there are no alarm that can alert the owner of the vehicle itself.

- **Alarm System**

  The alarm system is a standard usage for every car. Noise influences on thieves rapidly and effectively. Everyone recognizes the sound of a car alarm. Generally, vehicle alarm is embedded into the car for a security purpose. Cars that do not have any form of vehicle security are much easier targets than cars that have either an alarm or immobilizer installed.
- **Remote Keyless Entry System**

  This is an advanced mechanism uses encrypted pulse transmissions that guarantee higher safety and it is the system which locks and unlocks cars remotely [6].
- **Steering Wheels Lock**

  This method is quite effective as the steering firmly fitted and it is possibly impossible for theft to steal the car. However, we do not always lock our steering as if we want to park the car just for a short time.

- **Immobilizers**

  Basically, the immobilizer is to disable the ignition of an engine to prevent the car from being started. If the thief is well versed enough on how to stop the immobilizer, so it is possible for the thief to steal the car. The thief can break into a car and disable the immobilizer to allow the ignition of the engine [7].

2.2 Microcontrollers

A microcontroller is a highly integrated chip that contains a processor core, memory and programmable input/output peripherals to govern the operations of embedded system in motor vehicles, robots and many other machineries. Microcontrollers are used in automatically controls products and devices. Arduino is a simple microcontroller board and it is an open source development environment used for building electronics projects. According to Arduino official website, it has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button [8]. The alternative of Arduino microcontroller is Raspberry Pi which is the latest microcontroller as compared to Arduino. However, in developing a notification alert alarm system, Arduino has chosen to be the main microcontroller and the comparative study was carried out to compare Arduino and Raspberry Pi in Section 2.4.

2.3 Comparison between Microcontroller Devices

In this section, we will discuss the comparison between features of Arduino and Raspberry Pi. There are eight differences to be compared and to be discussed as showed in Table 2.

Table 2: Comparative Feasibility Study between Arduino and Raspberry Pi [8], [14], [15].

Area of Difference	Arduino	Raspberry Pi
Programming Language	C++	Python, C#
Operating System	None	Linux
Integrated Development Environment	Arduino IDE	Scrath, IDL, Anything with Linux Support
Interface	14 digital I/O pins	Broadcom Video Core
RAM	2KB	256MB
Clock Speed	16MHz	700MHz
Price	Low	High
External Power	Yes	No

Based on Table 2, the main programming language used by Arduino is C++. C++ adds object-oriented features to its predecessor, unlike C and Python. According to John Thomas, he said that C++ was quickly adopted for all types of development and in particular in the telecommunication industry [12]. Other than that, Arduino does not require any specific operating system as compared to Raspberry Pi which uses Linux to write and run the code. Other than that, Arduino can be programmed with the Arduino software which is Arduino IDE. The Arduino environment is easy-to-use for beginners and flexible enough for advanced users. Moreover, the large Arduino open community provides an overwhelming support in terms of sample codes, algorithms and hardware

integrations. In comparison Arduino and Raspberry Pi, Arduino board is a relatively inexpensive microcontroller. Besides, the clock speed and RAM for Raspberry Pi is more than Arduino. However, to send a notification alert through SMS to the user does not consume much RAM and clock speed. As been discussed, Arduino provides easiness to the system developers to code and implement as well as to provide robust compatibility with other systems.

2.4 Comparison between Communication Technologies

Global System for Mobile communications or GSM is the current and most widely used standard for mobile phones today while 3G is the next generation mobile technology that has begun to replace GSM. The study of differences between two communication technologies is being discussed in this section through Table 3.

Table 3: Comparative Feasibility Study between GSM and 3G [17], [18].

Area of Difference	GSM	3G
Data Bandwidth	14.4 kbps	2 Mbps
Cost	Low	High
Reliability	High	Low
Power Consumption	Low	High
Frequency Band	900MHz-1800MHz	1.8-2.5 GHz
Network Service	SIM Card specific	Handset specific
Advantages	• Worldwide roaming • Security • Provide better voice quality	• Uses IP connectivity • Constant internet access
Disadvantages	Can interfere with certain electronics	Not available in certain region

Based on Table 3, higher data bandwidth take less time to transmit the data from one point to another in a given time period. Based on the table above, GSM has the lowest data bandwidth which is 14.4 kbps as compared to 3G which is 2 Mbps. In this project, higher bandwidth is not necessary as GSM has to send a message to the mobile phone only. A short message not require high bandwidth and it is good for the rural areas because of their large search area. Besides that, GSM has the lowest cost as compared to 3G in terms of implementation of the base stations.

GSM also established a low-cost alternative to voice calls, the Short message service which is now supported on other mobile standards as well. To compare the reliability of GSM and 3G, GSM is more accessible especially at rural areas and at parking lots at the mall. Thus, GSM is suitable to use by all users at anywhere. The power consumption for GSM is lower as compared to 3G. Less consumption power means that the device utilizes less battery power. Low frequency travels much better than high frequency. It is suitable for a long separation interchanges communications as low-frequency exhibits low signal attenuation (loss intensity through a medium). The GSM device frequency is lowest as compared to 3G which is 900MHz to 1800MHz while 3G is 1.8GHz to 2.5GHz. It is a common belief that low frequencies travel longer distances than high frequency. Lower frequencies have better penetration, meaning they pass through objects such as walls with less attenuation. Briefly, in this project we will use GSM to concern the reliability for all places and to provide a lower cost alerting alarm system.

CHAPTER 3
RESEARCH METHODOLOGY

3.1 Project Flowchart

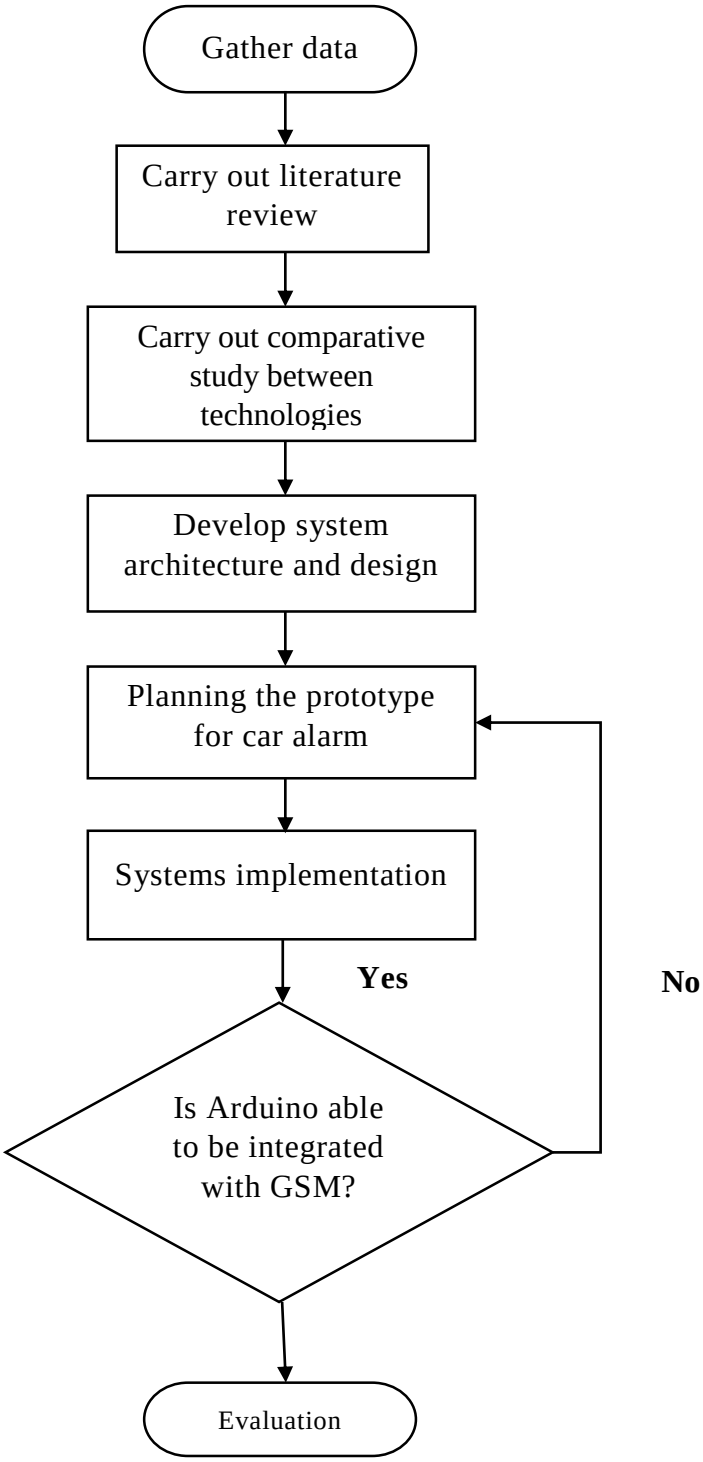


Figure 1: Process Flow of Methodology

Do Observation

From the observation, car theft cases are increasing every year and it has turned into a serious issue for the country. Most of the sophisticated vehicle alarm system have been equipped by expensive vehicles. The present vehicle alarm systems only deliver a combination of sound and light to alert the vehicle owners and nearby people which is considered ineffective in today's situation. Comparing Malaysia to other developed countries, vehicle owners from the United States, Canada, Germany and many others are willing to invest a large sum of money to protect their vehicles by equipping sophisticated security alarms.

It has been observed that, GSM device is inexpensive to be implemented as an upgrade to the present vehicle alarm system as compared with other communication technologies such as 3G and 4G. The focus of enhancing the alarm is to alert the owner from a remote location.

Data Collection

Data is gathered through perusing articles, journals, websites, books and previous research. From the data collection work, there are many existing vehicle alarm system in today's market. However, most of the commercial alarms are exceptionally expensive. From the readings, most of sophisticated alarms are installed in luxury cars only. Thus, data is gathered in order to propose and invent vehicle alarm that is low cost and more affordable to all people.

Carry out Literature Review

A literature review has been conducted by reading, analysing and comparing between existing projects from various sources. After reviewing relevant literatures, a clear idea of components to use in developing this project is obtained. The literature review is further discussed in Chapter 2.

Comparative Studies

In this project, there are two main comparative tables that have been discussed in Section 2.1 and Section 2.2 which are the comparison between devices and comparison between communication networks. The ultimate reason of conducting the comparative study is to analyse the most suitable hardware to be used. Other than that, it is important to know and understand all features for each device and components. The discussion and elaboration for each feature have been discussed in greater details in Section 2.1 and Section 2.2.

Develop and Design System Architecture

The system architecture diagram is defined into a chart and will be discussed in Chapter 4. The system architecture diagram will indicate the process flow of alarm system to notify an alert message to the vehicle owner mobile phone.

Planning Prototype

During this phase, a suitable model to be utilized has been planned out. All the needed components and hardware are identified and planned for purchase once confirmed. The Arduino, IComsat GSM and Piezoelectric sensor are the finalized items to be used as part of the implementation stage.

Hardware Implementation

The implementation starts by connecting hardware through tutorials and guidelines. Arduino environment is downloaded and installed. In order to run the GSM and Arduino application, we coded few lines by using C++ programming language. It is easy to use Arduino as there are many tutorials on how to send SMS through GSM.

3.2 Project Milestone

Below are the key milestones in order to assist the completion of the methodology of the study.

No	Activity	Week
Final Year Project 1		
1	Selection and proposal for the project title	3
2	Data collection of the project	4
3	Completion of literature review and collection of data	5-10
4	Submission of interim report for FYP 1	11
5	Proposal defence	13
Final Year Project 2		
1	Pre-SEDEX	10
2	Submission of technical paper	10
3	Submission of dissertation (Soft bound)	11
4	SEDEX	12
5	Viva	14
6	Submission of project dissertation (Hardbound)	15

CHAPTER 4
RESULT AND DISCUSSION

3.1 System Architecture

The system architecture provides a clear overview of the integration of all components of the proposed system. The experiment apparatus to be used are a piezoelectric sensor, GSM modem, Arduino Microcontroller and mobile phone.

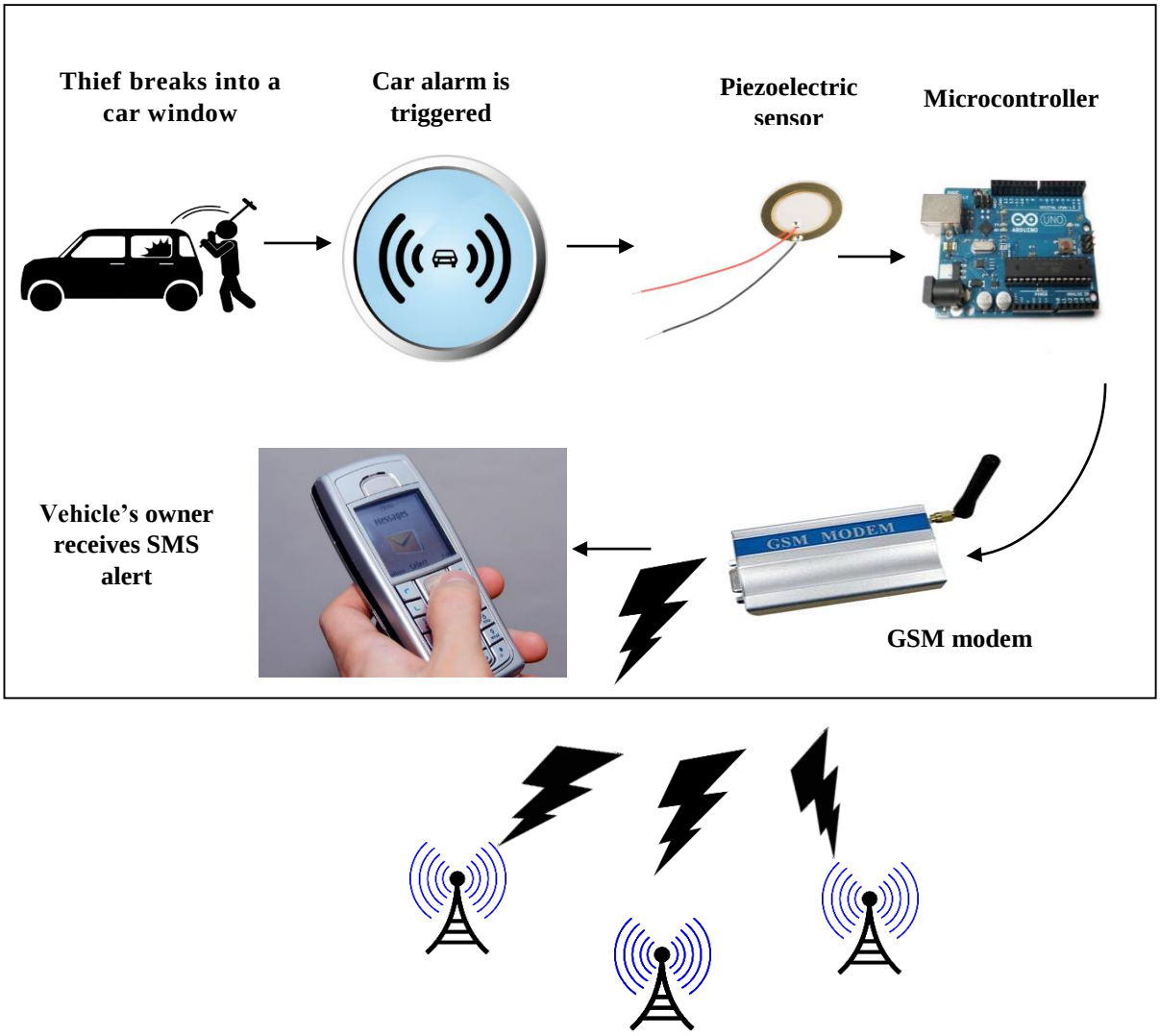


Figure 2: System Architecture Diagram

Based on Figure 2, there are numerous ways for thieves to force entry into any type of vehicles. In Figure 2, we assumed that the thief is breaking into a car window. The action of breaking into the window will trigger the car alarm system. In this project, when there is an abnormal surface pressure occur, the piezoelectric sensor will detect and convert it into an electrical signal. The reason of using piezoelectric vibration sensor is because it is capable of stably measuring a vibration with high precision [9]. Moreover, the piezoelectric sensor uses crystals to convert mechanical energy into electricity or vice-versa. It can measure changes in pressure, acceleration, temperature, strain or force by converting them into an electrical charge. Then, the sensor relays the info to the Arduino microcontroller, which then triggers text alert to the vehicle owner via the GSM

modem. In the GSM device, SIM card is inserted and is configured using the Arduino editor and compiler. The Arduino IDE environment needs to be installed first. The SIM is important as without SIM, the SMS alert will not be delivered. Lastly, GSM modem will send alert messages to the vehicle's owner himself. The message can be configured using the Arduino IDE.

