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The Time Efficiency and Effectivity Rate of GSM Sim800L-Integrated Arduino-based User-Dependent Speech Recognition System in Responding to Simulated Robbery Situations

A Research Presented to the Faculty of Senior High School
In Partial Fulfillment of the Requirements in Practical Research II

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Abstract

As robbery continues to be considered as one of the Philippines' major crimes, millions of Filipinos are falling victims to this misconduct. However, not only are an individual's money and possessions are at risk, but also their personal safety. For instance, one who does not comply with what a robber demands may be subjected to physical harm, and in worse situations, even murder. This creates a problem that inflicts fear in a national scale, which limits freedom and activities of the populace.

This study explored the time efficiency and effectivity rate of a GSM Sim800L-integrated Arduino-based User-Dependent Speech Recognition System when faced under a simulated robbery situation. The device took an average of 20.39 seconds to send an SMS message to a designated recipient when the voice stimulus was presented. It also showed a 66.67 percent effectivity rate, with eight (8) out of twelve (12) set-ups successfully responding.

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Chapter 1: The Problem and Literature Review

This chapter presents the synthesis of the conceptual framework to fully comprehend the research to be done and lastly the elaboration of terms which will be used for the better understanding of the study. This chapter also displays the related literature and studies regarding the topic after the well-aware and thorough search done by the researchers.

1.1 Background of the Study

A survey done by the Social Weather Station (SWS) on June 2018 states that around 1.5 billion Filipinos fell victim to common crimes during the first quarter of 2018. The conducted survey also showed that 6.6% of Filipino families reported victimization by crimes such as robbery, break-ins, car theft and physical violence. In December 2017, however, around 1.1 million families or 4.6% were victimized by street robbery. It was also shown that robbery is still one of the Philippines' major crimes.

As stated by the Philippine National Police, the police response time in the Philippines is still 15 minutes, which is a very long time for within this time period, criminals would be able to finish their job and would still have a fair amount of time to escape, leaving only minimal chances of them getting caught.

The main problem with robberies is that the victims fall into a state of panic and are not given enough opportunities to think about the situation, let alone to act. They also feel fear and simply just submit themselves to the robber and do as they are told.

The possible solution is to create something that can detect such situation and respond accordingly without the need of manual operation. Due to the rise of automation, a device can possibly be made even by students.

With the problem presented, the researchers aim to create a system that can possibly contribute to the solution through the integration of GSM Sim800L, Arduino Voice Recognition Module version 3.0 in an Arduino UNO Microcontroller-based Project. The device from the project will hypothetically determine such robbery situations and respond using a messaging alert system.

On behalf of the research, the researchers hope to lessen the response time it takes for the police to arrive in the said situations, increase the safety of the victim and the capture rate of the robber.

1.2 Conceptual Framework

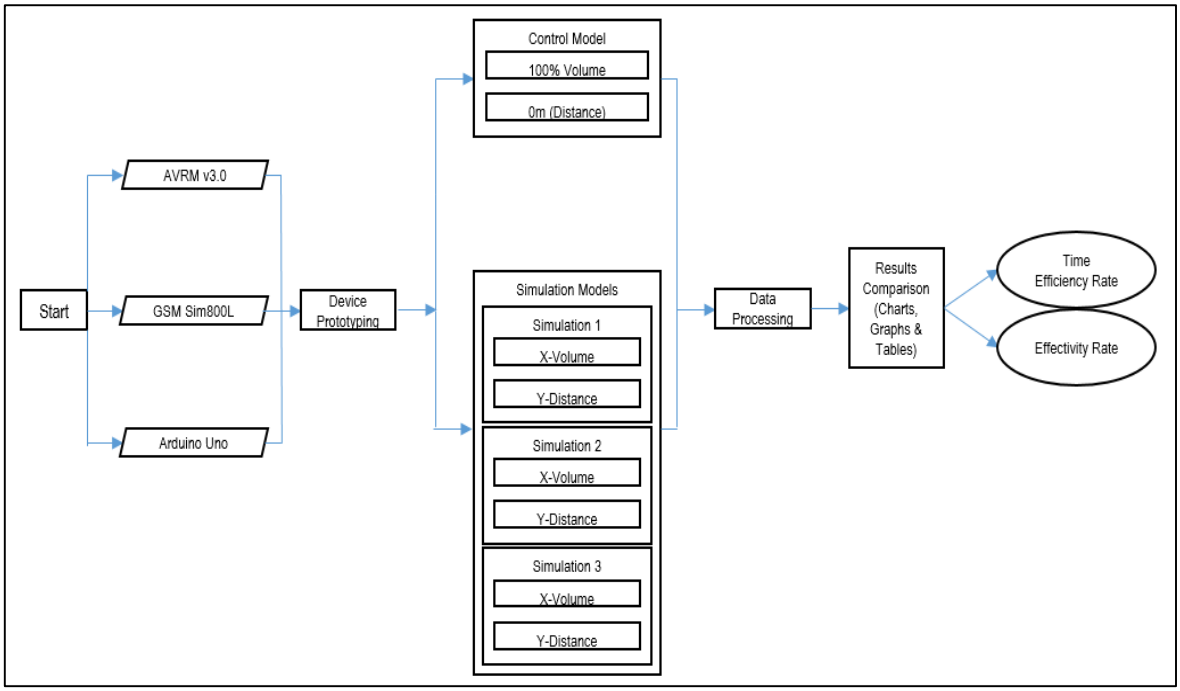


Figure 1. Logical Flowchart

The flow begins with the statement of the problem and background researches. The succeeding step is to gather helpful devices in consideration with the financial limitations of the researchers. Then, prototyping of the device wherein the researchers create a device that will hypothetically work. The prototype will undergo twelve (12) experimental models and one control model. All models are simulations that are capable of determining the device's time efficiency and effectivity rate in responding to the simulated situations. The boxes inside the models represent the variables present in the situations. After the experimentation, the data gathered will go through processing which will be simplified into charts, graphs, and tables to fully analyse results. The output of the framework is the efficiency and effectivity rate of the device in different simulation models.

1.3 Literature Review

Robbery in the Philippines

Defined as the use of threat or force to steal property from a person in public space, street robbery – also known as mugging – is a crime which is a major source of fear among public. Snatch theft differs from street robbery with the way it is performed; it is taking of one's property away without the employment of intimidation (Tompson, 2015). Additionally, Justia (n.d.) reported that robbery involves stealing the property of another from his or her person, or in their presence with the utilization of violence, intimidation, or threat which intends to deprive the victim of it permanently. It can only be considered a robbery if violence is used and if the crime occurred in the presence of the victim.

The Philippines, once considered the kidnapping capital of Asia, is said to have a relatively high crime rate, with theft being the most common crime. One of the reasons why thieves and pickpockets pervade the street is the Philippines having a cash economy – granting the criminals easy access to large amounts of money by stealing. Fortunately, according to the Philippine National Police (PNP), cases of robbery on 2018 in the Philippines had shown a drop of 32.38 percent from – from 16,076 to 10,870 on 2017.

Police Response Rate in the Philippines

Under the PNP budget proposal for the year 2014, the PNP guaranteed a 15-minute response time from the instance of receiving a crime report. This ensures the increase of police and car patrols by 25 percent as stated by Senate President Pr- Tempore Ralph Recto. Recto believed that the certainty of arrest can inhibit crime, but the police must be equipped with all the resources in order to stop and apprehend a criminal in the crime scene. The

PNP has a proposed budget of P72.1 billion in which 1.8 billion is provided for new vehicles and P925 million for other equipment (Sy, 2013).

In addition, according to the study of Research Directorate, Immigration and Refugee Board of Canada (2008), the PNP has reported an increase in police visibility, made use of foot patrol officers, established checkpoints, deployed motorcycle police, and undertaken night watch operators. The PNP also have an 88.37 percent in terms of crime solution efficiency. Moreover, PNP has been recorded to respond to 99.09 percent of crime incidents within a span of 15 minutes (Ayalin, 2019).

Survivability of victims

The probability of the survivability of a victim during a robbery incident is actually determined by how the victim acts during the situation, given that it is public knowledge how any criminal is expected and engaged to be ruthless and unpredictable. It is only a set of rare occasions when the victim is able to win the robber over, by persuasive conversation and "[using] self-defense weapons to protect themselves" (Fance, n.d). Therefore, it is important to take notes on what factors weigh these chances onto a safer end of the dichotomy, and how it should mitigate the gravity of such a traumatic moment.

Firstly, the survivability of a robbery victim is highly dependent on their obedience to the criminal. One must always be reminded that the money and valuables to be lost are more replaceable than the lives to be at stake when choosing to be defensive. Carefully and willingly following the instructions of the criminal will eventually lead to an exponential increase on the victim's chances of safety.

Another factor that will influence the victim's safety is the communication he or she offers to the criminal. The criminal must always be informed of what the victim is about to do, thus, offering no avenue for the criminal to be surprised and keeping the suspect from being doubtful. Based on an infographic of Cruz (2011), raising of hands and ensuring that robber will always see them will actually give him the assurance that the victim will do what is told, thus not compromising the victim's safety.

It is also necessary to keep watch on the victim's disposition during the incident when focusing on the victim's safety. Sudden volatile movements can easily trigger the criminal into causing harm to the victim; thus, it is highly recommended to stay very calm and watch one's self as well during an incident – careful not to imply that you might do something you weren't instructed as so. The Department of Public Safety of the United States of America stated in their article titled "What to Do During A Robbery" that the victim must "assure the robber [he/she] will cooperate and take no action that may jeopardize [his/her] safety. [He/she must not] make any quick or unexpected movements". Hence, keeping a calm facade is as important as obeying the robber's commands.

Aside from keeping watch of one's own safety, the victim must also take note of the details of the incident, most importantly of the robber himself, to be submitted during the filing of report to the authorities. The Department of Public Safety in the same article mentioned to memorize and estimate the suspect's race, age, height, hair, clothing, and unusual marks on their face or exposed parts of their bodies. It will also be helpful to mind where the criminal touches if his hands are exposed, what weapon he used for taunting, and the type, build and license plate number of the car used if there is such, given that in

the locale, there had been an increase of incidents of tricycle-aided robberies (ABS-CBN News, 2019).

Survivability of Victims in Correspondence to the Police Response Time

In 2014, Recto stated that the Philippine National Police had made a promise to reliably react to crime incidents within a time period of 15 minutes from the time they get the report.

In accordance with this, in a 2018 annual report of the Philippine National Police, it was demonstrated that they were able to respond to 99.09 percent of crime situations within their guaranteed reaction time of 15 minutes. Various news reports have additionally expressed that the 2018 total crime rates decreased by at least 9 percent. Records showed a total of 473,068 crime incidents in 2018, proving that was indeed 9.13 percent lower compared to the 2017 report with 520,641 total records. Furthermore, numerous reports from the PNP that focused on the eight major crimes including murder, homicide, physical injury, rape, robbery, theft and carnapping went down by a total of 28.14 percent – showing that 107,254 cases were reported in 2017 and 77,068 in 2018 (Tupas, 2018).

Anti-Crime Practices in the Philippines

As stated by ISSD-ITMS Development Team (2016), the PNP is devoted to protecting the Filipino's public safety and minimizing the fear and the incidence of crime in the community. However, every member of the society can reduce their chances of becoming a victim or the prevention of incidence of crime happening. The PNP urges the Filipinos to familiarize themselves with the information containing the crime prevention tips. Crimes take place because people let themselves and their families to criminal threats

most of the time. With the absence of security procedures and preservation of one's safety while at the streets, an individual is making himself an easy mark to the crooks. By acknowledging the presence of risks, it helps decrease the chances of being victimized. Crime prevention practices should start with themselves, their family and their home because it is their responsibility to preserve their own security.

Likewise, the PNP has a list of safety tips against crime occurring in the streets. First, they advise not to walk in dark streets, alleys and unsafe shortcuts especially if it's dark. Stay away from dark isolated places or vacant lots at night, these areas are hangouts of criminals and do not take chances. Second, they suggest to not walk between parked cars in parking lots. Avoid walking alone in unlit and uncertain places. At night, wait for buses, taxicabs or jeepneys in well-lighted areas. Lastly, when going to economically depressed areas (slums/squatter's area) communities, they recommend individuals not to wear expensive jewelry and carry substantial cash.