4.2 Data Flow Diagram

In this section, we will discuss on the data flow diagram proposed for this project. This explains how data is processed and transferred to each component in order to identify the input and output for the component.

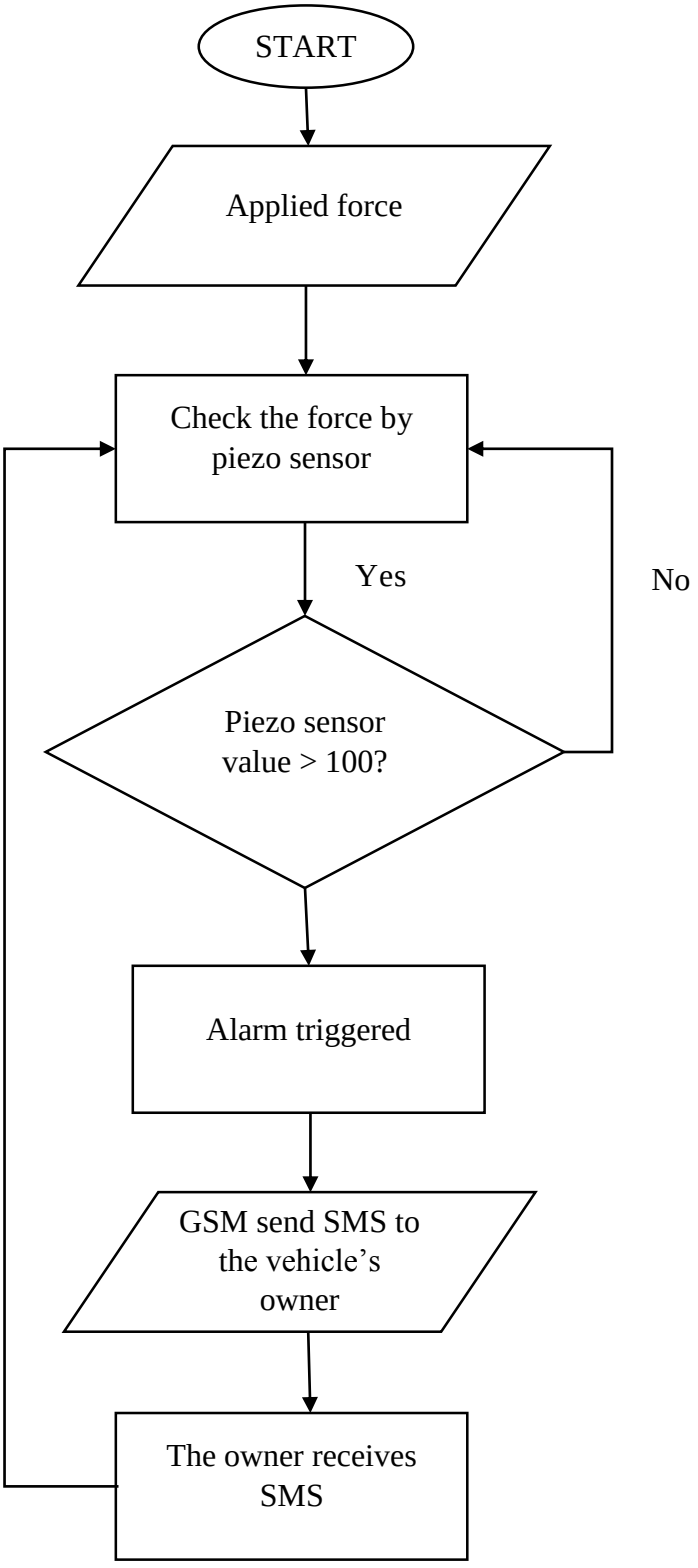


Figure 3: Process flow of Vehicle Alarm by using GSM

As illustrated in Figure 3, whenever the applied force occurred, the piezo sensor will check the analog value. To avoid false alarm from being triggered, 100 threshold analog value is being set in the coding. If the piezo sensor analog value reaches more than 100, the alarm car will trigger. Then, the GSM will send the SMS to the vehicle's owner mobile phone. However, if the piezo analog value is less than 100, the piezo sensor will continue checking the applied force. The mobile phone of the owner must be activated or it will not receive any incoming alert notification.

4.3 Logical Design

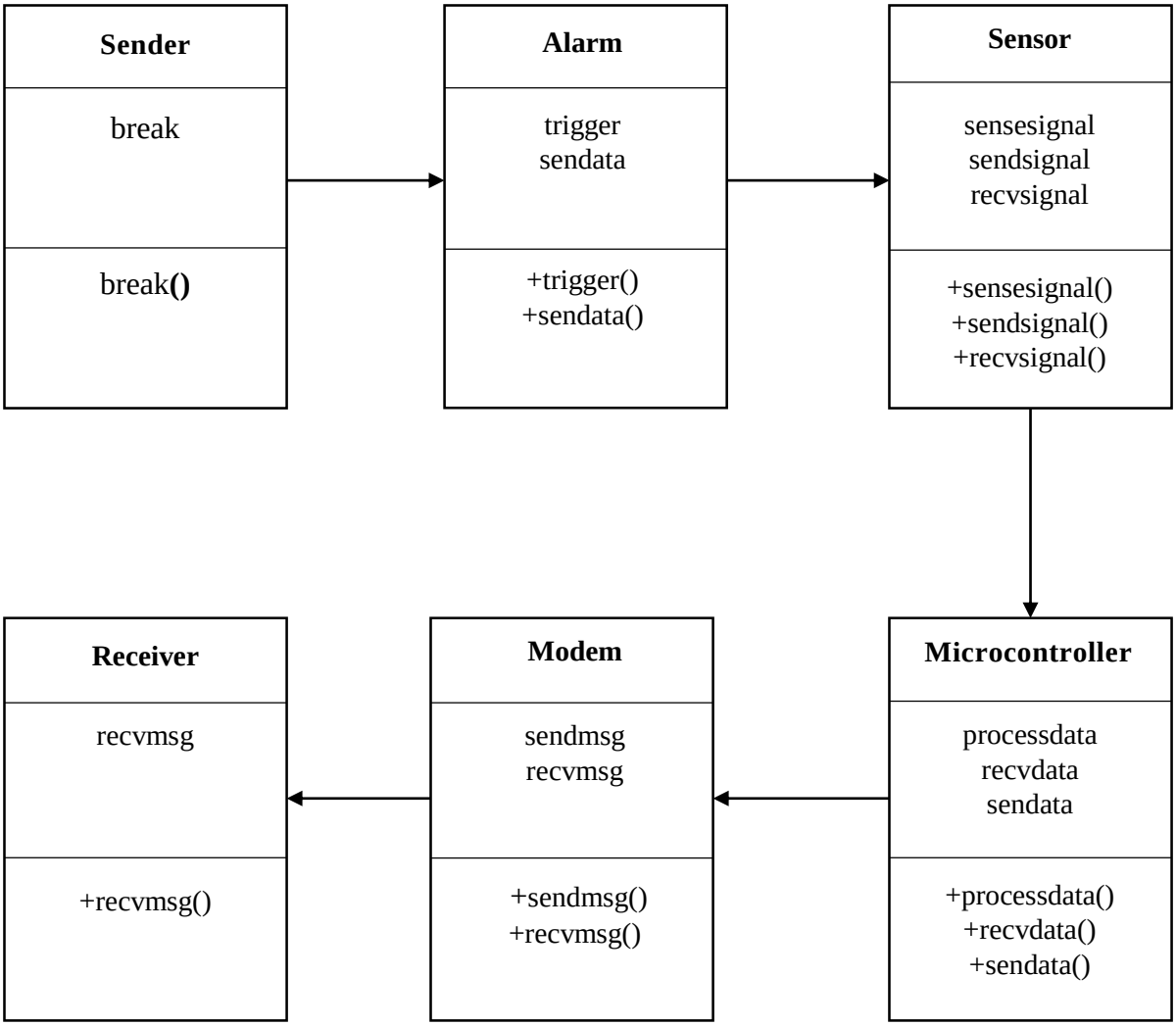


Figure 4: Proposed of Logical Diagram

As shown in Figure 4, the sender here means the thief who is attempting to steal the car. For instance, when they break the car window there is a progression of weight and movement recognized by the piezoelectric sensor which will trigger the alarm. The force produced from the act of breaking the car window by intruders is the input which triggers the alarm system. At that point, the sensor is responsible to send a signal to the Arduino microcontroller. The role of Arduino is to process the information received from the sensor and relay the information to the GSM modem. The code inside the Arduino Environment will be executed. After that, GSM will receive the instruction from Arduino and send a message to the recipient. A Subscriber Identity Module (SIM) card is installed inside the GSM modem so that SMS can be sent after it is activated with a cell phone service provider.

4.4 Testing

4.4.1 Force accuracy testing

The objective of this testing is to obtain the force values used to hit the car window and to obtain the threshold force value needed to crack the car window. This testing was carried out by using the asset of the heavyweight pendulum and it is corresponding pendulum software called PASCO Capstone. This software is used for data acquisition, display and analysis in physics and engineering labs. Each hit test was executed three times to get the average value and the mass been used in the test are up to 400g only. In this experiment, the angle of the pendulum is fixed to 45 ° so that the distance between the pendulum and window is fixed as well. The mass of the pendulum was manipulated from 100g, 150g, 200g, 250g, 300g, 350g and 400g. By conducting this testing, the force of the impact and the condition of the car window is recorded as shown in the tables and graphs below.

Procedure:

1) Clamp the window by using the holder to ensure it does not move easily

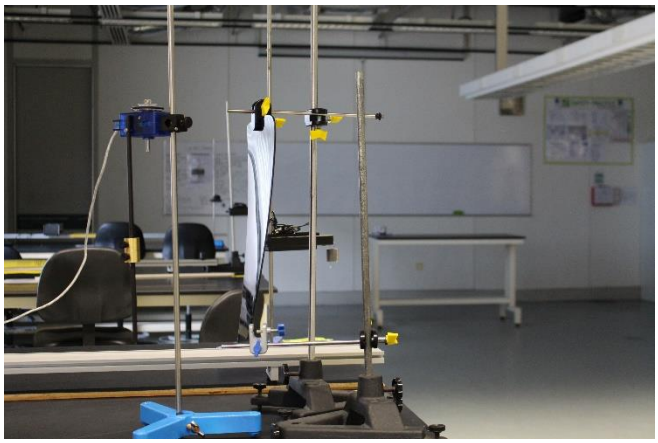


Figure 5: The pendulum set

2) Set up the pendulum and connect the wire into the computer.
3) Use the computer and PASCO software to read the graph force sensor.
4) Put the force sensor and attach it with the rod.

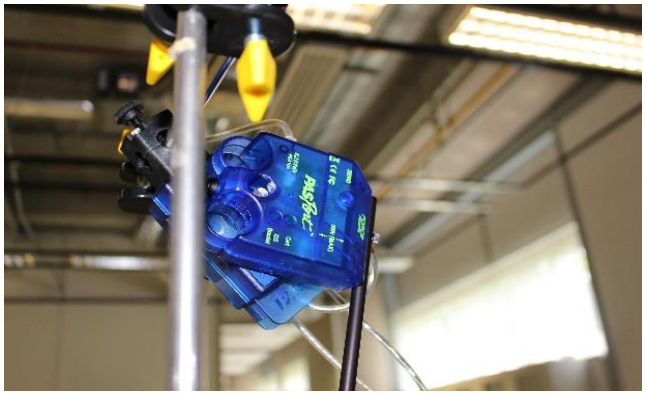


Figure 6: Force sensor been attached to give force value

5) Configure the software and ensure it detects the force.

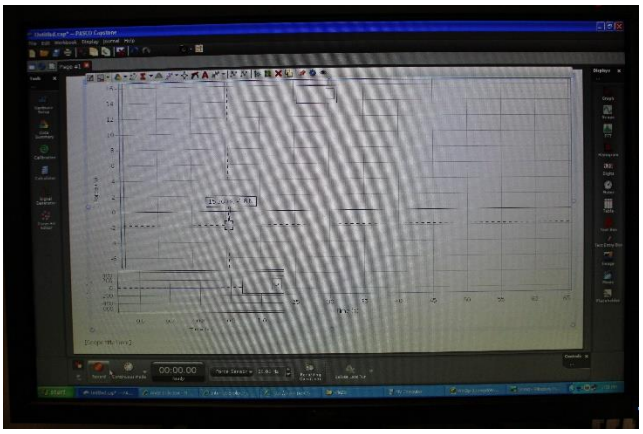


Figure 7: Screenshot of plotted graph by PASCO software

6) Attach the piezo vibration sensor on the window and put the pendulum on the pendulum's rod.

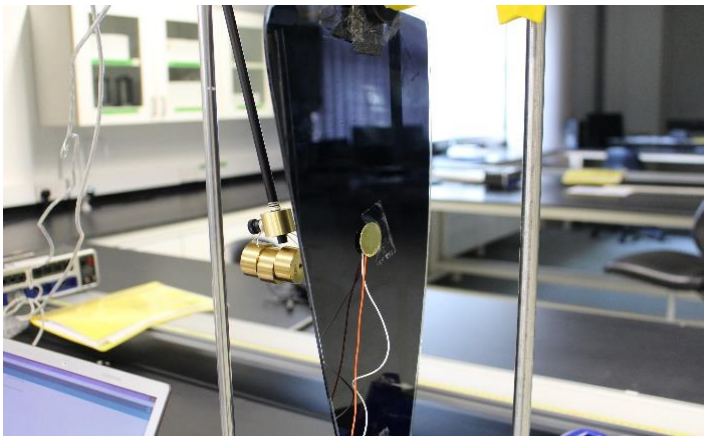


Figure 8: The piezo sensor have been attached at the back of the window to absorb vibration

7) Fix the constant angle to 45 ° by using angle indicator.

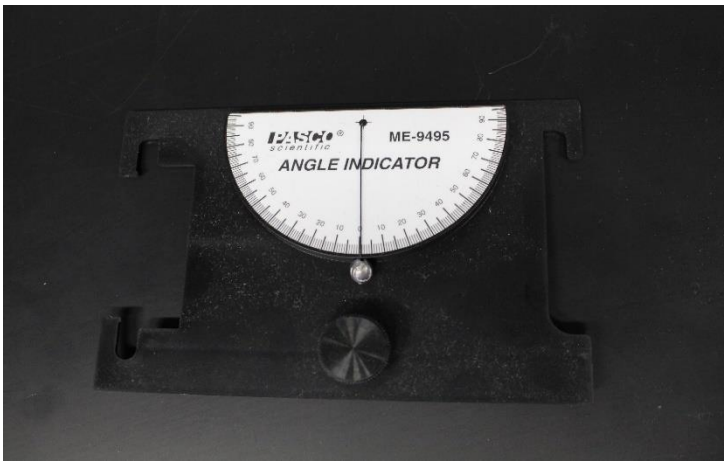


Figure 9: Angle indicator to adjust the angle

8) Conduct the experiment by using different mass of pendulum to get different force impact through the graph of the software.

Figure 10: Pendulum set for experimental

9) Record the data into the table and analysis the graph produced by the software.

Table 4: The result obtained

Mass (g)	Force (N)	Piezo Analog Value	Piezo Voltage (V)	Average Value for Piezo Voltage (V)
100	-4.9	125	2.441	2.669
100	-2.3	130	2.539	
100	-4.2	155	3.027	
150	-2.6	126	2.461	2.57833
150	-3.5	120	2.344	
150	-2.9	150	2.930	
200	-9.1	141	2.754	2.82533
200	-5.7	151	2.949	
200	-9.2	142	2.773	
250	-11.6	145	2.832	2.448
250	-14.2	117	2.285	
250	-8.8	114	2.227	
300	-13.8	128	2.500	2.66267
300	-12.5	126	2.461	
300	-14.1	155	3.027	
350	-14.4	139	2.715	2.591
350	-7.9	136	2.656	
350	-12.5	123	2.402	
400	-17.5	123	2.402	2.760333
400	-15.6	149	2.910	
400	-17.9	152	2.969	

Table 4 shows the result obtained from the force accuracy testing. From this testing, all the analog value from the piezo sensor recorded more than 100. The analog value can be converted to a voltage by using the following formula.

Formula converting from ADC reading to Voltage [10]:

$$\frac{\text{Resolution of the ADC}}{\text{System Voltage}} = \frac{\text{ADC Reading}}{\text{Analog Voltage}}$$

$$\text{Analog Voltage} = \frac{\text{ADC Reading}}{\text{Analog Voltage}} \times \text{System Voltage}$$

*The ADC on the Arduino is 8-bit ADC meaning it has the ability to detect 256 (2^8) discrete analog levels.

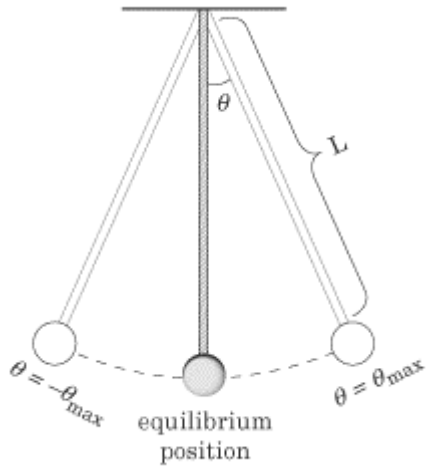


Figure 11: All forces recorded above are with negative sign because based on the motion of the pendulum. If it swings to the right it will give $\boldsymbol{\theta}$ value and if it swings to the left it will give $-\boldsymbol{\theta}$ value [11].

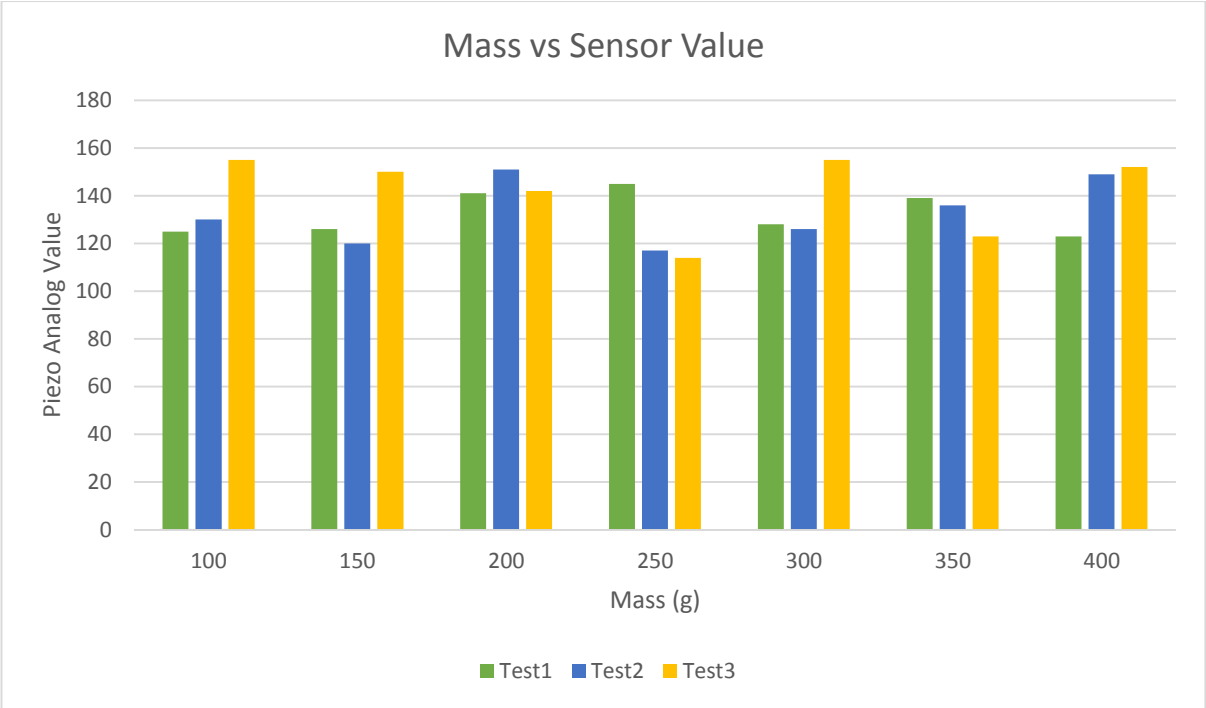


Figure 12: Mass vs sensor value

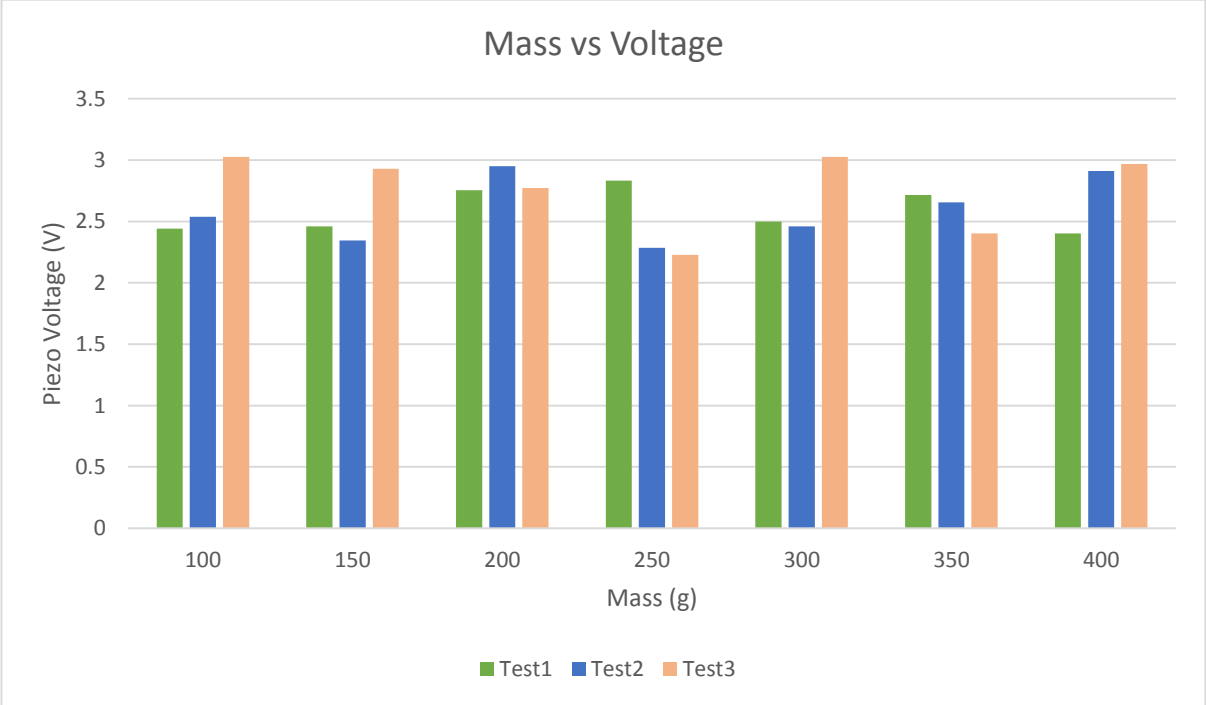
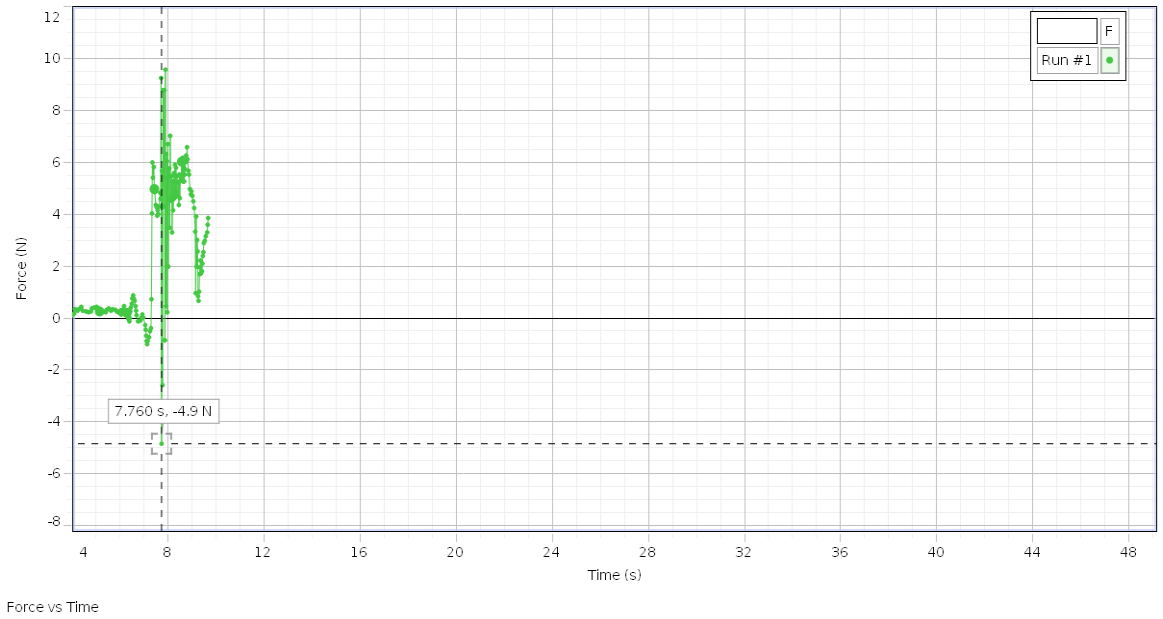


Figure 13: Mass vs voltage

Graphs of each mass

This section is the force graphs reading being taken for each of the mass. It was been for three times and the average force is taken.

1) Figure 14, Figure 15 and Figure 16 are the force impact reading by using 100g of the pendulum.



Force vs Time

Figure 14: 100g Test 1

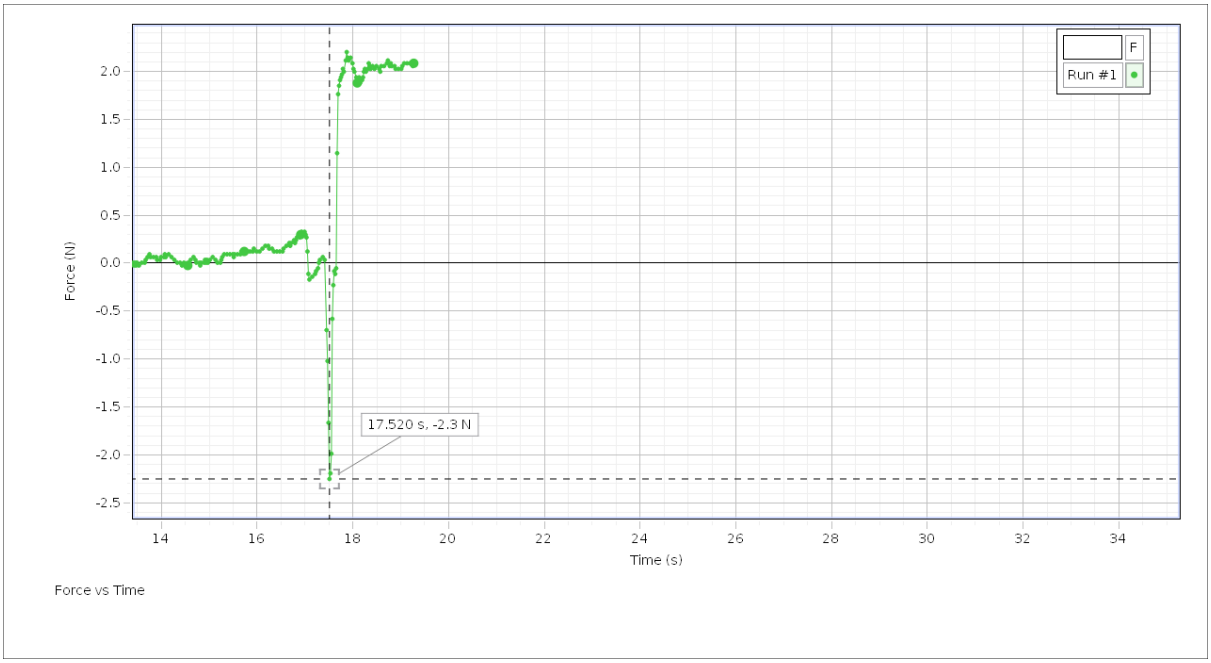


Figure 15: 100g Test 2

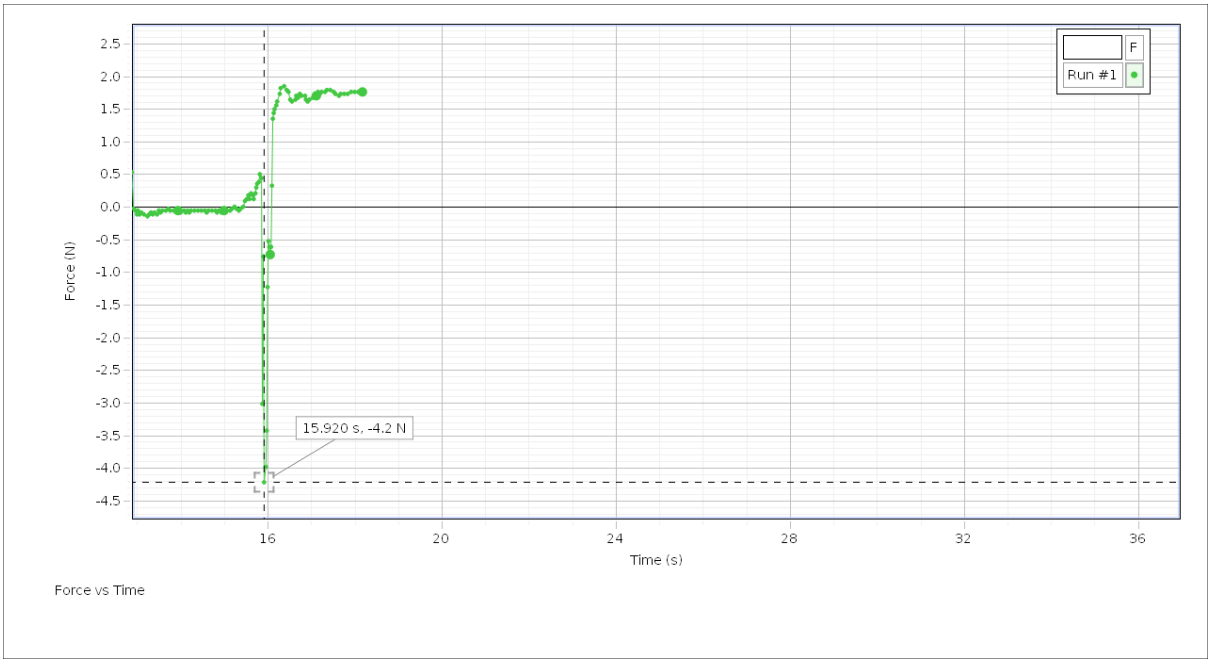


Figure 16: Figure 2: 100g Test 3

2) Figure 17, Figure 18 and Figure 19 are the force impact reading by using 150g of the pendulum.