How technology improves security

Throughout the years, the advancement in technology has offered numerous assistances in terms of security. The proliferation of Closed-Circuit Television (CCTV) made the apprehension of wrongdoers easier. Nowadays, these CCTVs are still being constantly upgraded to include new features. For instance, in China, a software has been developed that will allow the said camera to identify the person under surveillance using the country's national identification database (Klein, 2008, as cited in Byrne & Marx, 2011)

Additionally, there are even more advanced devices such as the Occly Blinc – an easy-to-wear arm band that acts as a personal guard. It brandishes a number of features: four cameras providing a 24-hour monitoring, a panic button, a microphone and LED lighting for ensuring lasting viability (Smith, 2017). There are also a smartbike designed by VanMoof which sports a GSM tracking system. If stolen, the bike will be monitored and its location will be pinpointed by VanMoof's "bike recovery team"; they guarantee that the stolen bike will be returned to the owner within two weeks (Omar, 2016).

The said available technology are just some of the plethora of available devices that currently help people around the world respond to crime incidences. Given more time and place for growth, anyone can expect that these innovations will be further improved to produce a more efficient and effective version of themselves in the years to come.

GSM SIM 800L

SIM800L V2 5V GPRS Wireless Mobile has the ability to send messages, make a call or transfer data over GPRS. It has a dimension of (15.8 x 17.8 x 2.4 mm), designed to be compact and consume low power. SIM800L module supports quad-band GSM/GPRS network. It is also one of the most commonly used GSM modules, it is widely used by hobbyists and Arduino community. SIM800L 5v integrates Bluetooth, FM, and embedded AT features to save time and money. Global System for Mobile Communication (GSM) is a digital mobile network that is widely used by phone users all over the world. It is programmed with the use of Arduino. Arduino is an open-source electronic prototyping platform that enables users to create interactive electronic objects. SIM800L should be supplied at least 4.6 V to power up. The module consumes much of its power when searching for network, sending and receiving data from a network carrier.

GSM is the most used among the three digital wireless telephone technologies that includes TDMA and Code-Division Multiple Access (CDMA). GSM has four separated parts that work together to function. The four parts are the mobile device itself, the Base Station Subsystem (BSS), the Network Switching Subsystem (NSS), and the Operation and Support Subsystem (OSS). The Subscriber Identity Module (SIM) card in our mobile phones provides its network with identifying information about the user. After sending an SMS, the SMS will go to the BSS; it handles traffic between the mobile phone and the NSS. BSS is consisted of two main components: Base Transceiver Station (BTS) and the Base Station Controller (BSC). The BTS is responsible of communicating with the user's mobile phone with the use of transmitter receivers and antennas, while the BSC communicates with and controls a group of base transceiver stations. The Network Switching Subsystem (NSS), often called the "core network", tracks the location of the transmitter of SMS or calls to enable the delivery of cellular services. Basically, GSM compresses and digitizes data and sends it down a channel that contains two other streams of user data. GSM is responsible of transmitting Short Message Service (SMS) or calls and receiving it to another user. General Packet Radio Services (GPRS) is a packet-based wireless communication services that has an average date rates from 56 up to 114 Kbps and continuous connection to the Internet for mobile phone and computer users. It is based on the Global System for Mobile (GSM) communication and complements existing services such as Short Message Service (SMS). GPRS services cost users less than circuit-switched services since communication channel are being shares. Since GPRS has become more widely available, together with the development of 2.5G and 3G, mobile users have been able to access the private network and continuously over wireless connection.

Generally, GPRS is provides moderate-speed data transfer like SMS or phone calls and accessing private networks faster and continuously.

Arduino Voice Recognition Module V 3.0

Voice recognition is one of the techniques that facilitates natural and convenient human-machine interfaces. Voice Recognition Module V3 is a compact and simple to use speech recognition board; it analyzes and extracts voices of humans that are delivered into a machine or computer through microphones. It can be easily interfaced with the use of Arduino. This module contains HM2007, a single chip CMOS voice recognition module and an on-chip analog front end large scale integrated circuit with voice analysis, speech and voice recognition systems control process. HN2007 can be operated by either Manual of CPU control mode. In manual mode operation, HM2007 builds simple recognition system by connecting such component like keypad, SRAM of 8Kbyte memory, etc. If powered on, HM2007 will start an initialization process, if the WAIT pin is L, it checks external memory (8Kbyte SRAM) whether if it is perfect or not. If the user didn't use what is programmed, it will just skip the process. In manual operation, users can train the module with new patterns by clearing old ones. In the CPU control mode, there are several functions called RECOG, TRAIN, RESULT, UPLOAD, DOWNLOAD, RESET that are provided in this module. Moreover, this product is a speaker dependent voice recognition module. It supports maximum of 80 voice commands in all, but only seven voice commands could work at the same time. Any sound can be "trained" as command. User should train the module first before letting it recognize any voice command. It stores voice commands in a large group called library. This board has two controlling ways: Serial Port (full function) and General Input Pins (Part of function). The General Input Pins on the

board can generate several kinds of waves while corresponding voice command is recognized. According to MAKERLAB Electronics its recognition rate is 99% under ideal environment. It is powered by 4.5v to 5v. This module's digital interface is 5v TTL level for UART interface and GPIO and its analog interface is 3.5 mm mono-channel microphone connector with microphone pin interface. It has a dimension of 31mm x 50mm.

Arduino in Technological World

From innovated everyday objects to complex scientific instruments, Arduino has been the base platform for thousands of electronic projects over the course of its existence. A massive amount of free knowledge was created in the community with the help of creative makers. And since the collection of contributions is free to access, all can benefit from the community - from starters to professionals (Arduino.cc, n.d.).

As soon as the platform grew and became a wider community, it started changing to adapt to the other and more difficult demands. From the starting point of having an 8-bit boards, it has developed to make IoT-integrated, 3D printing, and embedded environments possible. (www.arduino.cc)

The flexibility and ease of the software makes it applicable for both beginners and advanced users. It is used in schools to build low cost scientific instruments, to create a simple experimentation model, or to get started in the field of programming and robotics. Interactive prototypes can be built to help architects and designers. Musicians and artists can also use it for installations and experimentations with new musical instruments. Makers obviously use it to create innovative projects to display at fairs (www.arduino.cc).

Arduino continues to influence the technological world we have today. Its useful information and its accessibility have made it as popular as it is right now. And with this, creators around the world gather in a single community that has one specific purpose - to enhance the life we have today through the use of free and easy technology.

Arduino as a Community

Arduino, in its nature, is an open source platform for electronics and technology - meaning everyone can use, develop, and integrate the platform for their own purpose. Because of its flexibility and wide scale application feature, many use it as their base platform in various technological works - and mostly in prototyping. (www.arduino.cc)

Both beginners and experts have access to a wealth of free resources and materials to support them. Users can look up information on how to set up their board or even how to code on Arduino.

The free resources and materials provided in the community are all accessible to the public. These can include the various tutorials on how to setup the board, the software, or how to code in the on Arduino. (www.circuito.io)

In this very idea, Arduino became a community where people contribute or share their knowledge with regards to the said platform.

Arduino as an Integrated Development Environment (IDE)

The Arduino IDE is identified as a cross-platform application that can run on top of Windows, MacOS, and Linux based operating systems. The programming language it uses is Java. The software is used to upload encoded programs into (but is not limited)

Arduino compatible boards (Electronics Weekly, 2018). As per stated in the latest software update (Arduino 1.8.9), due to the open-source feature of the software, writing and uploading codes to the board is made easier. (www.arduino.cc)

Arduino Microcontroller

According to Sparkfun, the Arduino Microcontroller is the physical board where programs are uploaded and sensors and actuators are connected for a specific purpose. Arduino makes different types of boards according to different purpose or capability. And because it is an open source hardware as well, others are allowed to innovate, modify, or produce models of the boards that can provide a different capability and functionality. Since there are multiple types of boards available, the one recommended for starters is the UNO - since it has got everything they need to get started. The said board has the following: 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a Universal Serial Bus (USB) connection, a power jack, a reset button and other components.

Furthermore, Circuito.io stated that connection via USB is used to communicate the Arduino board to the computer where it can access the Arduino IDE. As the user programs the board through the IDE, the board is given the capability of interacting with input and output component such as sensors, motors, and lights.

1.4 Research Problems and Hypotheses

The researchers considered multiple factors in order to determine the overall efficiency and effectivity of the device - such factors are speech recognition, time of

response, GPS function, and effectivity of each component. After careful considerations, the researchers aim to answer the following research questions:

1. The device is capable of performing the following:
    a. Speech Recognition
    b. SMS sending
    c. GPS Parsing
2. What is the mean response time of the device during the simulations?
3. What is the effectivity rate of the device based on the experiment?
4. In what simulation model does the speech recognition work better?

Considering previous and researched knowledge, the researchers hypothesize the following:

1. The device is capable of performing the following:
    a. Speech Recognition
    b. SMS Sending
    c. GPS Parsing
2. Null Hypothesis: The mean response time of the device during the simulation is less than or equal to sixty (60) seconds.

    Alternative Hypothesis: The mean response time of the device during the simulation is greater than sixty (60) seconds.
3. Null Hypothesis: The effectivity rate of the device during the experiment is equal to 100%.

Alternative Hypothesis: The effectivity rate of the device during the experiment is less than 100%.

4. The speech recognition works better in simulation model 4 (minimum distance, maximum volume)

1.5 Scope, Limitations, and Delimitations

The research will be integrating Arduino-based speech recognition system with GPS and GSM technology to invent a device capable of responding on simulated robbery situation.

The researchers will test the time efficiency and effectivity rate of the device - with consideration of factors such as speech recognition, response time, text alert system through GSM technology, and GPS parsing.

The researchers limit the study in terms of modules and electronic components used to cope up with the financial limitations.

1.6 Significance of the Study

The main purpose of the study is to explore the time efficiency and effectivity rate of GSM SIM800L-Integrated Arduino-based Speech Recognition System with the use of simulated robbery situations. In line with this, the researchers seek to find a potential solution to the problem stated above.

Philippine National Police. With the feasibility of being capable of sending SMS to the police, it can lessen their response time, allowing them to have a fair amount of time to catch the robber.

Students. Students owning the device can help protect them by informing the selected recipients of the SMS about their current situation.

Parents. The device aims to benefit the user's parents or guardians through informing them if the user is faced with a robbery situation.

Workers. This device will be beneficial especially to those employees or workers who work at night, for it will help them to feel safe even if they are commuting alone.

Future Researchers. The study will benefit future researchers who are studying in the same field by providing concrete quantitative results and recommendations.

Objectives:

The researchers carefully considered the processes that will be involved in the study and formulated specific objectives that the research will aim to attain. In this way the research will also be able to fulfill the significance presented above. Listed below are the said objectives:

1. Develop an Arduino-based device that can perform speech recognition, GPS parsing, and GSM function (text alert system).
2. Design multiple robbery simulation models that the device will undergo during the experimentation.

3. Analyse results and interpret the data gathered to determine the time efficiency and effectivity rate of the device.

1.7 Definition of Terms

Conceptual

Arduino Uno - a microcontroller board based on a removable, dual-inline-package (DIP) ATmega328 AVR microcontroller. (Arduino UNO. (n.d.). Retrieved July 2019, from https://www.pololu.com/product/2191.)

Arduino Voice Recognition Module (AVRM) v3.0 - a module designed by *elechouse* that can perform speaker-dependent voice recognition. (Elechouse.com)

Global Positioning System (GPS) - a satellite navigation system used to determine the ground position of an object. (Techterms.com)

GSM Sim800L - is a miniature cellular module which allows for GPRS transmission, sending and receiving SMS and making and receiving voice calls. (SIM 800L GSM/ GPRS MODULE. (n.d.) Retrieved July 2019, from https://nettigo.eu/products/sim800l-gsm-grps-module.)

Integrated Developmental Environment (IDE) - a software suite that consolidates basic tools required to write and test software. (Rouse, M., Gills, A., & Silverthorne, V. (2018, September). Integrated Development Environment. Retrieved July 2019, from https://searchsoftwarequality.techtarget.com/definition/integrated-development-environment.)

Microcontroller - a compact integrated circuit designed to govern a specific operation in an embedded system. (Rouse, M., & Shea, S. (2017, June). Microcontroller. Retrieved July 2019, from https://internetofthingsagenda.techtarget.com/definition/microcontroller.)

Parsing - breaking a data block into smaller chunks by following a set of rules, so that it can be more easily interpreted, managed, or transmitted by a computer. (BusinessDictionary.com)

SMS - stands for Short Message Service and is the most widely used type of text messaging. (What's the difference between SMS and MMS? (n.d.). Retrieved July 2019, from https://twigby.zendesk.com/hc/en-us/articles/115010624828-What-s-the-difference-between-SMS-and-MMS-.)

Speaker-Dependent Voice Recognition - operates by learning the unique, individual characteristics of a single person's voice, in a way similar to voice recognition. New users must first "train" the software by speaking to it, so the computer can analyse the way in which the person talks. This usually means users have to read a few pages of text to the computer before they can use the speech recognition software. (The Difference Between Speaker-dependent and Speaker-independent Recognition Software. (2016, May 4). Retrieved July 2019, from https://speechangel.com/2016/05/04/difference-speaker-dependent-speaker-independent-recognition-software/.)

Speaker-Independent Voice Recognition - designed to recognize anyone's voice, so it requires no device training. (The Difference between Speaker-dependent and Speaker-independent Recognition Software. (2016, May 4). Retrieved July 2019, from

https://speechangel.com/2016/05/04/difference-speaker-dependent-speaker-independent-recognition-software/.)

Operational

Durability - Assurance or probability that an equipment, machine, or material will have a relatively long continuous useful life, without requiring an inordinate degree of maintenance.

Effectivity Rate - It is defined as the proportion between the number of set-ups with a successful response from the voice stimulus and the total number of set-ups made for the experiment.

Portability - a state of an object/product to be easily transported from one place to another.

Response Rate - the time it takes for a mechanism or system to respond to a trigger.

Robbery - the crime of stealing from somewhere or someone.

Time Efficiency - the minimum time consumed for a particular function to happen.

Trigger - a value or phenomenon that reaches the threshold of variable/factor.

Chapter 2: Methodology

This chapter displays the methods, experimental design, statistical treatments, experimental preparations and pre-checkups, tryouts, and pre-analysis of data. This chapter is divided into two parts, namely Developmental Phase and Validation Phase. Developmental Phase focuses on the proper processes involved in developing the device while the Validation Phase focuses on the data gathering in the experimentation.

Developmental Phase

2.1 Introduction

The rate of efficiency has been one of the most comprehensively studied device characteristics of all time due to its huge implications in the modern technology world. There have been many efforts to accurately measure the entire content domain of time efficiency by carrying out trials on several factors that affect it. In the study, time efficiency pertains to the rate of speed that the device responds to a certain stimulus or trigger.

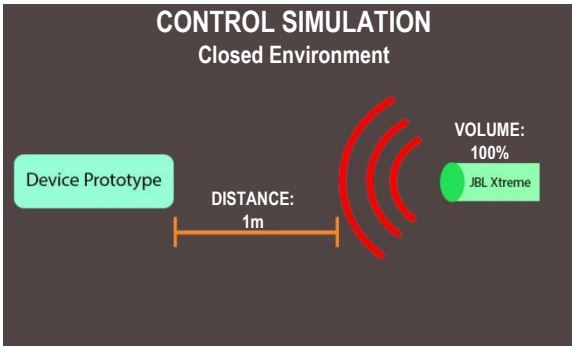
Another aspect that was extensively measured was the rate of effectivity. It is defined as the proportion between the number of set-ups with a successful response from the voice stimulus and the total number of set-ups made for the experiment.

In order to compute for the time efficiency, the researchers will get the mean of all the time inputs from the set-ups only that generated a response. Meanwhile, to get the effectivity rate of the device, the researchers will divide the total number of set-ups that resulted to a response by the total number of set-ups.

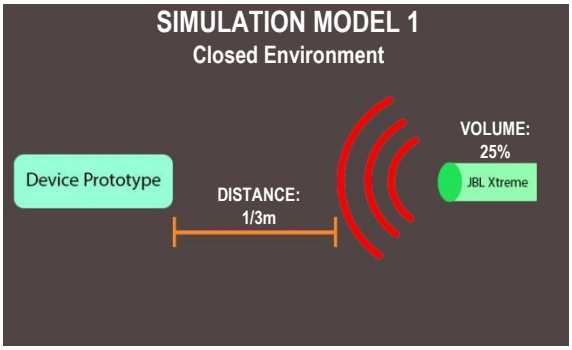
In this experimental research study, the researchers aim to measure the time efficiency and effectivity rate of GSM-Sim800L Integrated Speech Recognition System device which is its entire content domain. The researchers will test several factors of the device like its speech recognition, SMS sending, and GPS parsing. To test the device's speech recognition, SMS sending and GPS parsing, the researchers will simulate a controlled robbery situation which have two (2) variables altered (distance and volume of speaker), and the researchers will measure the device's capability picking up the phrases or words uttered by the criminal (pre-recorded speech and played through speaker), lastly, the researchers will measure out how long does the SMS and the GPS function operates. The objective of attaining the effectivity rate of the device is to ensure that the device will work in real-life situations. Meanwhile, the objective of getting the device's rate of efficiency is to know how fast the device will be able to respond during such situations.

2.2 Scaling Technique / Test Format

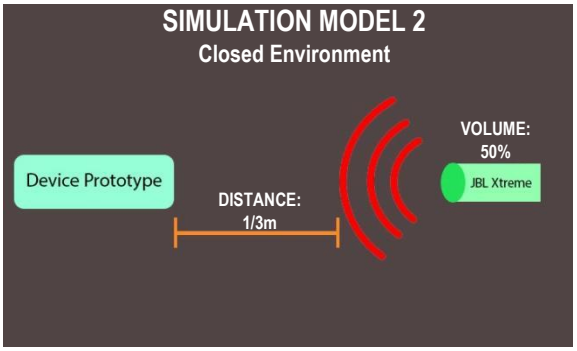
The device will be tested in different test environments. Each one differs in terms of distance from device to speaker and speaker volume. The researchers will set three (3) specified distances wherein the device will be tested in each distance with four different volumes: 25 percent, 50 percent, 75 percent and 100 percent. The graphical representations are as presented:



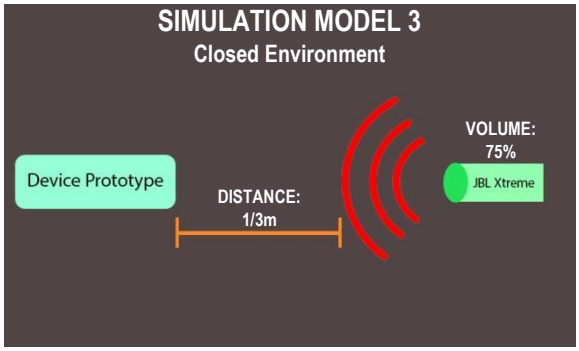
Control Model. Device at 1 meter distance under 100%



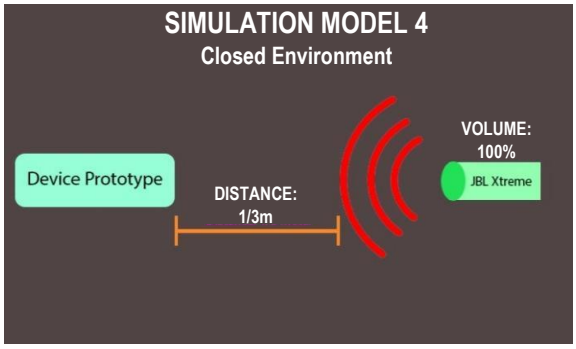
Simulation Model 1. Device at 1/3 meter distance under 25% volume



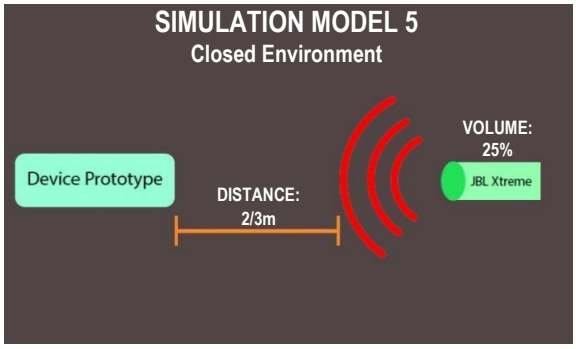
Simulation Model 2. Device at 1/3 meter distance under 50% volume.



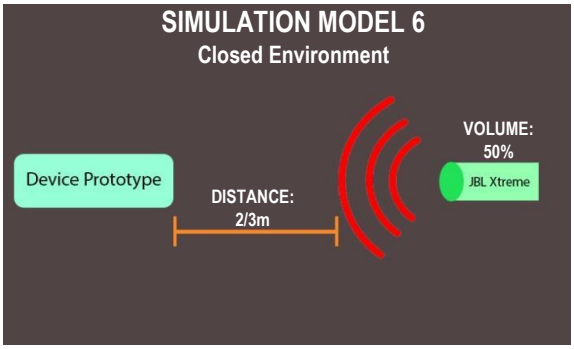
Simulation Model 3. Device at 1/3 meter distance under 75% volume.



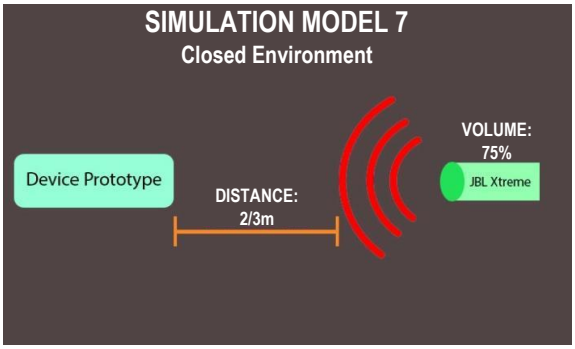
Simulation Model 4. Device at 1/3 meter distance under 100% volume.



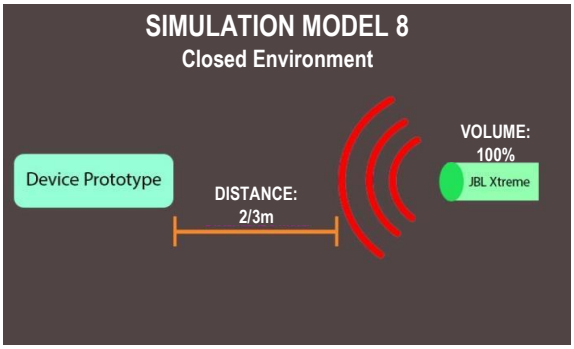
Simulation Model 5. Device at 2/3 meter distance under 25% volume



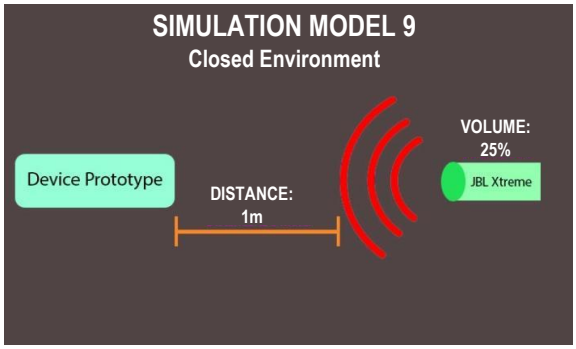
Simulation Model 6. Device at 2/3 meter distance under 50% volume



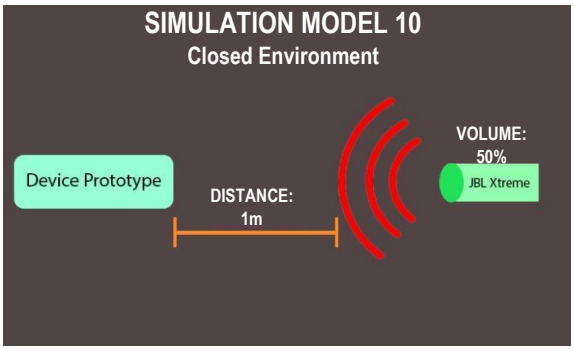
Simulation Model 7. Device at 2/3 meter distance under 75% volume.



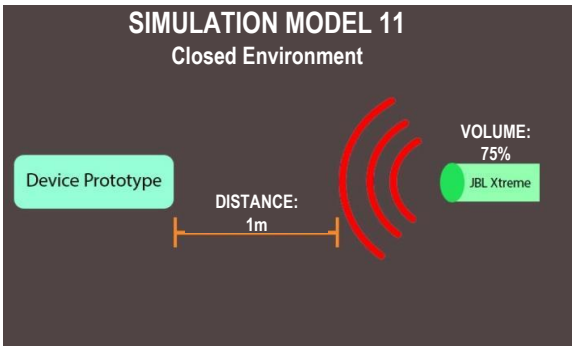
Simulation Model 8. Device at 2/3 meter distance under 100% volume.