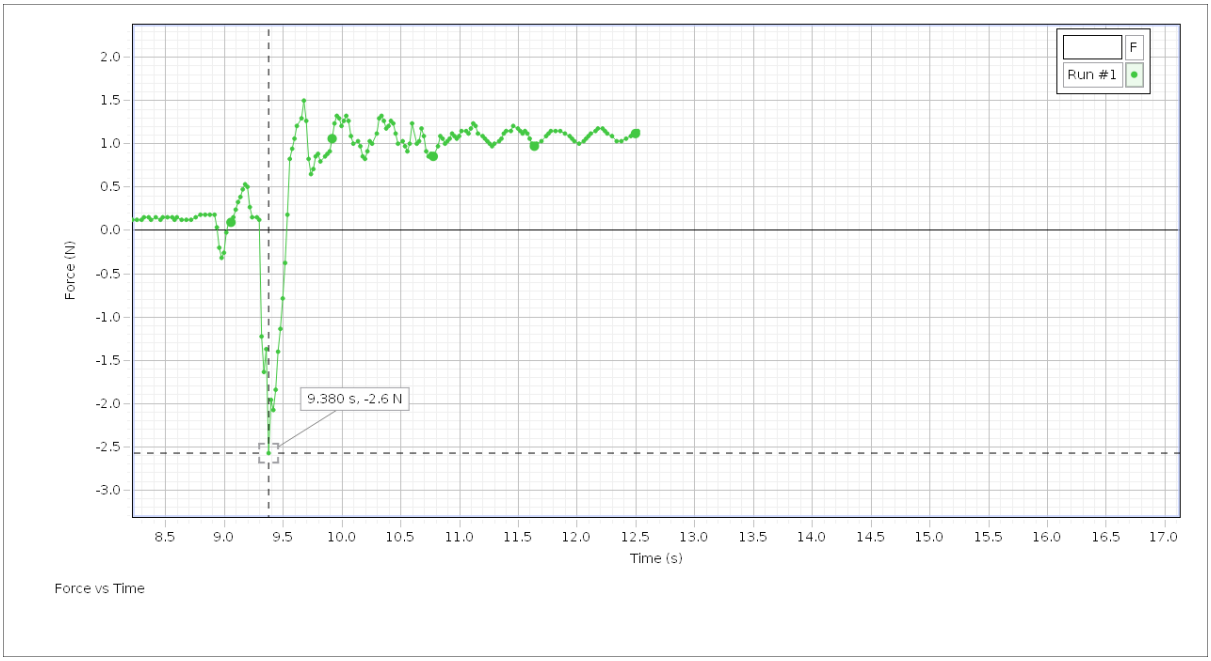


Figure 17: 150g Test 1

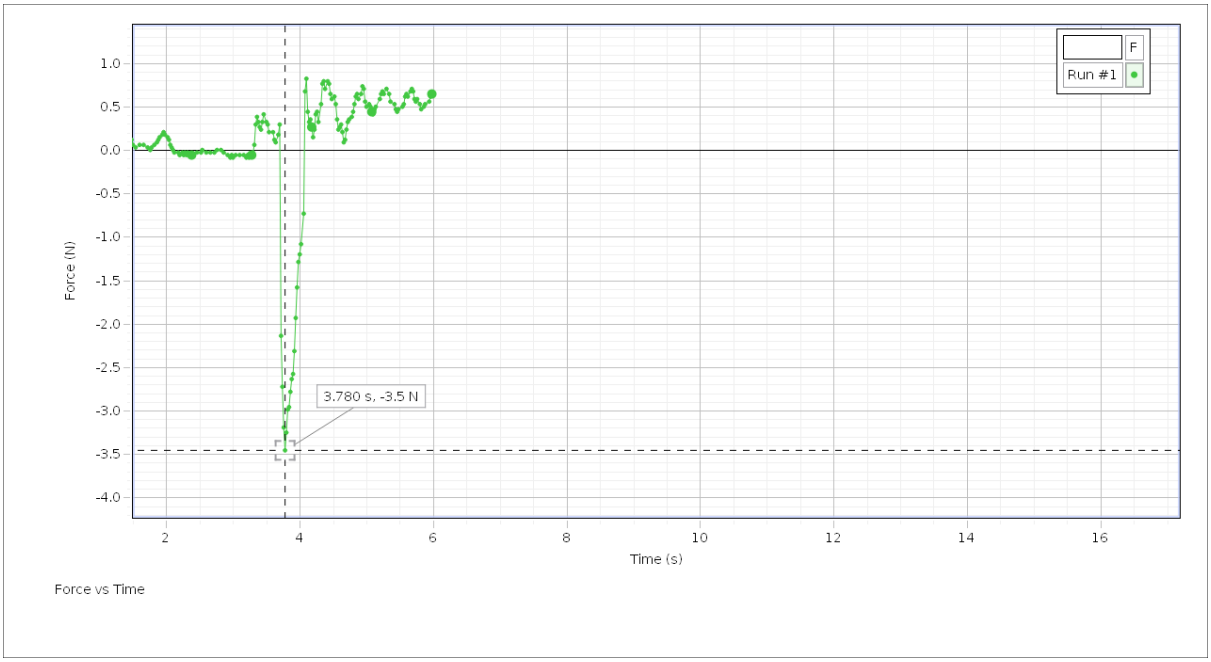


Figure 18: 150g Test 2

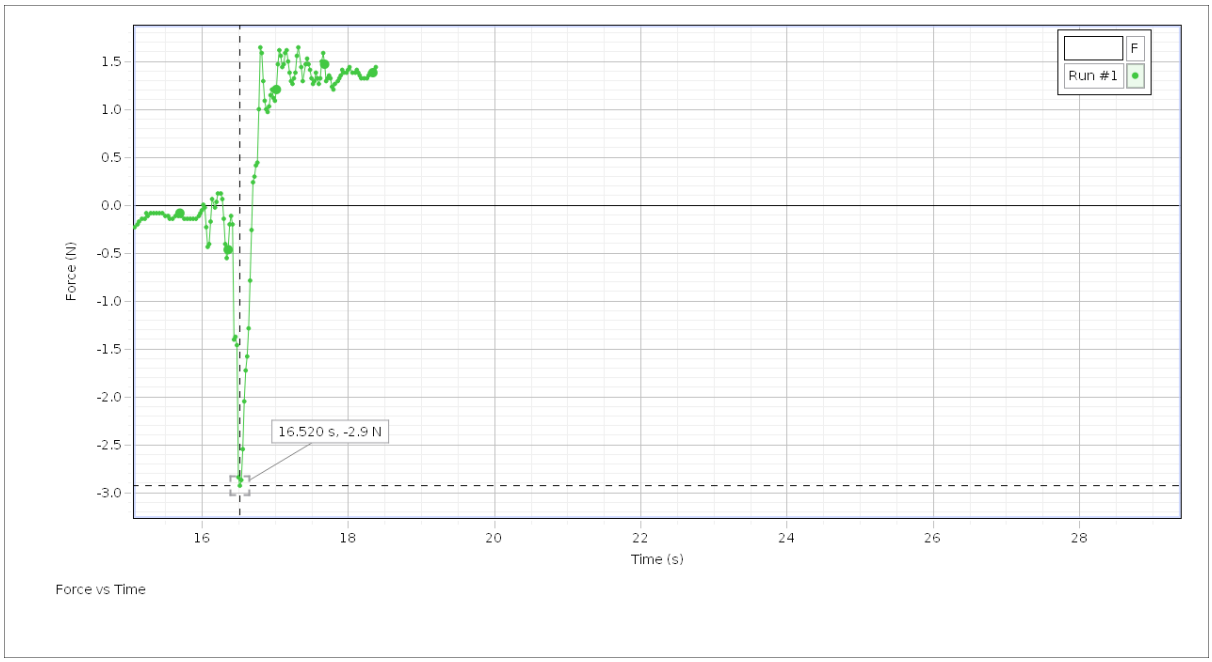


Figure 19: 150g Test 3

3) Figure 20, Figure 21 and Figure 22 are the force impact reading by using 200g of the pendulum.

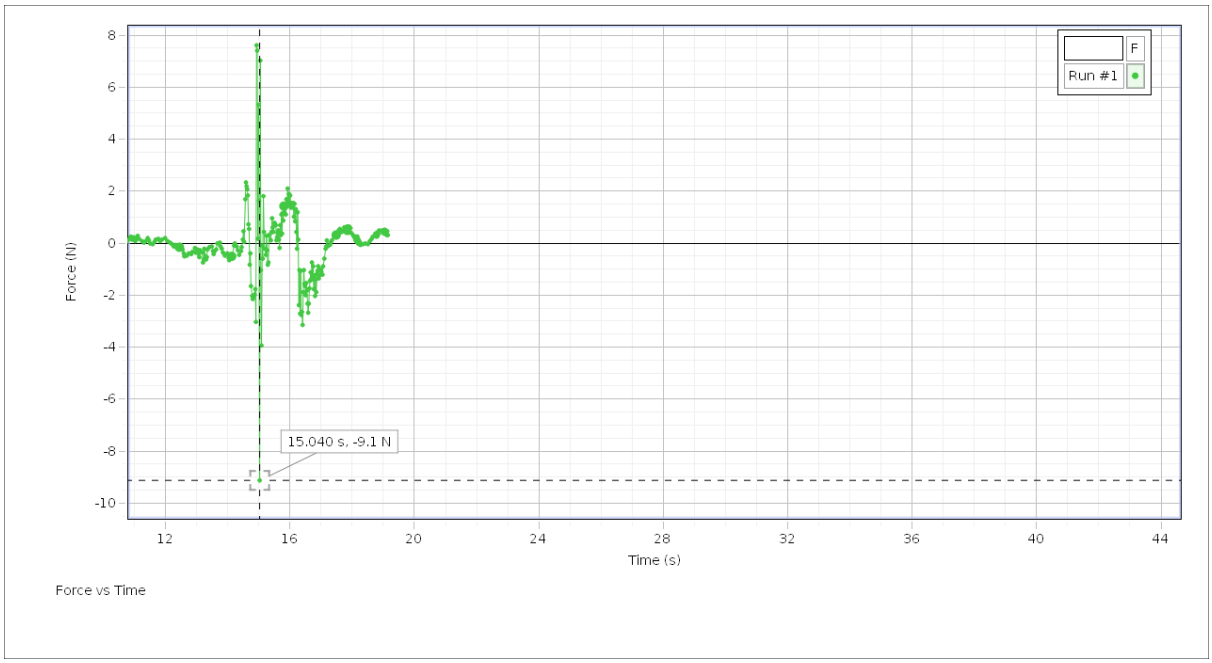


Figure 20: 200g Test 1

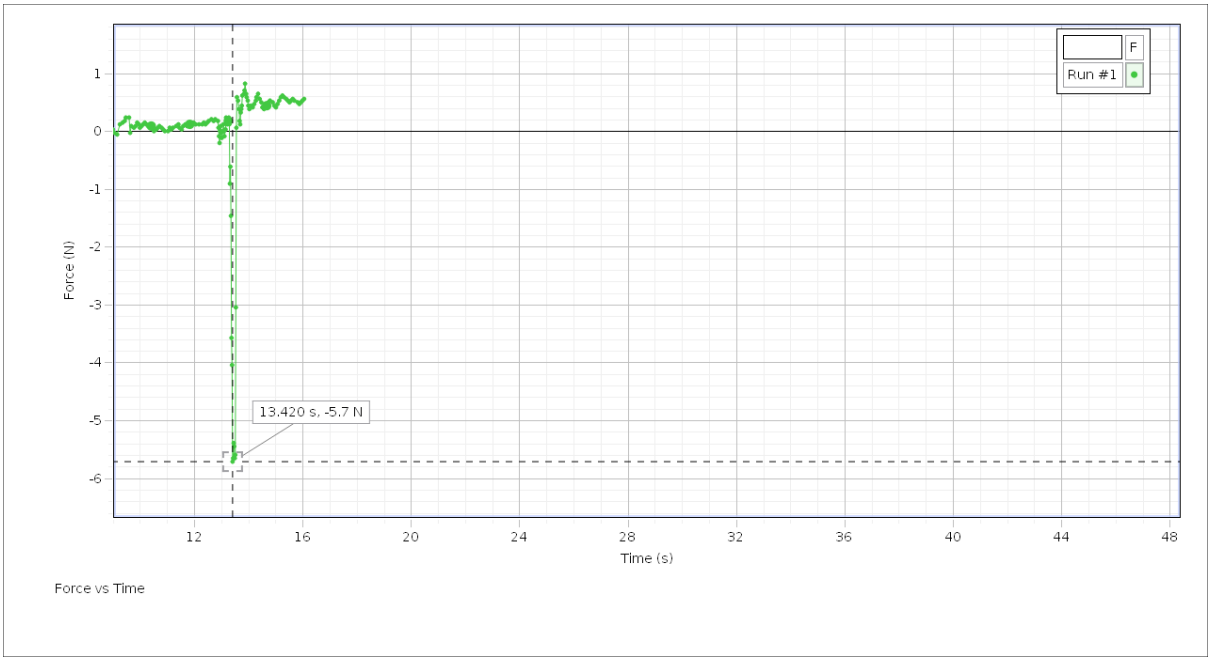


Figure 21: 200g Test 2

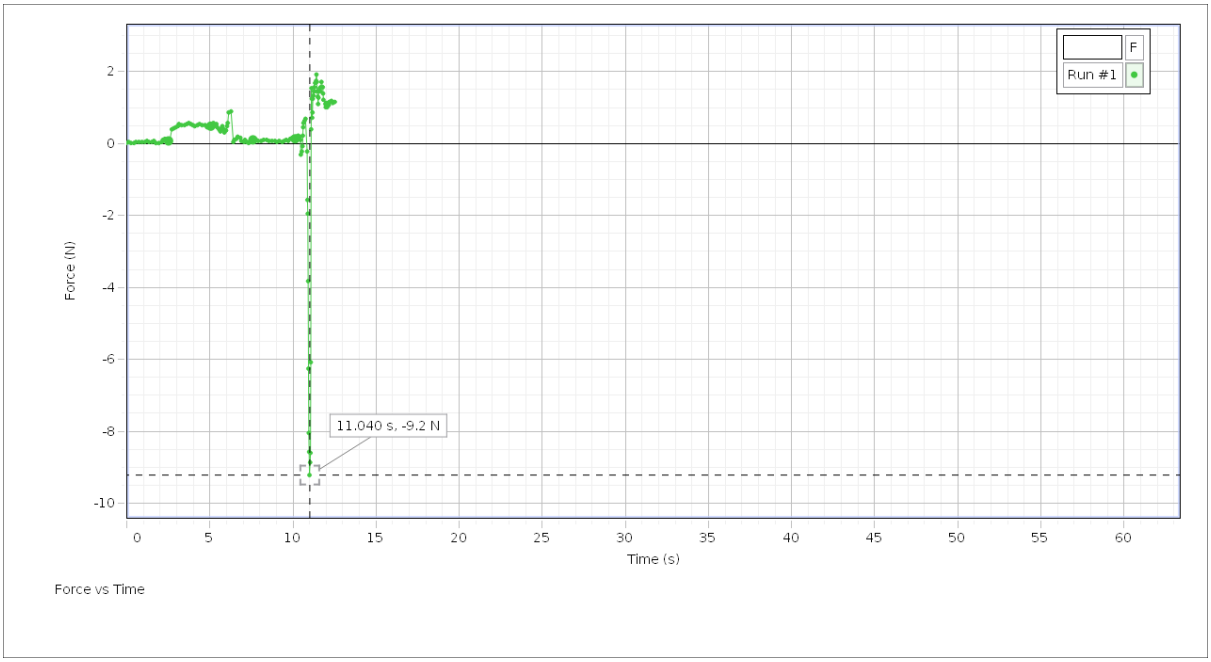


Figure 22: 200g Test 3

4) Figure 23, Figure 24 and Figure 25 are the force impact reading by using 250g of the pendulum.