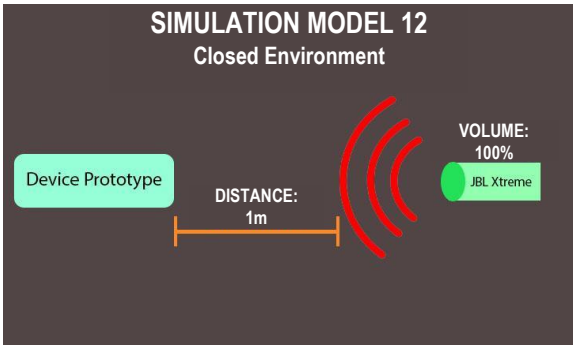
Simulation Model 9. Device at 1meter distance under 25% volume.



Simulation Model 10. Device at 1 meter distance under 50% volume



Simulation Model 11. Device at 1 meter distance under 75% volume



Simulation Model 12. Device at 1 meter distance under 100% volume.

Figure 2.1. Control and Simulation Models for the Experiment

These models will represent the entire set-up that will done for the first testing. As shown in the diagrams, the volume of the speaker and the distance of the speaker of the AVRM to the speaker varied per model. The data logging sheet will correspond to the model.

2.3 Statistical Treatment

In order to come up with a more accurate interpretation of data, the researchers applied the following statistical treatments:

Mean. A measure of central tendency that focuses on the weights of each score. Computed by taking the average score from the sample.

$$Mean = \frac{sum\ of\ all\ values}{number\ of\ values}$$

Standard Deviation. Determines the effect of the difference of each score to the mean.

$$\sigma = \sqrt{\frac{\sum(x - \bar{x})^2}{n}}$$

Effectivity Rate. The ratio of successful trials and the total number of trials, expressed in percentage.

$$Effectivity\ Rate = \frac{successful\ trials}{total\ number\ of\ trials}\ x\ 100$$

2.4 Item Writing (Table of Specs)

To develop the envisioned prototype device, the researchers determined the necessary parts that will serve as the constituents as well as the instruments that will take part in the experiment.

Device	Specification
Arduino UNO (See picture on the next page)	A microcontroller board based on the ATmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button.

	
Arduino Voice Recognition Module V3.0 	**QUICK SPECS:** Voltage: 4.5-5.5V Current: Digital Interface: 5V TTL level for UART interface and GPIO Analog Interface: 3.5mm mono-channel microphone connector + microphone pin interface Size: 31mm x 50mm Recognition accuracy: 99% (under ideal environment) **FEATURES:** Support maximum 80 voice commands, with each voice 1500ms (one or two words speaking) Maximum 7 voice commands effective at same time Arduino library is supplied Easy Control: UART/GPIO

	User-control General Pin Output
GSM SIM-800l 	**Functions:** Supports Quad-band 850/900/1800/1900 MHz, which can transmit voice calls, SMS messages and low power data. GPRS multi-slot class 12/10 GPRS mobile station Class B Compatible with GSM 2/2 + Class 1 (1 W 1800 / 1900MHz) Class 4 (2 W @ 850 / 900MHz) Bluetooth 3.0 + EDR compatibility FM: International band 76 ~ 109MHz, 50KHz correction level. Control over AT instruction set Voltage: 4.1 ~ 5VDC Operating Temperature: -40 ~ 85
JBL Xtreme (See picture on the next page)	**General Specifications** Output power (W): 2 x 20 Music playing time (9hrs): 15 **Speaker Specifications** Transducer: Woofer 2 x 63 mm

Audio Specifications

Signal-to-Noise Ratio: 80 dB

Frequency Response: 70Hz – 20kHz

Dimensions

Dimensions (in): 4.96 x 11.14 x 4.8

Dimensions (cm): 12.6 x 28.3 x 12.2

Weight (kgs): 2.11

Weight (lbs): 4.65

Control and Specifications

Bluetooth version: 4.1

Features

Powerbank: Yes

Splashproof: Yes

JBL Connect: Yes

Speakerphone: Yes

Bluetooth: Yes

3.5 mm audio cable input: Yes

	Auto-power off: Yes **Battery** Battery capacity (mAh): 10,000 Charging time (hrs): 3.5

2.5 Ethical Considerations

The researchers will be using open-source devices and software that are available for everyone. Due to the research being conducted in a controlled environment, the team believes that there will be no ethical issue that will be at stake performing the experiment.

Validation Phase

2.6 Item Review and Revision

Before starting the experimentation process, the researchers did a series of tests on the device to check for the following:

a. Do the metallic parts of the device display any presence of rust?
b. Does the device turn on and off?
c. Does the device send messages through the GSM SIM800L?
d. Does the device perform the GPS parsing?
e. Does the device perform voice recognition?

2.7 Pilot Testing / Testing No.1

To test the response rate of the device, it will undergo different set-ups that have varying volume of the speaker and distances between the device and the speaker. The table represents each testing set-up.

Model #	Distance	Volume	Time of Response	GSM Activated
0	0	100%	23.04 seconds	Yes
1	1/3	25%	Ø	Yes
2	1/3	50%	Ø	No
3	1/3	75%	Ø	No
4	1/3	100%	Ø	No
5	2/3	25%	Ø	No

6	2/3	50%	Ø	No
7	2/3	75%	Ø	No
8	2/3	100%	Ø	No
9	1	25%	Ø	No
10	1	50%	Ø	No
11	1	75%	Ø	No
12	1	100%	Ø	No

Table 2.2 Data Logging Sheet for Testing No. 1

2.8 Second Testing / Testing No. 2

Considering the previous results, the researchers have decided to change the data logging process to further see a more accurate and reliable results. The Number ofVoice-Command Repetitions was added to the revised data logging sheet.

The new column should be able to overcome the no-response dilemma. To standardize the process, the maximum number of voice-command repetitions should only reach 10 repetitions per model.

Model #	Distance	Volume	Time of Response	Number of Voice-Command Repetitions	GSM Activated
0	0	100%	15.92 seconds	1	Yes
1	1/3	25%	Ø	10	No
2	1/3	50%	20.60	4	Yes
3	1/3	75%	21.13	3	Yes
4	1/3	100%	19.50	1	Yes
5	2/3	25%	Ø	10	No
6	2/3	50%	20.30	7	Yes
7	2/3	75%	19.52	4	Yes

8	2/3	100%	20.78	1	Yes
9	1	25%	Ø	10	No
10	1	50%	Ø	10	No
11	1	75%	20.56	1	Yes
12	1	100%	20.70	3	Yes

Table 2.3 Data Logging Sheet for Testing No. 2

2.9 Potential Ethical Issues

The experiment will not be violating any ethical and moral issues, given that firstly, the processes involved promote the aims and values of research, and that the general public may trust in the impending results. The researchers shall be held accountable for the experimentation, and in the assurance that no moral and social issues are tampered with.

Chapter 3

Results and Discussion

This chapter encompasses the graphs and tables that contain the data of the experiments conducted by the researchers to test the efficiency of the device. This data will also be analyzed and interpreted to form conclusions to be discussed in the next chapter.

3.1 Test Results of Pilot Testing / Testing No.1

Model #	Distance	Volume	Time of Response	GSM Activated
0	0	100%	23.04 seconds	Yes
1	1/3	25%	Ø	Yes
2	1/3	50%	Ø	No
3	1/3	75%	Ø	No
4	1/3	100%	Ø	No

5	2/3	25%	Ø	No
6	2/3	50%	Ø	No
7	2/3	75%	Ø	No
8	2/3	100%	Ø	No
9	1	25%	Ø	No
10	1	50%	Ø	No
11	1	75%	Ø	No
12	1	100%	Ø	No

Table 3.1 Data Result Sheet for Testing No. 1

Figure 3.2 Graphical Representation for Testing No.1

From the set of results for the first testing, it can be inferred that in putting the device with zero distance against the speaker with 100% volume, only then can the GSM be activated. Any volume lower or distance higher than what is set for the control setup will make the device work under one repetition of testing.

3.2 Test Results of Second Testing / Testing No. 2

Model #	Distance	Volume	Time of Response	Number of Voice-Command Repetitions	GSM Activated
0	0	100%	15.92 seconds	1	Yes
1	1/3	25%	Ø	10	No

2	1/3	50%	20.60	4	Yes
3	1/3	75%	21.13	3	Yes
4	1/3	100%	19.50	1	Yes
5	2/3	25%	Ø	10	No
6	2/3	50%	20.30	7	Yes
7	2/3	75%	19.52	4	Yes
8	2/3	100%	20.78	1	Yes
9	1	25%	Ø	10	No
10	1	50%	Ø	10	No
11	1	75%	20.56	1	Yes
12	1	100%	20.70	3	Yes

Table 3.3 Data Result Sheet for Testing No. 2

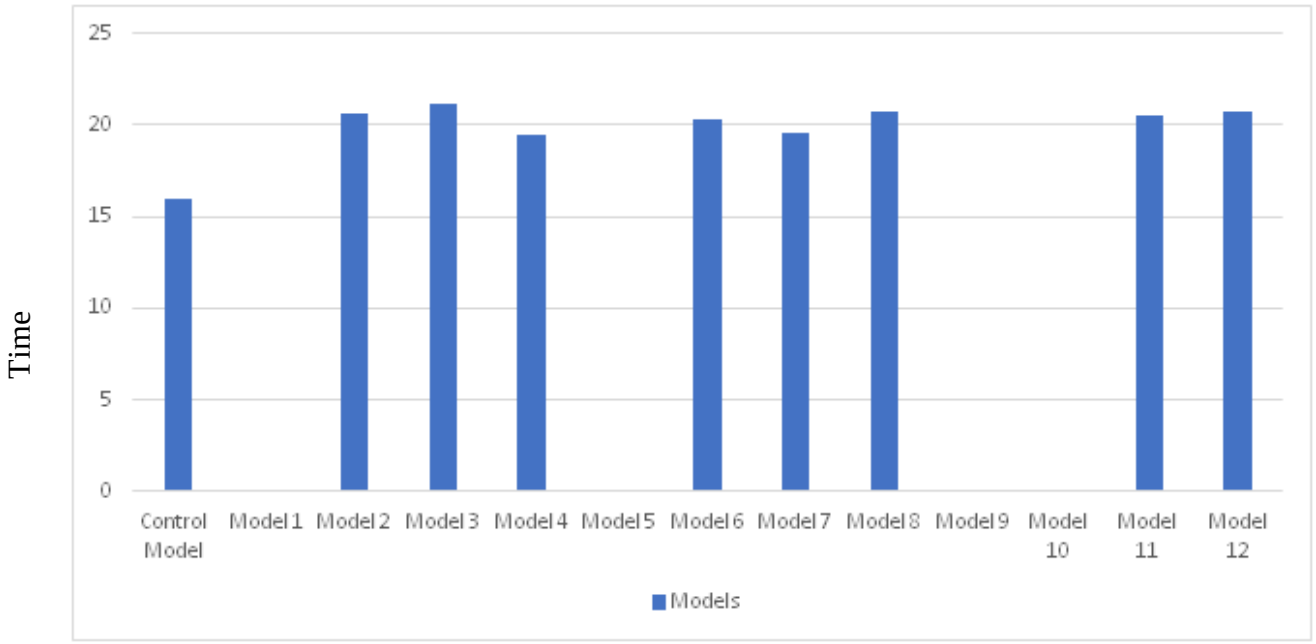


Figure 3.4 Graphical Representation for Testing No.2 (Model X Time)

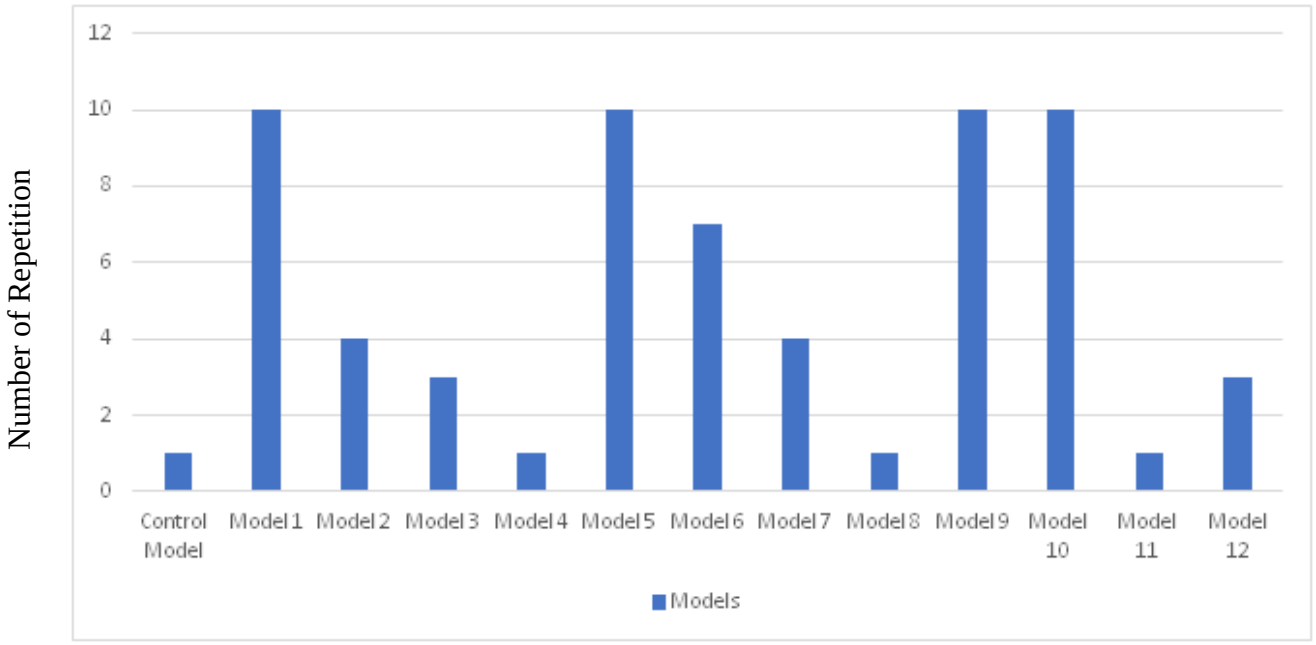


Figure 3.5 Graphical Representation for Testing No.2 (Model X Number of Repetition)

Model 0 (Control Model) took 1 repetition in order to respond, having 15.92 seconds of response time. The model also performed the message alert system.

Model 1 took 10 repetitions and still did not respond. The model also did not perform the message alert system.

Model 2 took 4 repetitions in order to respond, having 20.60 seconds of response time. The model also performed the message alert system.

Model 3 took 3 repetitions in order to respond, having 21.13 seconds of response time. The model also performed the message alert system.

Model 4 took 1 repetition in order to respond, having 19.50 seconds of response time. The model also performed the message alert system.

Model 5 took 10 repetitions and still did not respond. The model also did not perform the message alert system.

Model 6 took 7 repetitions in order to respond, having 20.30 seconds of response time. The model also performed the message alert system.

Model 7 took 4 repetitions in order to respond, having 19.52 seconds of response time. The model also performed the message alert system.

Model 8 took 1 repetition in order to respond, having 20.78 seconds of response time. The model also performed the message alert system.

Model 9 took 10 repetitions and still did not respond. The model also did not perform the message alert system.

Model 10 took 10 repetitions and still did not respond. The model also did not perform the message alert system.

Model 11 took 1 repetition in order to respond, having 20.56 seconds of response time. The model also performed the message alert system.

Model 12 took 3 repetitions in order to respond, having 20.70 seconds of response time. The model also performed the message alert system.

From the graphs translated from the table of values for the second testing of the device, it may be observed that the device doesn't respond under a 25% speaker volume, regardless of the distance of the device from the speaker. Under 50% volume, the device will respond with a distance less than 1 meter from the speaker. From these experiment results, it can be concluded that the smaller the distance of the speaker from the device, and the stronger the volume, the more efficient the device becomes in responding to the input.

The number of repetitions taken before the device responded also aligns with this interpretation. Model no. 6 follows the pattern, requiring seven (7) trials to make the device respond, in contrast to other models having 1-4 repetitions.

Chapter 4

Summary, Conclusion, and Recommendations

This chapter discusses the summary of the findings, conclusions, and recommendations suggested by the researchers based on the gathered data that have been analyzed and interpreted.

4.1 Summary

The researchers, after availing and working out with their components, successfully developed a device that has speech recognition and SMS-sending capability. GPS parsing however, was not brought in the final development of the device due to issues with the component used (GSM-SIM800l). The device was put under different set-ups to test its effectivity against a robbery situation using simulations. To do this, the researchers varied the distance of the speaker (JBL Xtreme) from the device, and also changed the volume of the speakers.

Having tested the device in all the set-ups, the researchers found that higher speaker volume and a shorter distance between the speaker and the device resulted in a successful response from it; the device was able to send an SMS message after recognizing phrase that was assigned to trigger the device. They discovered that there is only a small difference in the time it took for the successful set-ups to send an SMS message. The average time was 20.39 seconds with a standard deviation of 0.55 seconds.

Furthermore, they also observed that it took less attempts to get a response from set-ups that have higher volumes, regardless of the distance from the speaker.

4.2 Conclusion

The results provided by the experiment were analysed by the researchers in order to formulate conclusions. The conclusions, which were in lined with the research questions, are as follows:

1. The device is capable of performing the following:
    a. Speech Recognition
    b. SMS sending
2. The mean response time of the device during the simulations is 20.39 seconds, with a standard deviation of 0.55 seconds.
3. The effectivity rate of the device based on the experiment is 66 percent, from the experiment that consisted of twelve (12) set-ups.
4. The device worked better on set-ups / simulation models that have higher volumes of speaker than those with lower volumes.

4.3 Recommendation

The researchers considered the results and analyzed it carefully to form summary and conclusions. Though the experimentation gave a meaningful result, the researchers still came up with recommendations to improve the research and also the development of the device. Listed below are the following recommendations:

- For the device prototype, the researchers suggest that an improvement of the following is needed to achieve maximum effectivity:
    - From using a user-dependent voice recognition device, it is recommended to use a user-independent voice recognition device. This is to ensure that the trigger phrase will be detected by the prototype.
    - Instead of using GSM SIM-800L, it is recommended to use a more updated version of the device such as GSM SIM-900 to create a drastic drop in the time needed to send a message.
    - An addition of a GPS module is needed to reach the main goal of the device. This can also be achieved by using a GSM-GPRS device which is a combination of GSM and GPS function in one module.
    - A use of a smaller microcontroller board such as Arduino Nano is needed to achieve a more portable and aesthetic design.
    - Having a better quality of microphone will ensure that the device will recognize the trigger phrase.
- The researchers also suggest for future developers of the device to create a durable and portable casing, as well as consider a possible branding name.
- For the experimentation, the current researchers suggest to the future researchers to have a more detailed tests and a greater number of trials in order to reach a more accurate result.
- The researchers also suggest for future researches to consider having a more accurate simulation model.

- With the consideration of having a device that may have the potential to reach the market, the researchers suggest that the final draft of the device should be patented to avoid issues in commercialization.

Bibliography

ABS-CBN News (2019). Paggamit ng tricycle sa holdapan dumadalas: MPD. Retrieved from https://news.abs-cbn.com/news/06/27/19/paggamit-ng-tricycle-sa-holdapan-dumadalas-mpd on July 17, 2019.

Argete, G., Taeza M.G. & Villavicencio, J. (2016). General Safety and Crime Prevention Information. Retrieved from http://pnp.gov.ph/operations/622-general-safety-and-crime-prevention-information?fbclid=IwAR0NNV1P

Cruz, F. (2011). What to do during an armed robbery? ABS-CBN News. Retrieved from https://francinatra.tumblr.com/post/12198813757 on July 17, 2019.

Fance, C. (n.d). What to do during an armed robbery. Retrieved from https://www. lifehack.org/articles/lifestyle/what-during-armed-robbery.html on July 17, 2019.

Rouse, M. (2007, May). GPRS (General Packet Radio Services). Retrieved July 16, 2019, from https://searchmobilecomputing.techtarget.com/definition/GPRS

Rouse, M., & Mixon, E. (2019, March). GSM (Global System for Mobile communication). Retrieved July 16, 2019, from GSM (Global System for Mobile communication)

SIM800L V2.0 5V Wireless GSM GPRS MODULE Quad-Band MOD313. (n.d.). Retrieved July 16, 2019, from https://www.faranux.com/product/sim800l-v2-0-5v-wirelessgsm-gprs-module-quad-band/

SIM800L V2 5V Wireless GSM GPRS Module. (n.d.). Retrieved July 16, 2019, from https://www.makerlab-electronics.com/product/sim800l-v2-5v-wireless-gsm-gprs-module/

Voice Recognition Module. (n.d.). Retrieved July 16, 2019, from http://www.nskelectronics.com /voice_recognition_module.html

The Difference Between Speaker-dependent and Speaker-independent Recognition Software. (2016, May 4). Retrieved July 2019, from https://speechangel.com/2016/05/04/difference-speaker-dependent-speaker-independent-recognition-software/.

Voice Recognition Module V3. (n.d.). Retrieved July 16, 2019, from https://www.makerlab-electronics.com/product/sim800l-v2-5v-wireless-gsm-gprs-module/

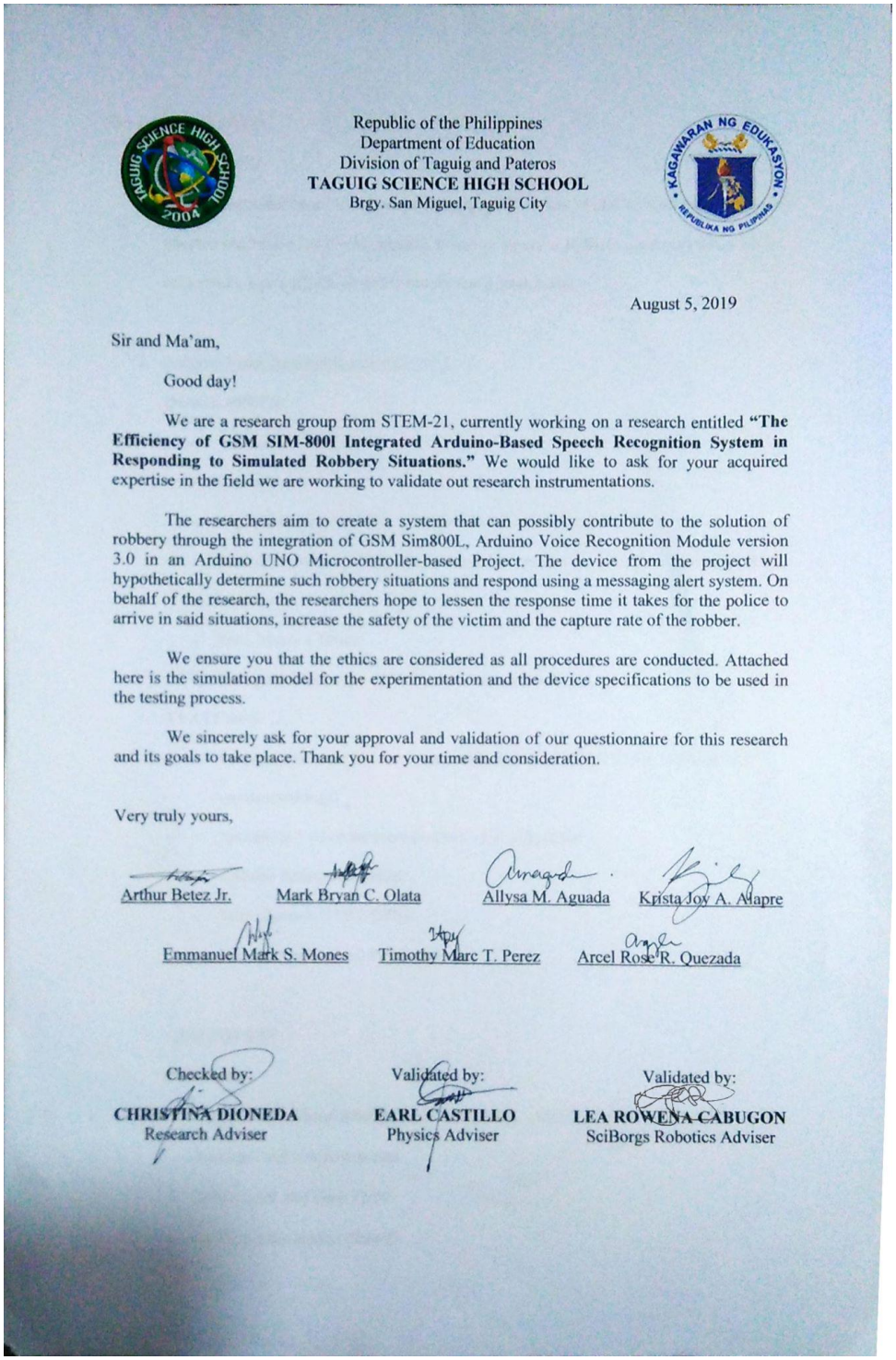
What is Arduino? (n.d.). Retrieved July 16, 2019, from https://www.arduino.cc/

What to Do During A Robbery. (n.d.). Safety Tips. Retrieved from https://dps.usc.edu/safety-tips/suspicious-activity/robbery/ on July 17, 2019. (n.d.). Retrieved July 16, 2019, from https://www.makerlab-electronics.com/product/voice-recognition-module-v3/.