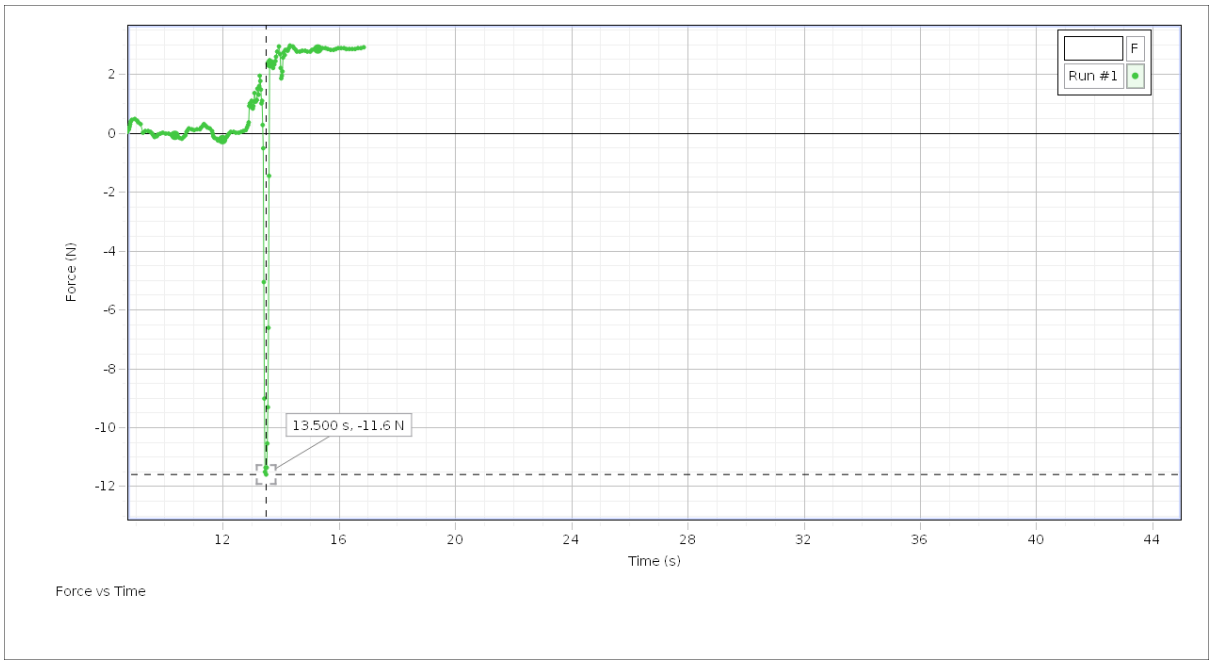


Figure 23: 250g Test 1

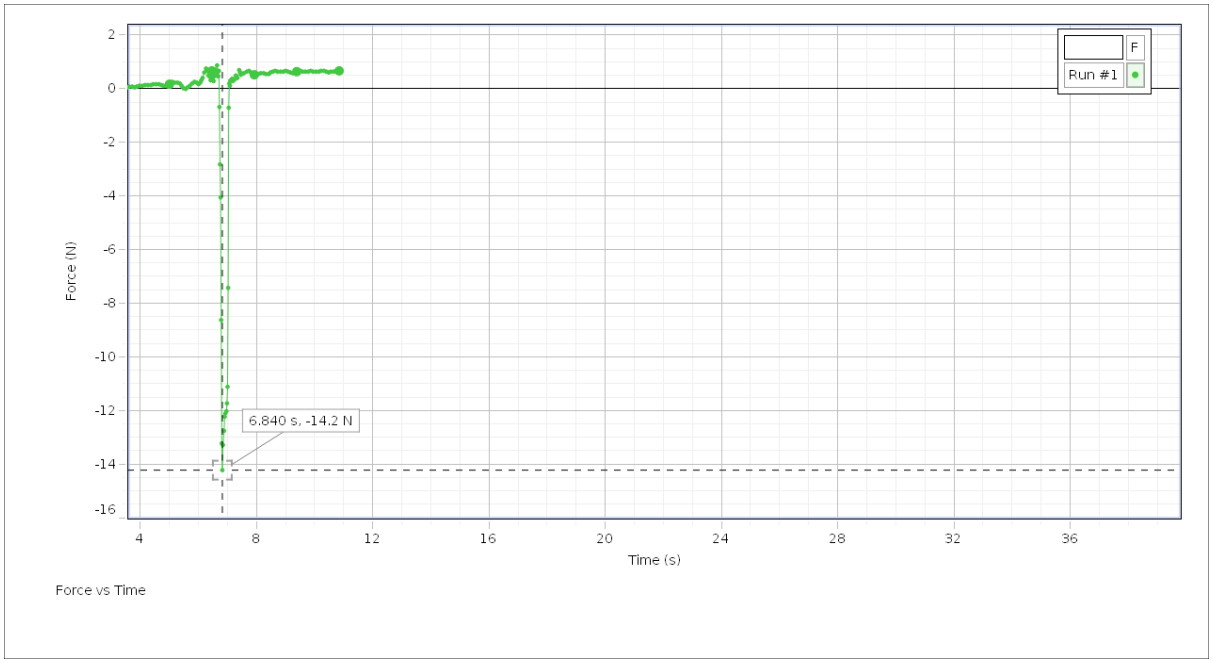


Figure 24: 250g Test 2

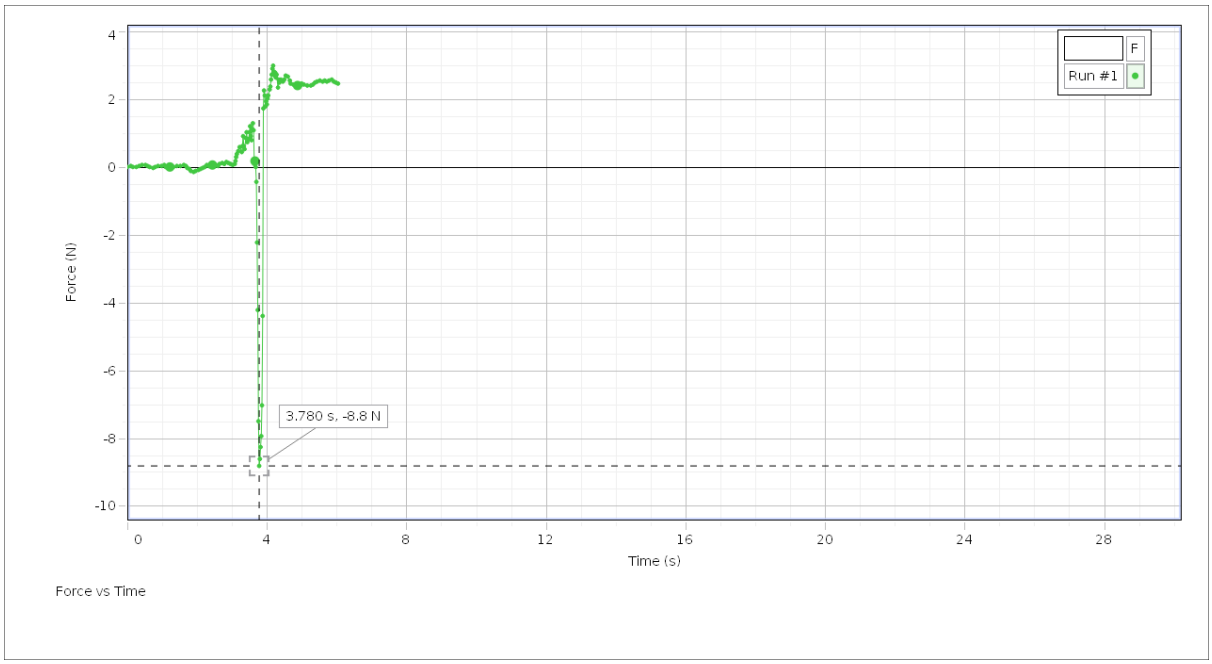


Figure 25: 250g Test 3

5) Figure 26, Figure 27 and Figure 28 are the force impact reading by using 300g of the pendulum.

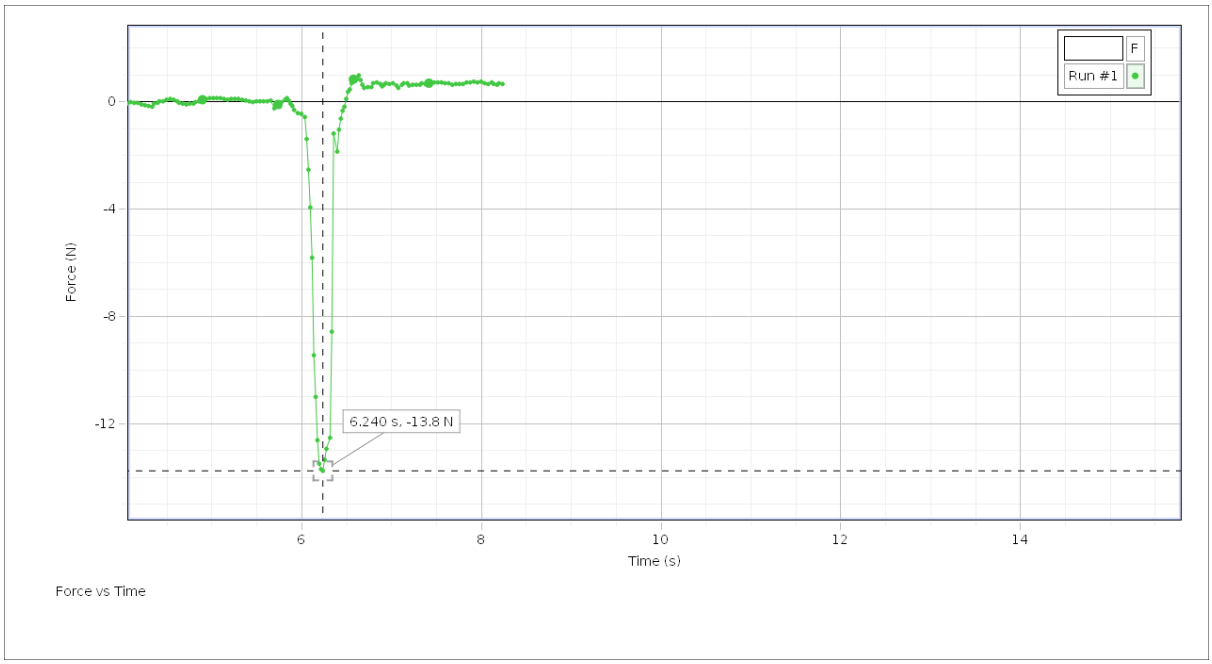


Figure 26: 300g Test 1

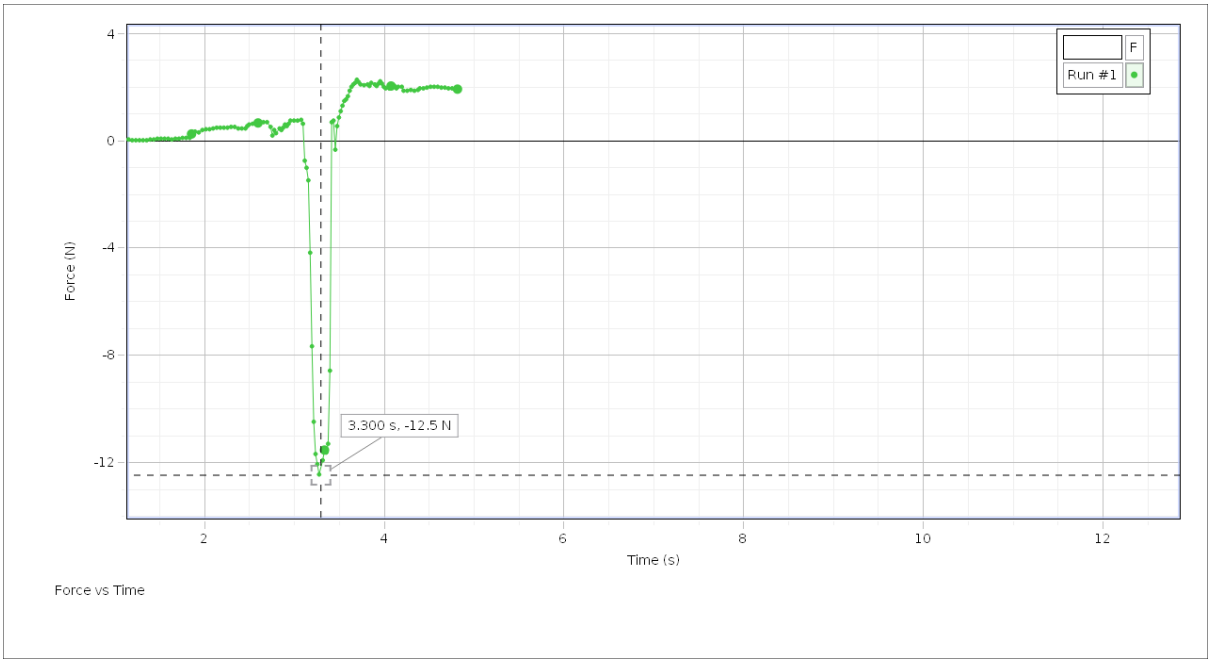


Figure 27: 300g Test 2

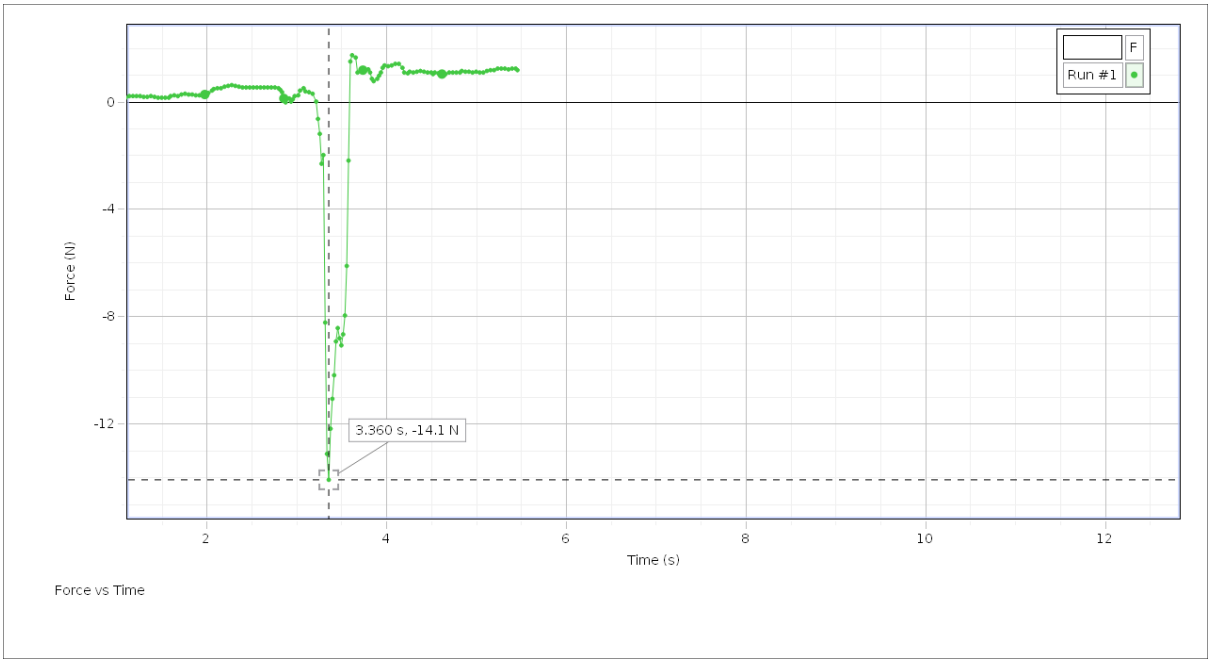


Figure 28: 300g Test 3

6) Figure 29, Figure 30 and Figure 31 are the force impact reading by using 350g of the pendulum.

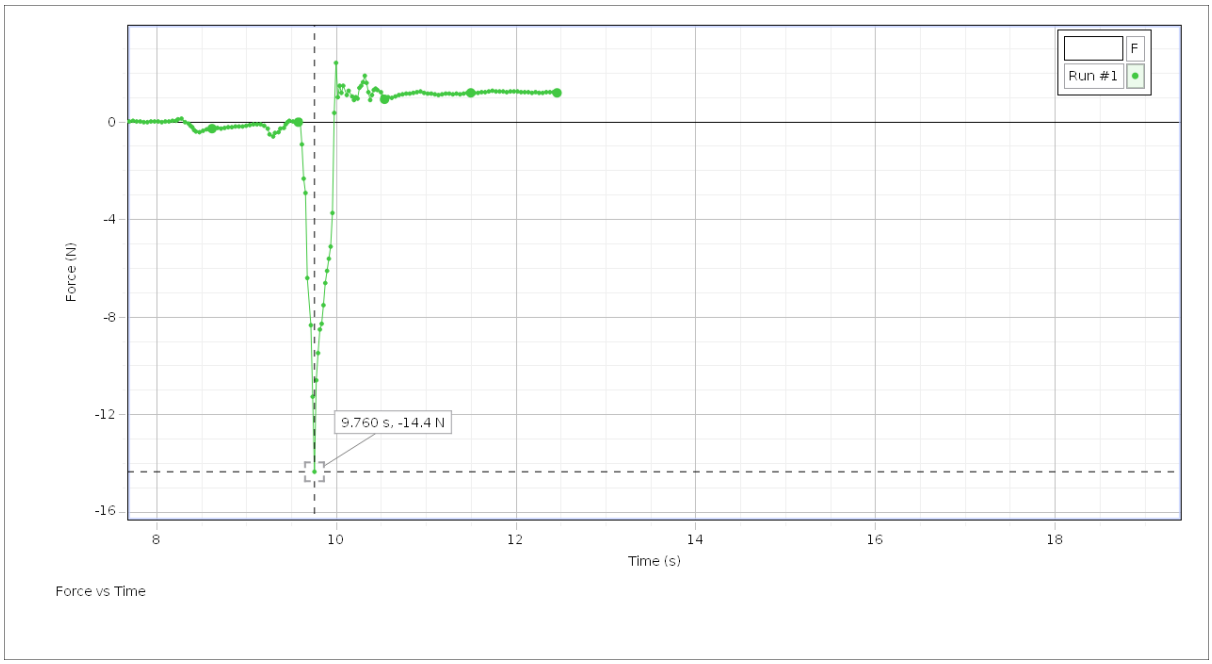


Figure 29: 350g Test 1

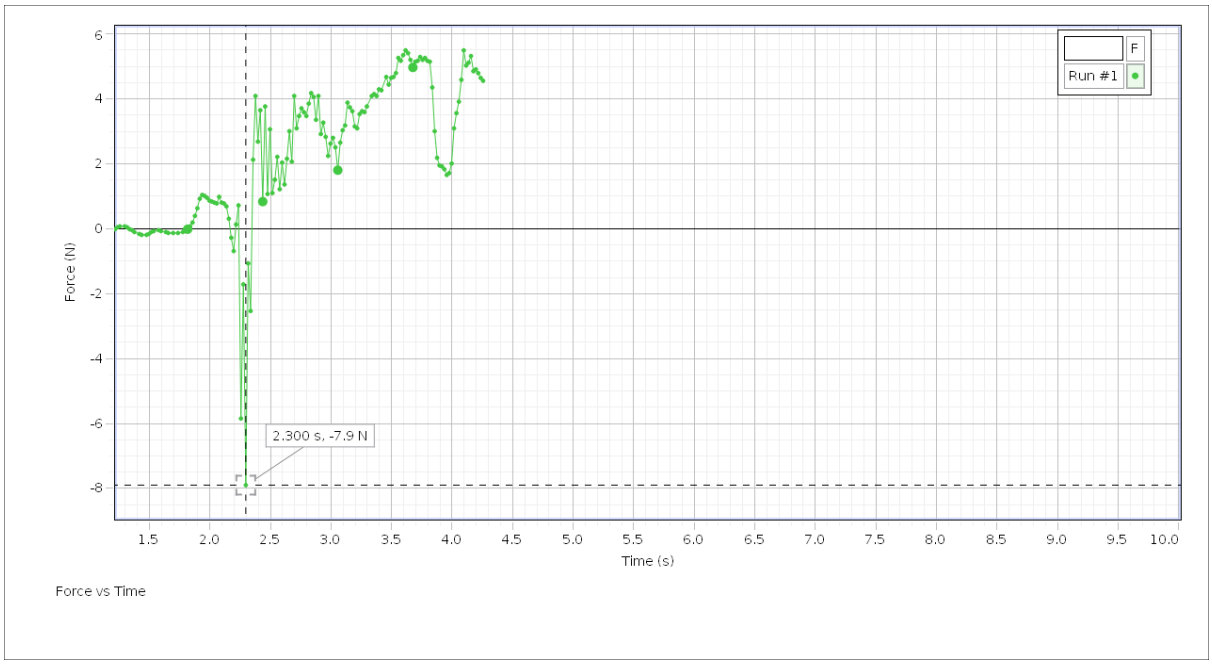


Figure 30: 350g Test 2

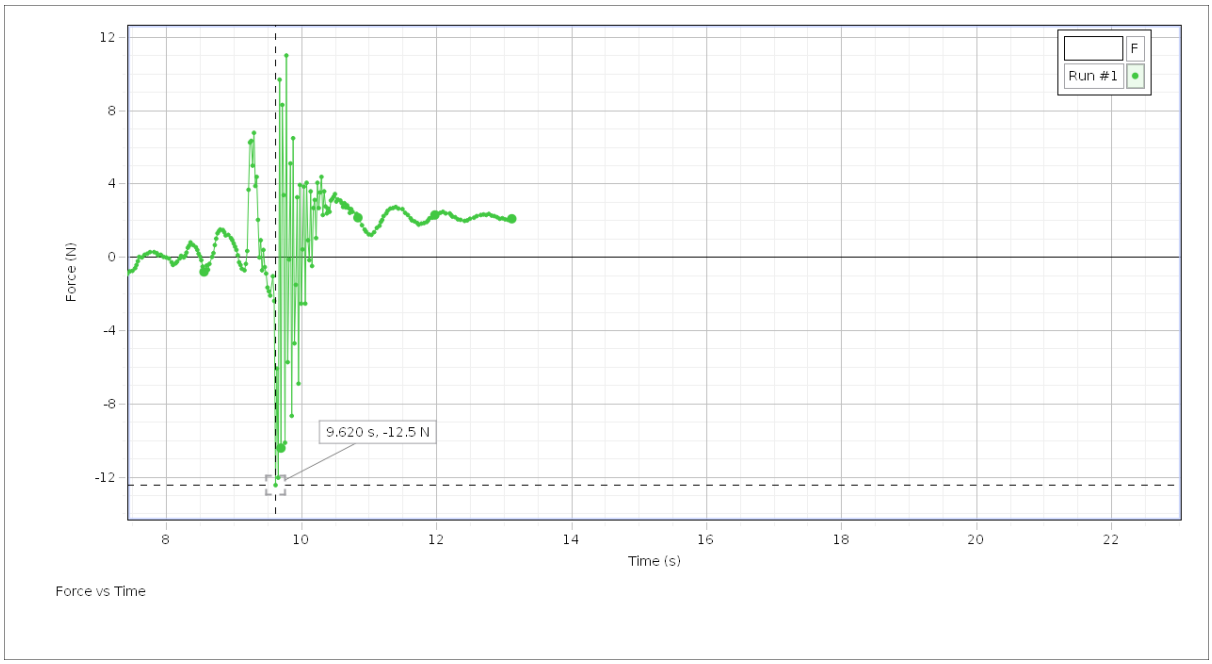


Figure 31: 350g Test 3

7) Figure 32, Figure 33 and Figure 34 are the force impact reading by using 400g of the pendulum.