Tupas, E. (2018). PNP: Total crime volume down in 2018. Retrieved from https://www.google.com/amp/s/www.philstar.com/nation/2019/02/26/1896714/pnp-total-crime-volume-down-2018/amp/

Appendices

Appendix A. Letter of Validation



Republic of the Philippines
Department of Education
Division of Taguig and Pateros
TAGUIG SCIENCE HIGH SCHOOL
Brgy. San Miguel, Taguig City

August 5, 2019

Sir and Ma'am,

Good day!

We are a research group from STEM-21, currently working on a research entitled **"The Efficiency of GSM SIM-800l Integrated Arduino-Based Speech Recognition System in Responding to Simulated Robbery Situations."** We would like to ask for your acquired expertise in the field we are working to validate out research instrumentations.

The researchers aim to create a system that can possibly contribute to the solution of robbery through the integration of GSM Sim800L, Arduino Voice Recognition Module version 3.0 in an Arduino UNO Microcontroller-based Project. The device from the project will hypothetically determine such robbery situations and respond using a messaging alert system. On behalf of the research, the researchers hope to lessen the response time it takes for the police to arrive in said situations, increase the safety of the victim and the capture rate of the robber.

We ensure you that the ethics are considered as all procedures are conducted. Attached here is the simulation model for the experimentation and the device specifications to be used in the testing process.

We sincerely ask for your approval and validation of our questionnaire for this research and its goals to take place. Thank you for your time and consideration.

Very truly yours,

Arthur Betez Jr. Mark Bryan C. Olata Allysa M. Aguada Krista Joy A. Alapre

Emmanuel Mark S. Mones Timothy Marc T. Perez Arcel Rose R. Quezada

Checked by:
CHRISTINA DIONEDA
Research Adviser

Validated by:
EARL CASTILLO
Physics Adviser

Validated by:
LEA ROWENA CABUGON
SciBorgs Robotics Adviser

Device Specifications

1. Arduino UNO

   A microcontroller board based on the ATmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button.

2. Arduino Voice Recognition Module V3.0

   QUICK SPECS:

   - Voltage: 4.5-5.5V
   - Current:
   - Digital Interface: 5V TTL level for UART interface and GPIO
   - Analog Interface: 3.5mm mono-channel microphone connector + microphone pin interface
   - Size: 31mm x 50mm
   - Recognition accuracy: 99% (under ideal environment)

   FEATURES:

   - Support maximum 80 voice commands, with each voice 1500ms (one or two words speaking)
   - Maximum 7 voice commands effective at same time
   - Arduino library is supplied
   - Easy Control: UART/GPIO
   - User-control General Pin Output

3. GSM SIM-800l

   Functions:

   - Supports Quad-band 850/900/1800/1900 MHz, which can transmit voice calls, SMS messages and low power data.
   - GPRS multi-slot class 12/10
   - GPRS mobile station Class B

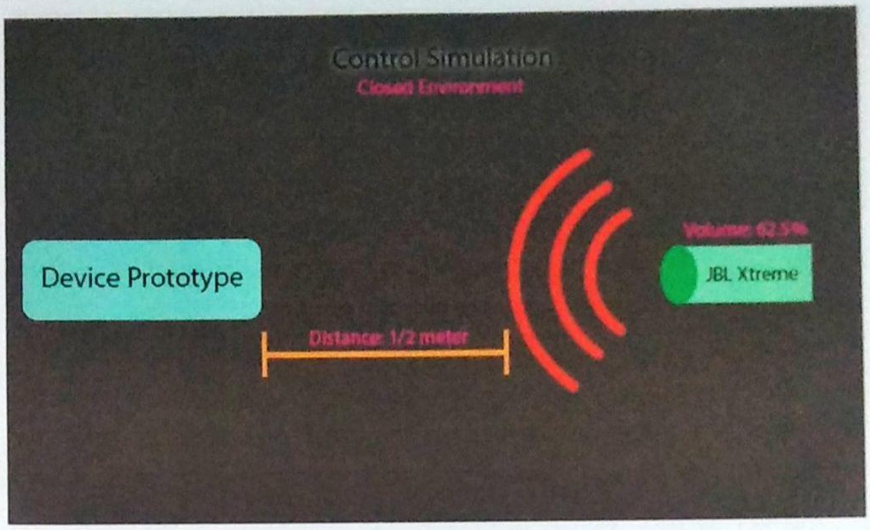
- Compatible with GSM 2/2 +
    a. Class 1 (1 W 1800 / 1900MHz)
    b. Class 4 (2 W @ 850 / 900MHz)
- Bluetooth 3.0 + EDR compatibility
- FM: International band 76 ~ 109MHz, 50KHz correction level.
- Control over AT instruction set
- Voltage: 4.1 ~ 5VDC
- Operating Temperature: -40 ~ 85

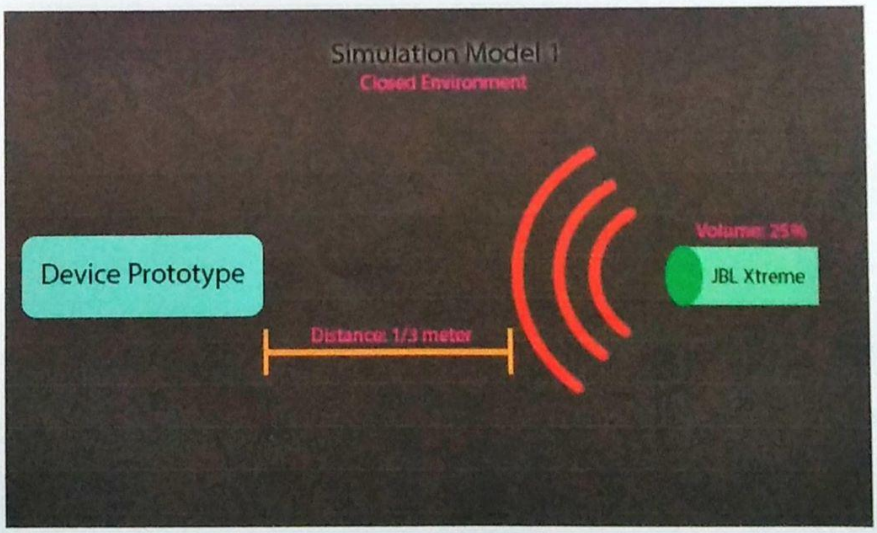
4. JBL Xtreme

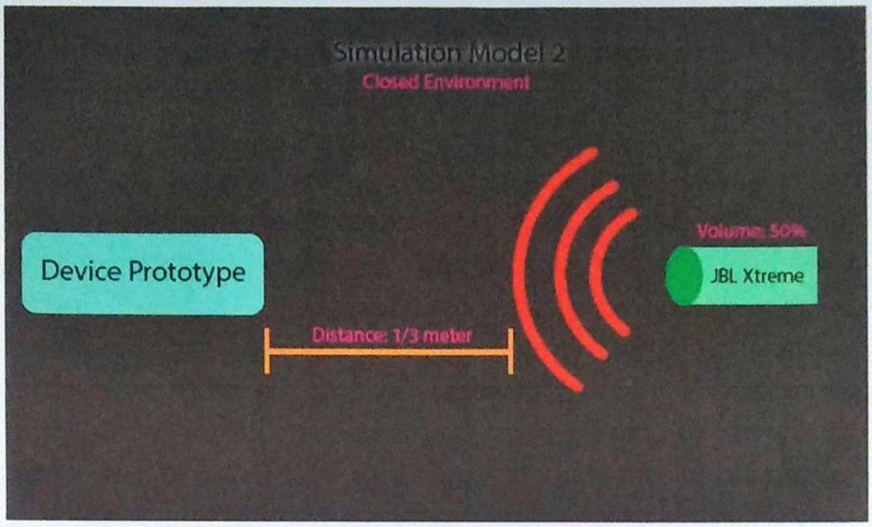
General Specifications		Audio Specifications	
Output power (W)	2 x 20	Signal-to-Noise Ratio	80 dB
Music playing time (hrs)	15	Frequency Response	70Hz – 20kHz
Speaker Specifications		**Dimensions**	
Transducer	Woofer 2 x 63 mm	Dimensions (in)	4.96 x 11.14 x 4.8
		Dimensions (cm)	12.6 x 28.3 x 12.2
		Weight (kgs)	2.11
		Weight (lbs)	4.65

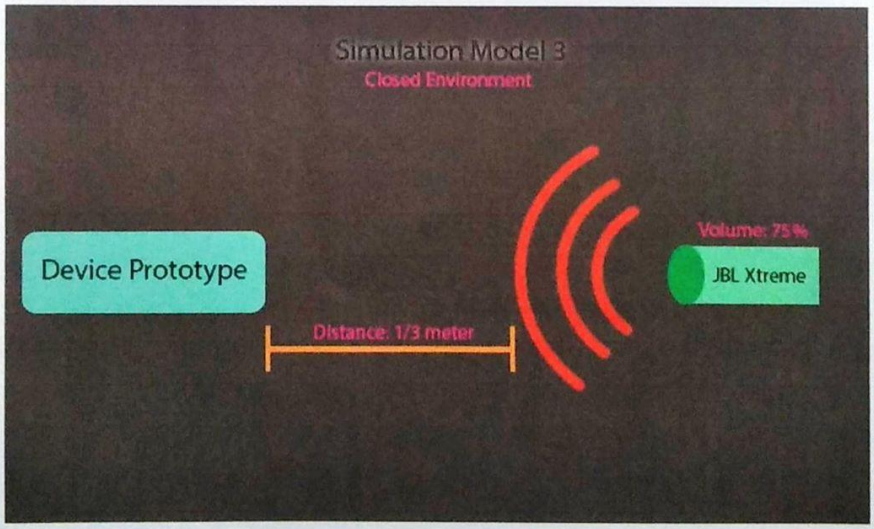
Control and Connection Specifications		Battery	
Bluetooth version	4.1	Battery capacity (mAh)	10,000
		Charging time (hrs)	3.5
Features			
Powerbank	Yes		
Splashproof	Yes		
JBL Connect	Yes		
Speakerphone	Yes		
Bluetooth	Yes		
3.5 mm audio cable input	Yes		
Auto-power off	Yes		