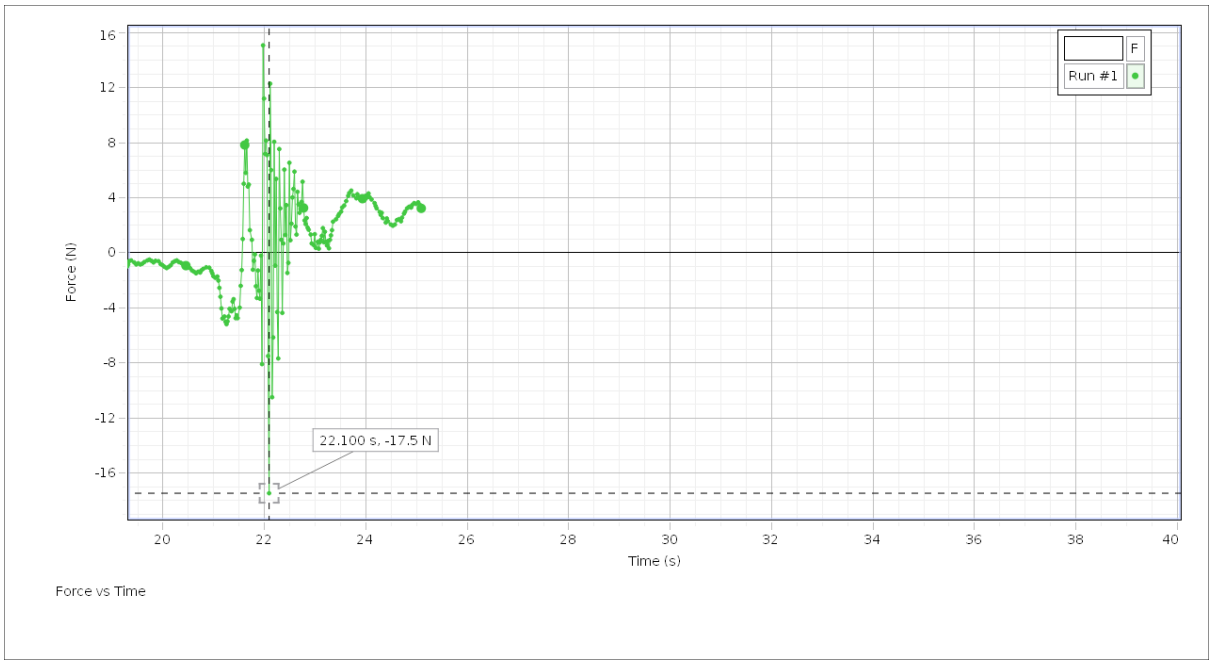


Figure 32: 400g Test 1

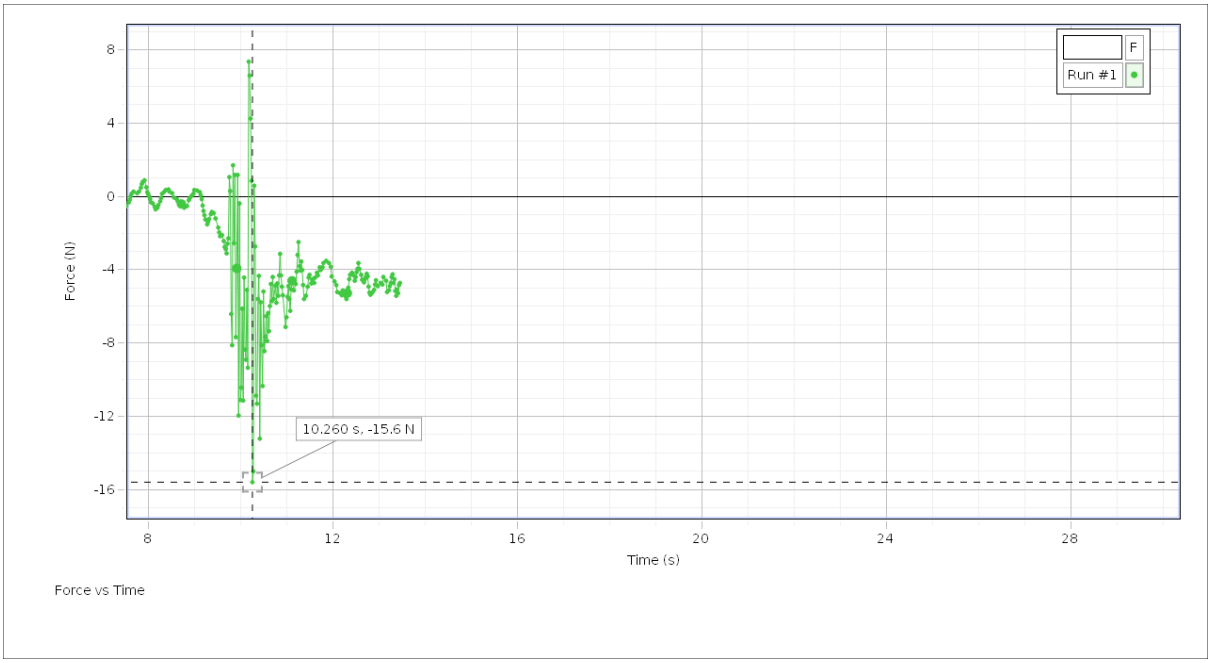


Figure 33: 400g Test 2

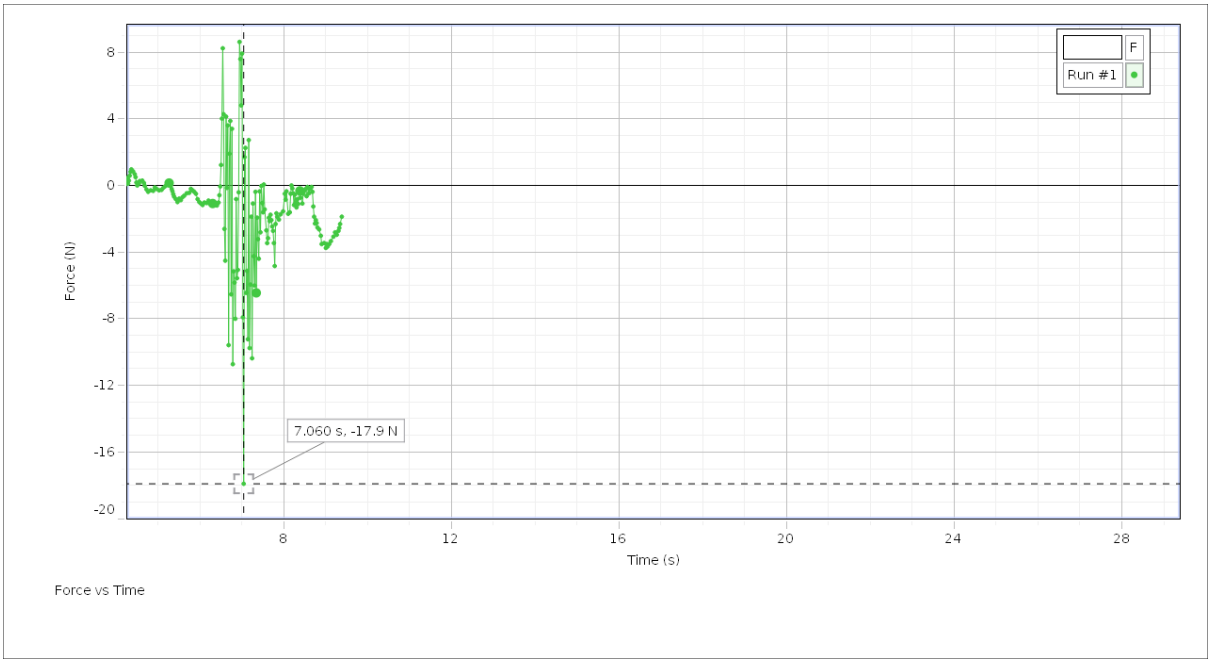


Figure 34: 400g Test

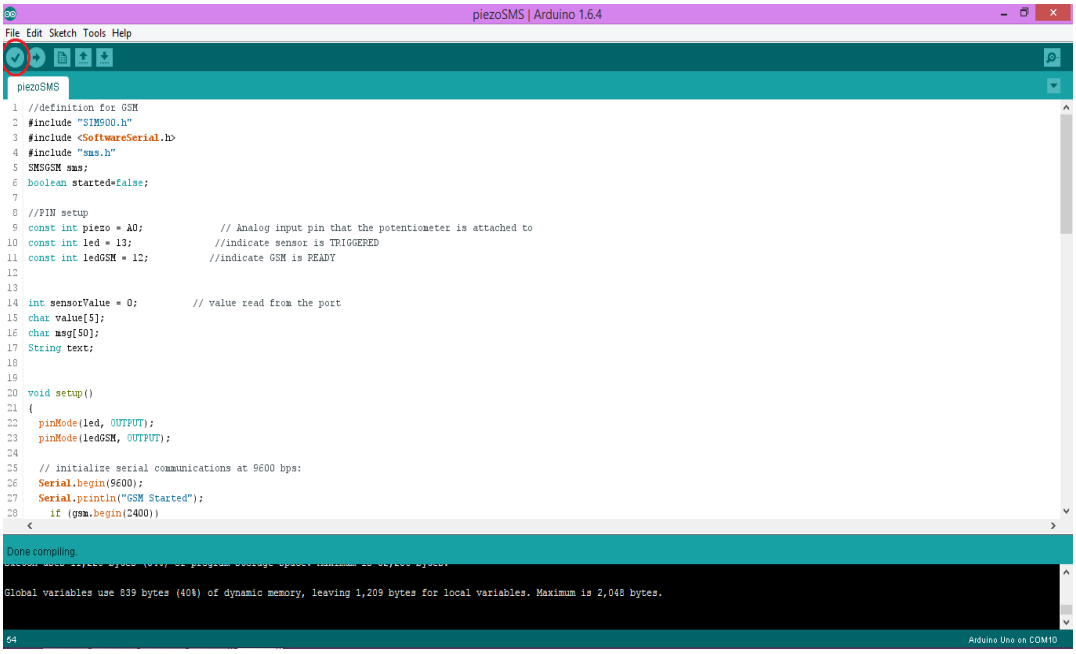
To consolidate for all tests conducted, every impact of the pendulum gives more than 100 on the piezo sensor reading. The range of force marked in the graph is between 2N to 20N. Thus, 100 analog value of the sensor can be set up in the coding as a threshold value to differentiate between an intrusion and a false alarm caused by natural causes. From this value, we can determine whether an alarm is genuine or not.

4.4.2 Time interval of receiving message

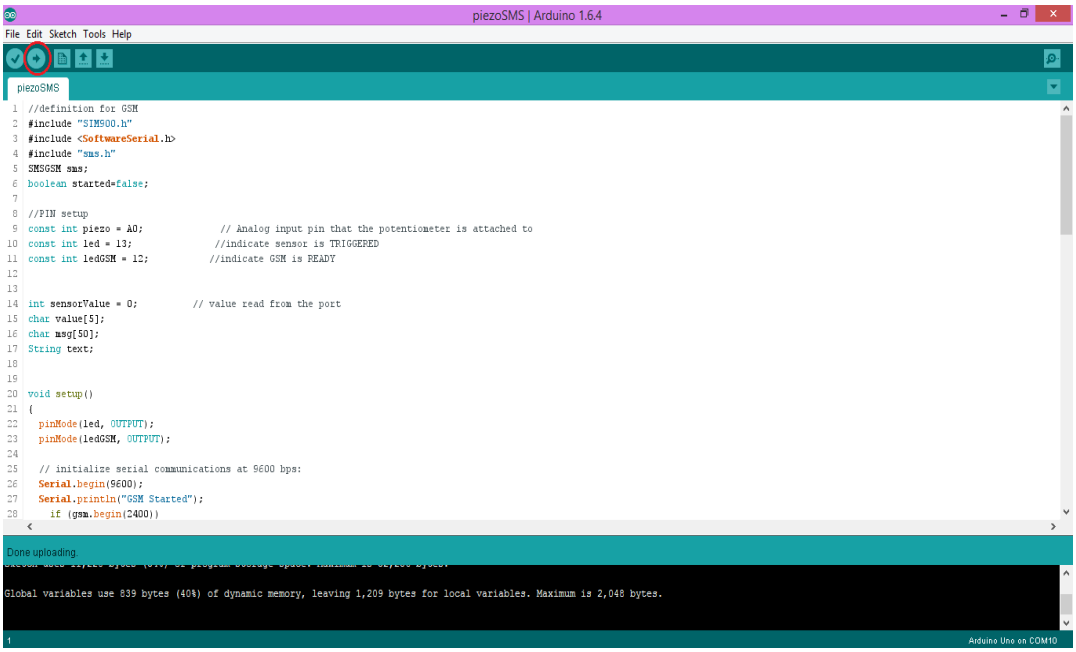
The objective of this testing is to find the average time taken for GSM to send SMS to the owner's mobile phone once it reaches or exceeds the threshold values set in the code. In this experiment, the message will be sent if the piezo value reaches more than 10.

Procedure:

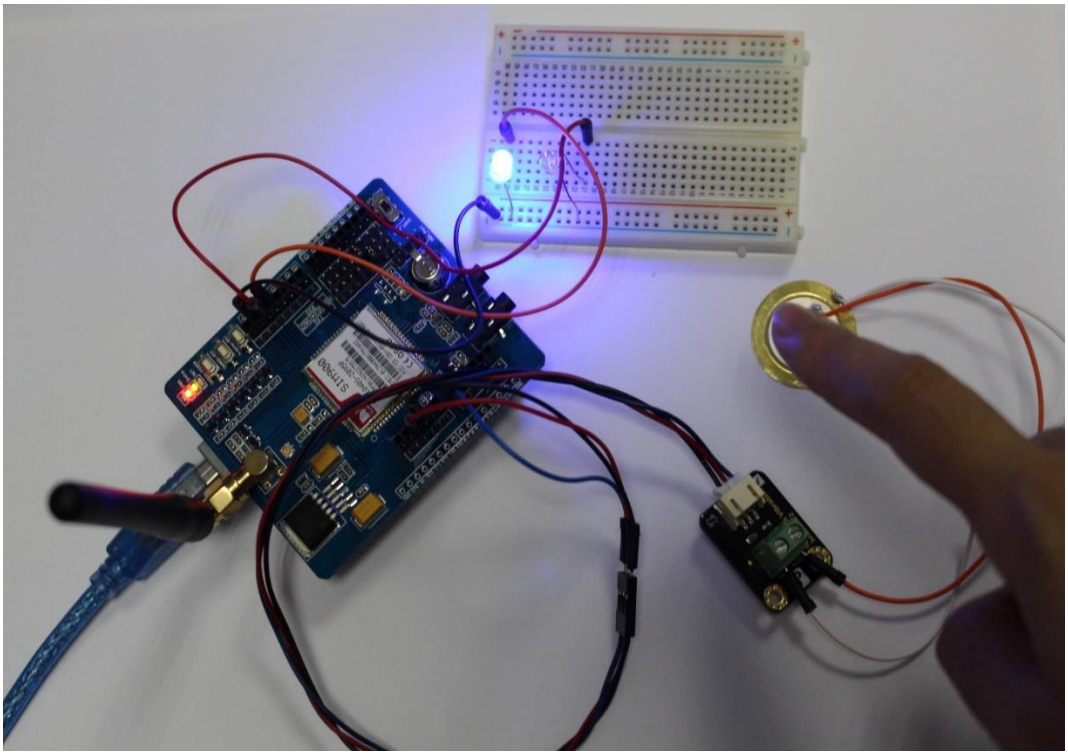
1) Verify the code to ensure there is no error.



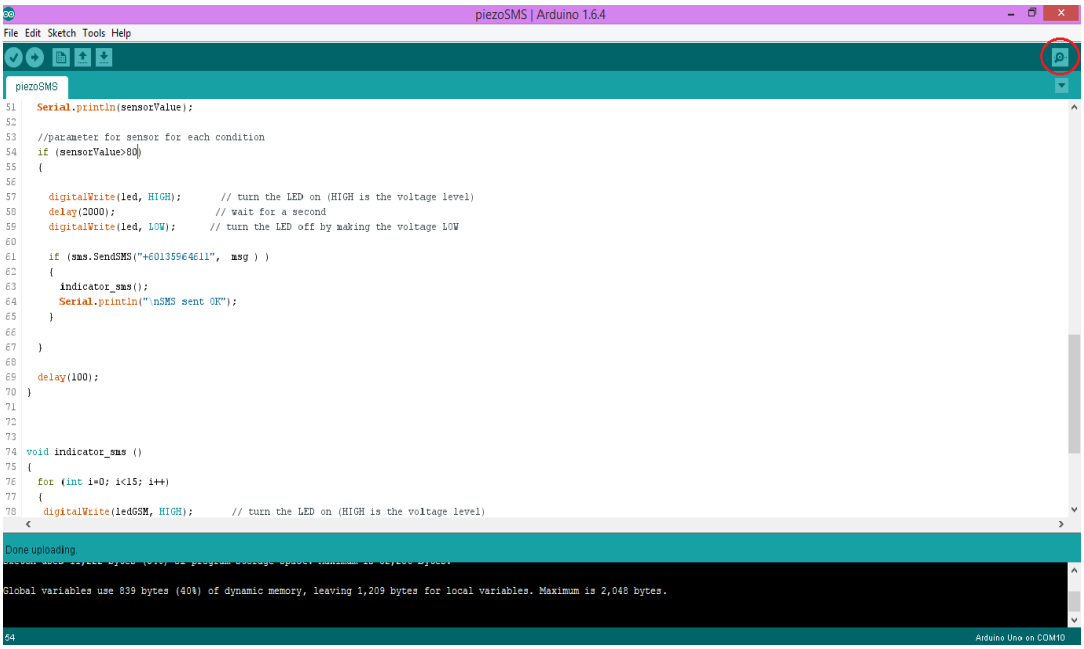
2) Upload the code into the Arduino board.



3) Knock the piezo sensor to generate vibration



4) Open the serial monitor to monitor the piezo analog value.



5) Record the value in the table.
6) Record the time by using stopwatch.

Results and data

Table 5: Time interval of receiving SMS to the owner's mobile phone

No. of Trial	Piezo Value (Analog)	Time (s)
1	124	10.70
2	71	09.08
3	111	10.11
4	66	10.19
5	110	10.48
6	119	10.50
7	85	11.33
8	90	9.70
9	31	10.00
10	62	10.15
11	57	10.72
12	71	11.04
13	57	10.68
14	112	11.11
15	30	10.03
16	110	10.31
17	20	10.66
18	122	9.82
19	107	9.98
20	93	10.58
Average Time Taken (s)		**10.39**

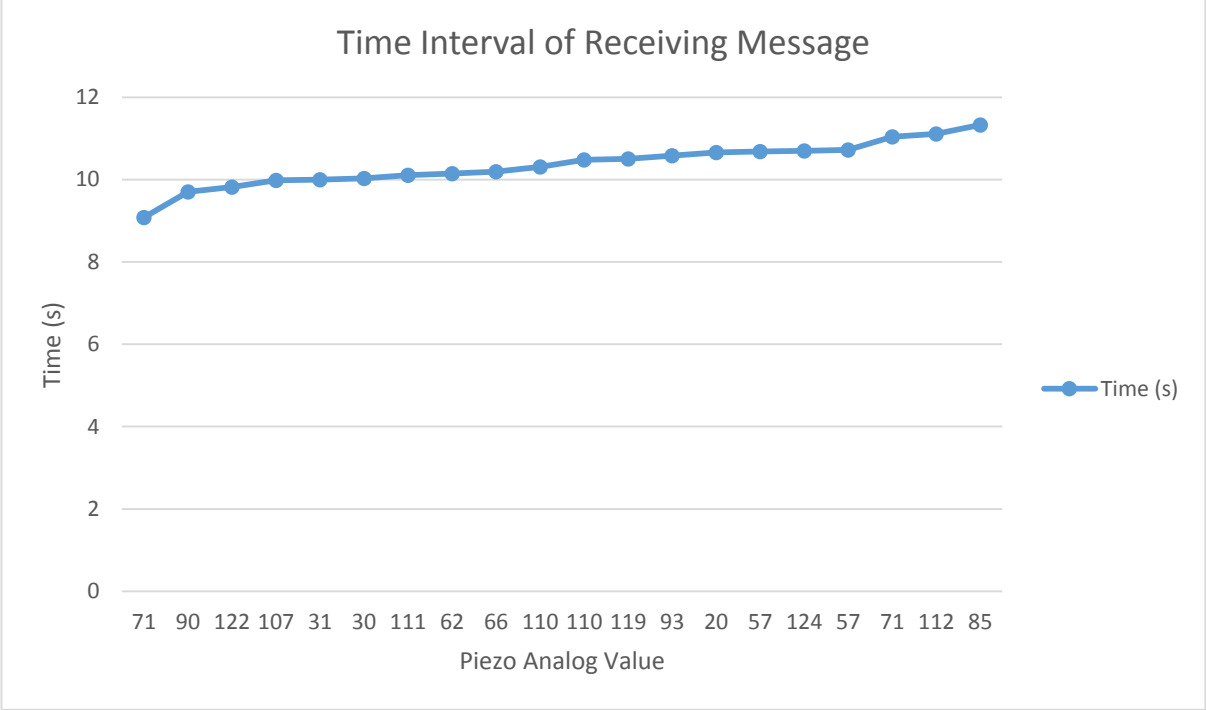


Figure 35: Graph for time interval of receiving SMS to the owner's mobile phone

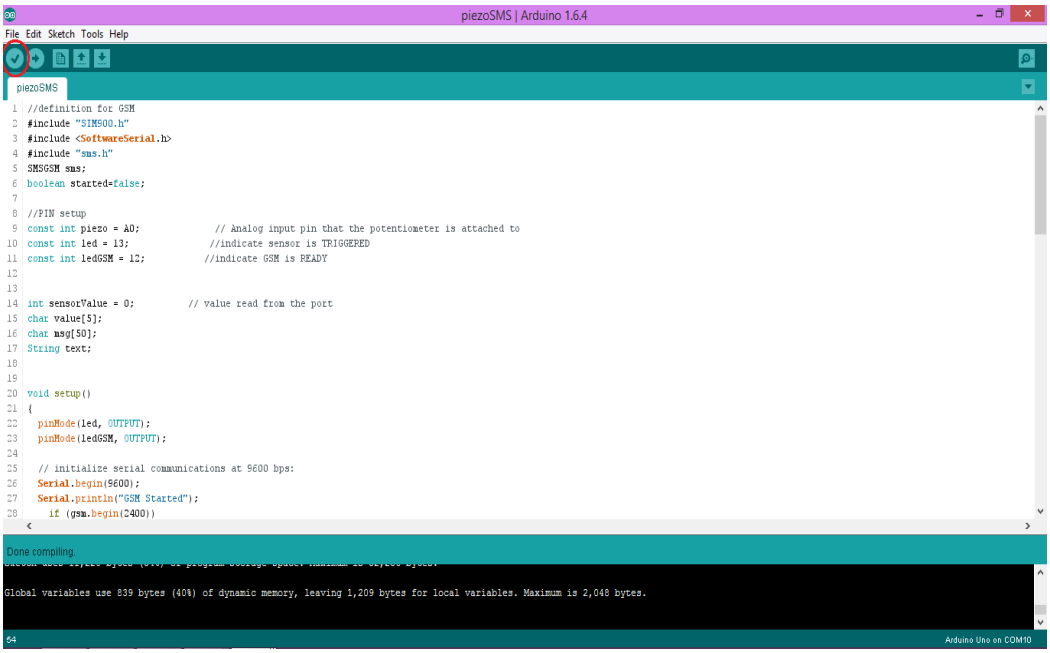
From the testing, Figure 35 shows that the graph of the time taken to receive SMS is almost constant. The range of the period for GSM to send SMS to the mobile phone is between 9 seconds to 12 seconds only. The difference between those values might be due to the strength of network connectivity and also human error in measuring the time taken using a stopwatch during the testing.

4.4.3 Distance of Sensor Detection

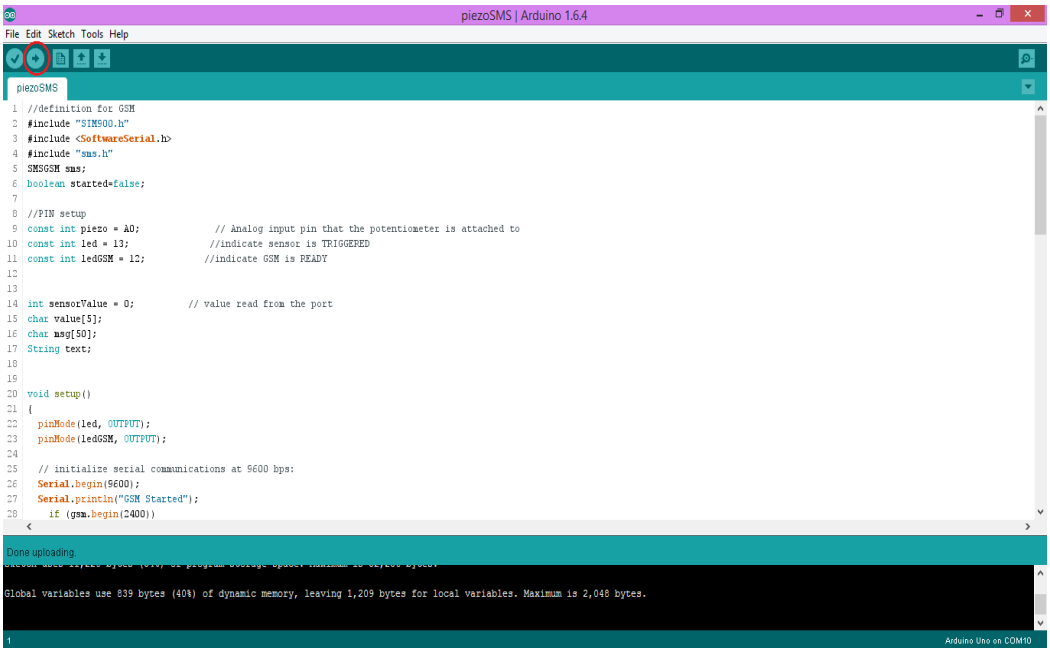
The purpose of this test is to identify whether the distance between the force impact points has effect on the value of the sensor. The further the vibration point from the sensor, the lesser the value of the recorded piezo analog value. The mass and the height of the load is fixed. Then, the load will be dropped to the point that have been marked at a different distance.

Procedure:

1) Verify the code to ensure there is no error.



2) Upload the code into the Arduino board.



3) Mark the point on the surface as well as mark the height of load to be dropped onto.
4) Record the sensor value for each distance.

Table 6: Distance of sensor detection.

Distance	Piezo Analog value	Average of Piezo Analog Value
5	144	135.33
5	140	
5	122	
10	139	109.67
10	126	
10	64	
15	62	91.33
15	65	
15	147	
20	44	51.33
20	53	
20	57	
25	21	35.33
25	39	
25	46	

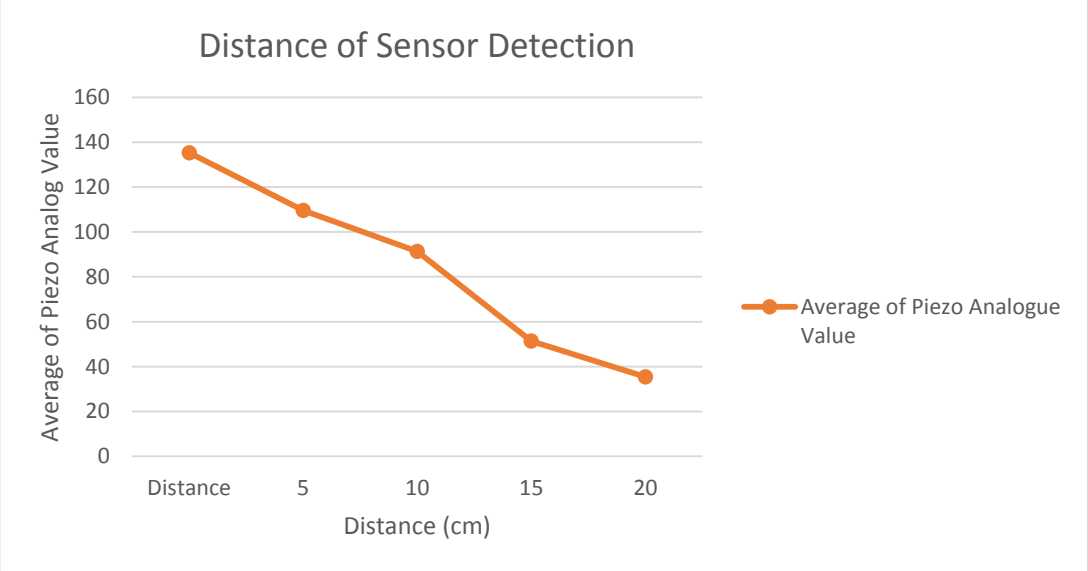


Figure 36: Graph for distance of sensor detection.

Figure 36 shows that if the distance between the sensor and impact pressure point is increased, the analog value is slightly decreased. The further the distance, the smaller the analog value of piezo sensor. This is because the sensitivity of the piezo sensor to detect vibration decreases if the impact pressure point increases. Other than that, the diameter of piezo sensor disc also influences the sensitivity of the sensor to detect the vibration produced. The size of the disc are 20mm, 27mm, 35mm and also 43mm as for this project we are using 20mm disc.

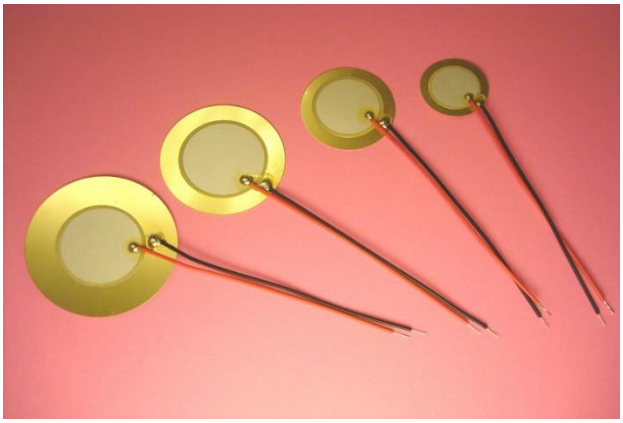


Figure 37: Different sizes of piezo sensor disc

4.4.4 Condition testing for sensor value

This test was conducted to study the value of each condition to detect a false alarm. The sensor was placed on the surface of the car window. Since the SMS that will be sent to the owner's mobile phone is the value that is generated from the sensor, the purpose for this test is to obtain the value for each different condition to avoid false alarm from being triggered easily.

Table 7: Reverberation condition testing is to gain the sensor value

Condition	Piezo Analog Value	Average Piezo Analog Value
Close car door	9	5.67
Close car door	4	
Close car door	4	
Open car door	45	63
Open car door	67	
Open car door	77	
Knocking the window	136	70.67
Knocking the window	41	
Knocking the window	35	
Alarm sound	1	2
Alarm sound	2	
Alarm sound	3	

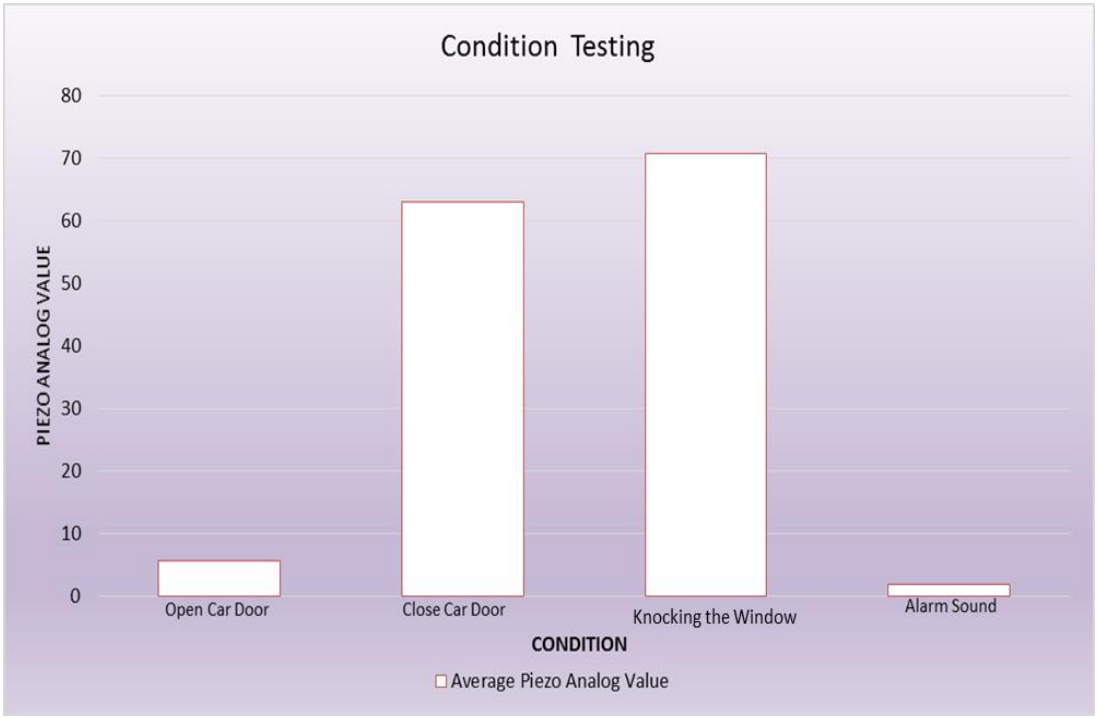


Figure 38: Graph of condition testing

From this test, all conditions above have shown the sensor value to be less than 100. This means that, the value 100 can be set up as the threshold in the coding. If the value is less than 100, the alarm will not be triggered and the SMS will not be sent. The purpose is to avoid false alarm from being triggered as it depends on the value of the sensor received from the reverberation. As proven in the first testing which is test force accuracy, Table 9 shows that the value of an attempt for intruders to crack the window is more than 100.

Summary

All test cases carried in this project are to obtain the threshold value of breaking the glass window to provide the user with information via SMS on whether an intrusion or some other possible factors have triggered the alarm. Moreover, it is also to differentiate between false or genuine alarm based on the value test result obtained in Section 4.4.1 and Section 4.4.4. Besides, test cases to test the sensitivity of the piezo sensor is to determine whether the sensor is suitable to use in this project or not. Based on the results, the piezo sensor shows high sensitivity and provide the analog output value whenever it detects vibration. Thus, the piezo sensor provides easiness to read its value through the serial monitor in Arduino environment. The time delay message conducted to identify the time taken to send SMS to the user so that we know the time taken is effective enough for the user to take quick action when the alarm is switched ON.

The experiment conducted with orderly procedure and handled with care. Most of the experiments are carried in the laboratory to ensure the accuracy result by using a specific equipment.

After carried out the test, there are few improvements can be done in order to enhance the alarm system. The improvement and recommendation proposed will further discuss in Chapter 5.

CHAPTER 5
CONCLUSION AND RECOMMENDATION

5 CONCLUSION AND RECOMMENDATION

In a conclusion, the proposed project title which is conceptual study and design of vehicle alarm notification system using GSM network is an attempt to build a low cost vehicle alarm system which can alert the owner of the vehicle by sending SMS to notify the owner. The ultimate purpose of this project is to avoid and prevent thieves from stealing cars or force break entry as well as to ensure the owner can take a quick action in order to safe their vehicle.

It is hoped that the content of this report will give benefits to all vehicle owners. The major advantage of this project is that it can be built with less amount of investment and also can be used in an automobile. It is a simple technology that could help control the theft rate at anywhere as long as there is a 2G signal coverage.

This project can be further enhanced by implementing a feature to control remotely the siren from far. It might be switched off remotely through the mobile phone as well as control the volume of the siren to avoid people around the vehicle to be distracted. Other than that, a feature of finger print detector of the intruder can also be implemented in the future work. Afterwards, this project would be also beneficial for the home automation system, security in the bank and parents to look after their children.

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