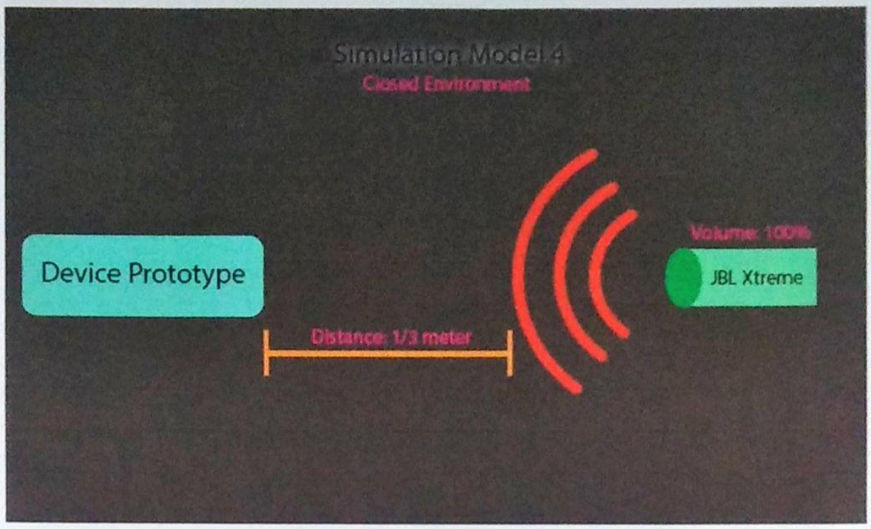
Simulation Models

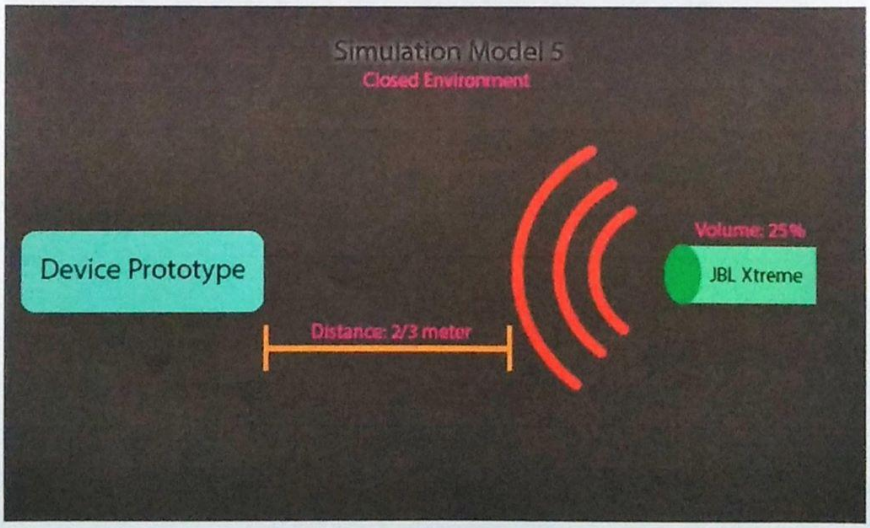


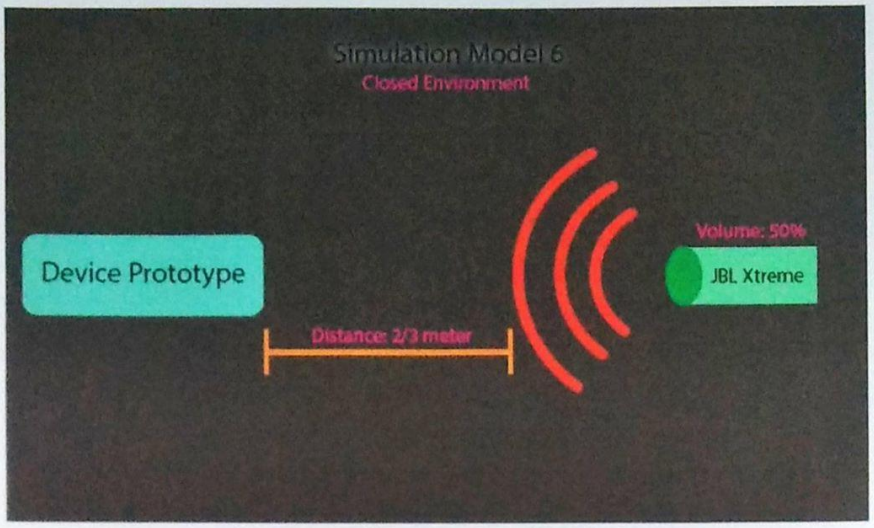


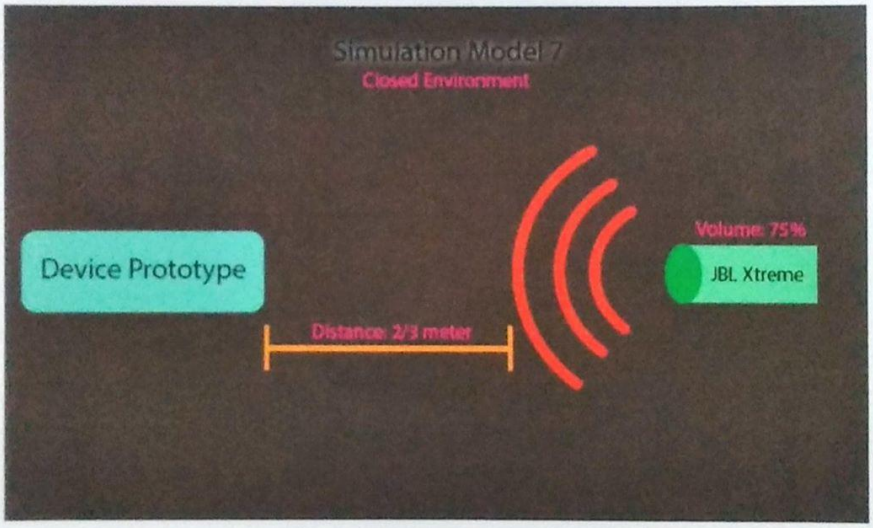

Simulation Model 2
Closed Environment
Device Prototype
Distance: 1/3 meter
Volume: 50%
JBL Xtreme

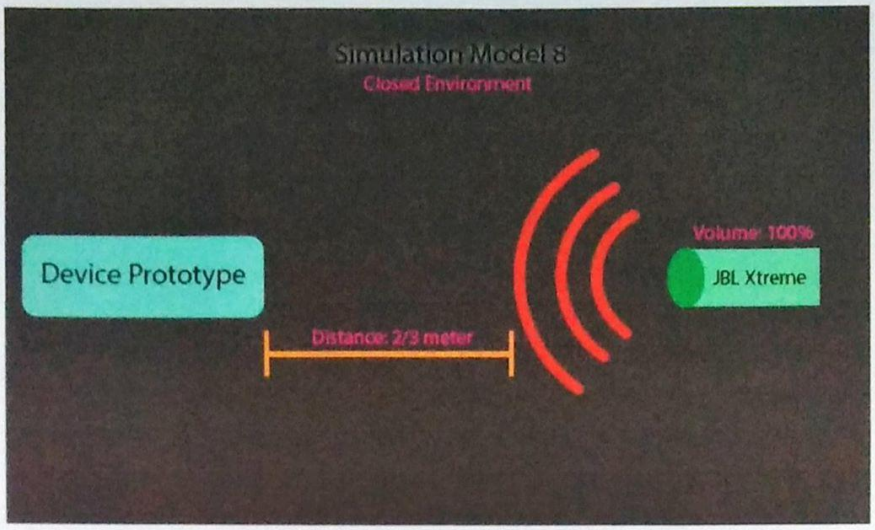

Simulation Model 3
Closed Environment
Device Prototype
Distance: 1/3 meter
Volume: 75%
JBL Xtreme

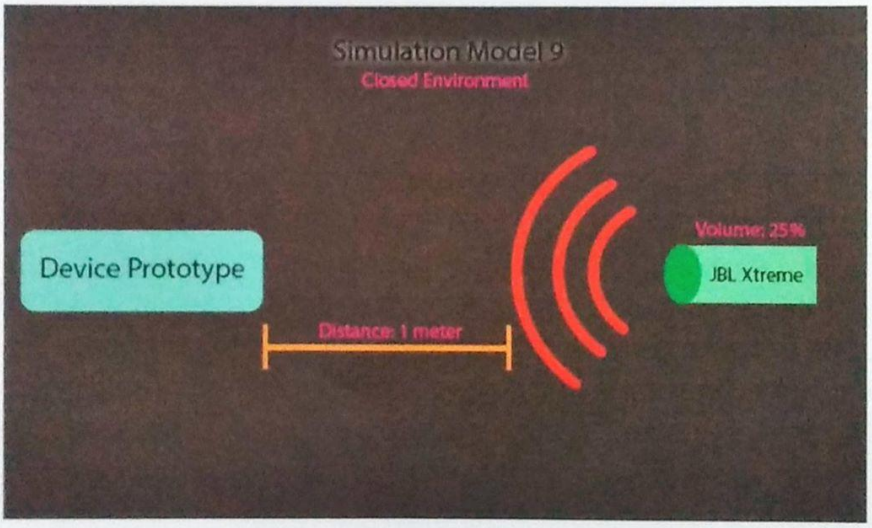

Simulation Model 4
Closed Environment
Device Prototype
Distance: 1/3 meter
Volume: 100%
JBL Xtreme

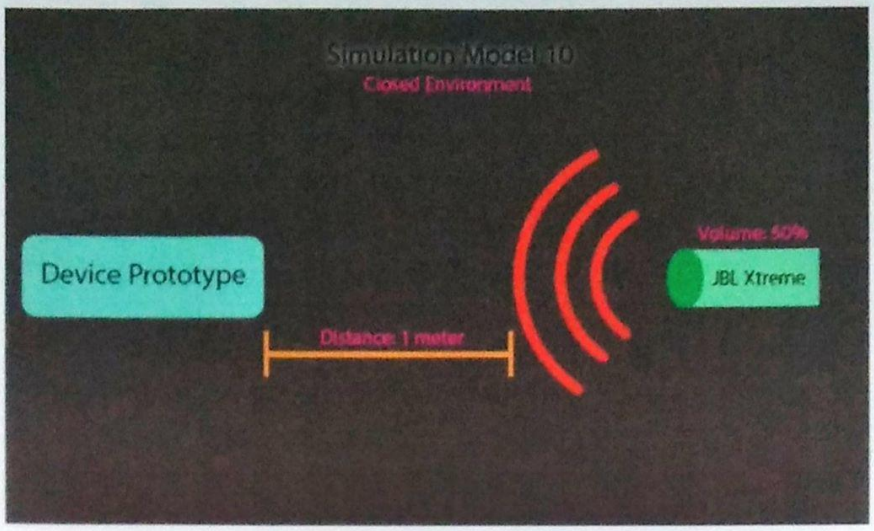

Simulation Model 5
Closed Environment
Device Prototype
Distance: 2/3 meter
Volume: 25%
JBL Xtreme

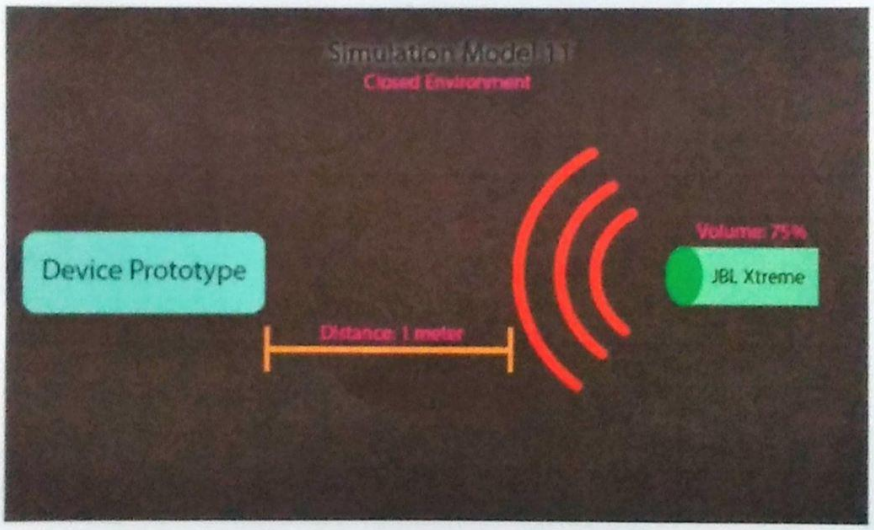

Simulation Model 6
Closed Environment
Device Prototype
Distance: 2/3 meter
Volume: 50%
JBL Xtreme

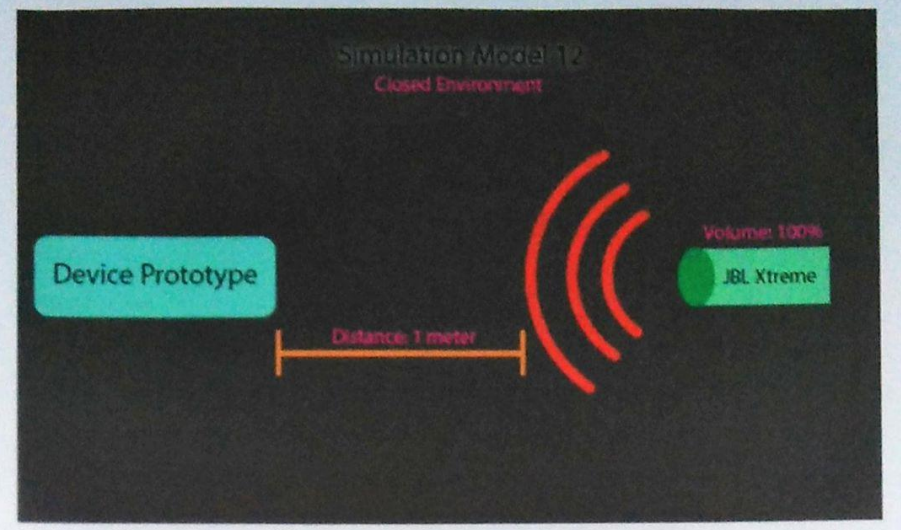

Simulation Model 7
Closed Environment
Device Prototype
Distance: 2/3 meter
Volume: 75%
JBL Xtreme


Simulation Model 8
Closed Environment
Device Prototype
Distance: 2/3 meter
Volume: 100%
JBL Xtreme


Simulation Model 9
Closed Environment
Device Prototype
Distance: 1 meter
Volume: 25%
JBL Xtreme


Simulation Model 10
Closed Environment
Device Prototype
Volume: 50%
JBL Xtreme
Distance: 1 meter


Simulation Model 11
Closed Environment
Device Prototype
Volume: 75%
JBL Xtreme
Distance: 1 meter


Simulation Model 12
Closed Environment
Volume: 100%
Device Prototype
JBL Xtreme
Distance: 1 meter

Appendix B. Tabulation of Data

C.1 Data Logging Sheet for Testing No. 1

Model #	Distance	Volume	Time of Response	GSM Activated
0	0	100%	23.04 seconds	Yes
1	1/3	25%	Ø	Yes
2	1/3	50%	Ø	No
3	1/3	75%	Ø	No
4	1/3	100%	Ø	No
5	2/3	25%	Ø	No
6	2/3	50%	Ø	No

7	2/3	75%	**Ø**	No
8	2/3	100%	**Ø**	No
9	1	25%	**Ø**	No
10	1	50%	**Ø**	No
11	1	75%	**Ø**	No
12	1	100%	**Ø**	No

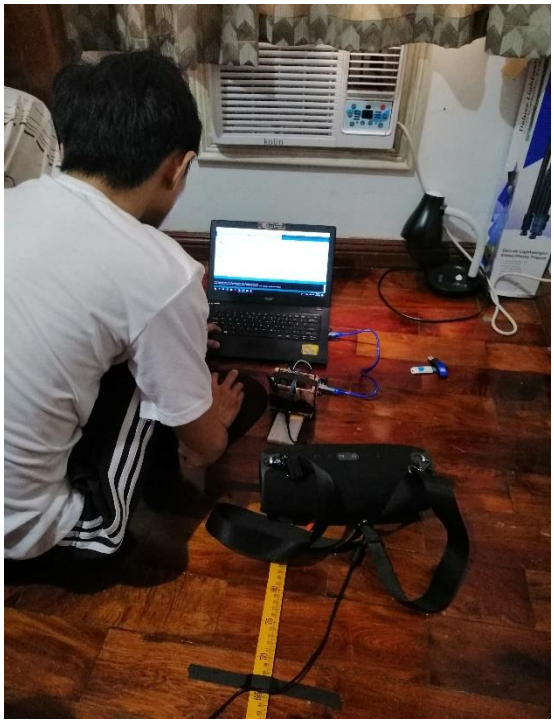
C.2 Data Logging Sheet for Testing No. 2

Model #	**Distance**	**Volume**	**Time of Response**	**Number of Voice-Command Repetitions**	**GSM Activated**
0	0	100%	15.92 seconds	1	Yes
1	1/3	25%	**Ø**	10	No
2	1/3	50%	20.60	4	Yes

3	1/3	75%	21.13	3	Yes
4	1/3	100%	19.50	1	Yes
5	2/3	25%	Ø	10	No
6	2/3	50%	20.30	7	Yes
7	2/3	75%	19.52	4	Yes
8	2/3	100%	20.78	1	Yes
9	1	25%	Ø	10	No
10	1	50%	Ø	10	No
11	1	75%	20.56	1	Yes
12	1	100%	20.70	3	Yes

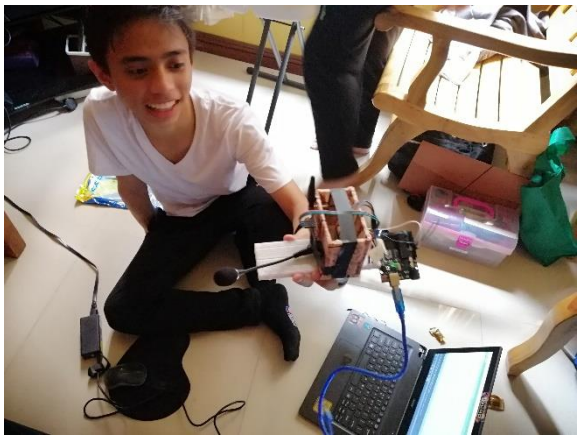
Appendix C. Documentation

KEEPING THE VARIABLES CONSTANT. The researchers set up both the measurement instrument and the speaker for the different control setups for the experiment

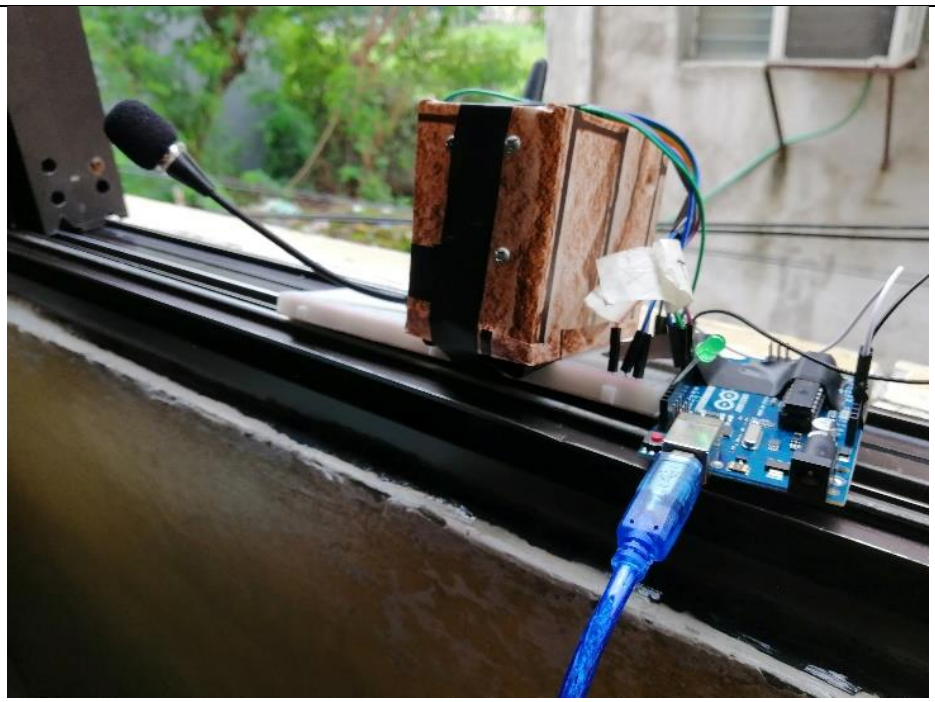


ON-SCREEN. One of the researchers set up the software components of the device for the experiment set-up.

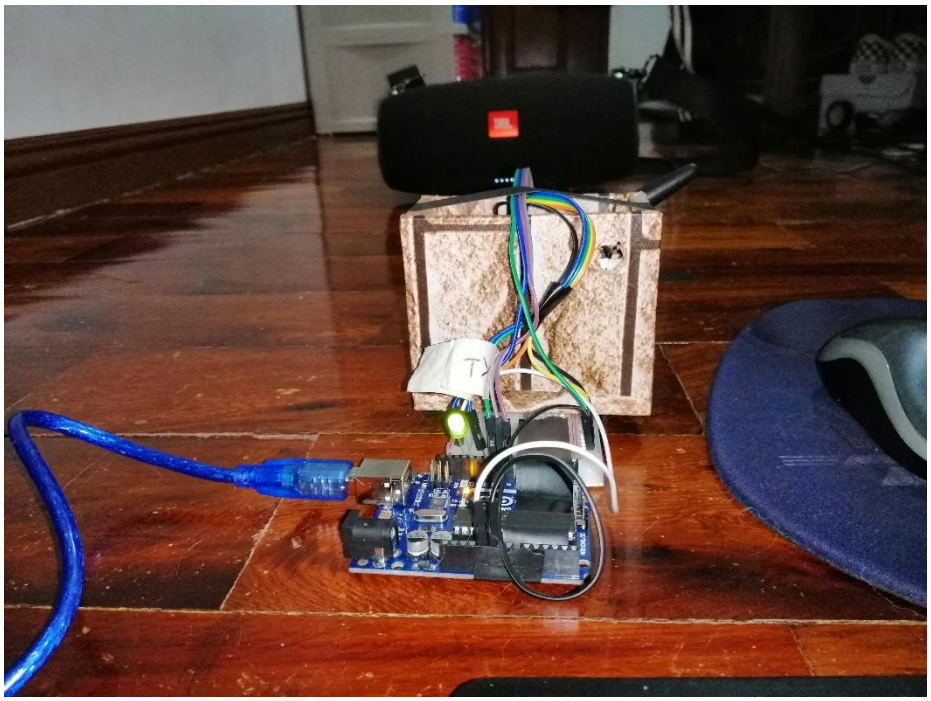
COLLABORATION. The researchers use their computers to encode the data gathered from the experiment.



A REWARDED SMILE. After the results have been gathered, the researchers show pride for their device once again.



THE DEVICE. After assembling the prototype, the device is now ready for experimentation.



ONTO EFFCIENCY. GPS parsing and signal trans-receiving tests were conducted before the actual experimentation.

Appendix D. Curriculum Vitae

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PERSONAL INFORMATION

GENDER	:	MALE
AGE	:	18
BIRTHDATE	:	AUGUST 13, 2001
RELIGION	:	ROMAN CATHOLIC
NATIONALITY	:	FILIPINO
CIVIL STATUS	:	SINGLE
LANGUAGE	:	FILIPINO, ENGLISH
SKILLS & INTEREST	:	LISTENING TO MUSIC

SPECIAL SKILLS

- KNOWLEDGE IN CIRCUITRY AND PROGRAMMING

EDUCATIONAL QUALIFICATIONS

- PRIMARY SCHOOL (2008-2014)
  EM's Signal Village Elementary School
- JUNIOR HIGH SCHOOL (2014-2018)
  Taguig Science High School
- SENIOR HIGH SCHOOL (2018-Present)
  Taguig Science High School (Science, Technology, Engineering, and Mathematics Strand)

ACHIEVEMENTS

- 23rd FIRA Robo World Cup China Open - Creative Category, Technical Award
- DOST Youth Excellence in Service Awardee, February 2019

CHARACTER REFERENCES

- Ms. Wilhelminah C. Estrada
  English Teacher at Taguig Science High School
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- Mrs. RechieBula
  Economics Teacher at Taguig Science High School
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PERSONAL INFORMATION

GENDER	:	MALE
AGE	:	16
BIRTHDATE	:	APRIL 29, 2003
RELIGION	:	BORN-AGAIN CHRISTIAN
NATIONALITY	:	FILIPINO
CIVIL STATUS	:	SINGLE
LANGUAGE	:	FILIPINO, ENGLISH
SKILLS & INTEREST	:	WRITING AND NUMERICAL SKILLS

SPECIAL SKILLS

- LEADERSHIP SKILLS
- KNOWLEDGE IN MUSICAL INSTRUMENTS

EDUCATIONAL QUALIFICATIONS

- PRIMARY SCHOOL (2008-2014)
  Pillar of Truth Educational Foundation, Inc. (2008-2011, 2012-2014)
  Jeffrey F. Konghun Special Education Centre (2011-2012)
- JUNIOR HIGH SCHOOL (2014-2018)
  Taguig Science High School
- SENIOR HIGH SCHOOL (2018-Present)
  Taguig Science High School (Science, Technology, Engineering, and Mathematics Strand)

ACHIEVEMENTS

- Division Schools' Press Conference and Contests 1st Place in Online Desktop Publishing
- Silver Medalist in the 2019 International Mathematics Wizard Competition
- Bronze Medalist in the 10th World Mathematics Team Competition

CHARACTER REFERENCES

- Ms. Myla Dignos
  Araling Panlipunan Teacher at Taguig Science High School
- Mr. Nikko Mediana
  MAPEH Teacher at Taguig Science High School

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PERSONAL INFORMATION

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BIRTHDATE	:	DECEMBER 3, 2011
RELIGION	:	JEHOVAH'S WITNESS
NATIONALITY	:	FILIPINO
CIVIL STATUS	:	SINGLE
LANGUAGE	:	FILIPINO, ENGLISH
SKILLS & INTEREST	:	READING BOOKS, WATCHING MOVIES

SPECIAL SKILLS

- WRITING ESSAYS, NEWS ARTICLES, AND FEATURE ARTICLES
- ABLE TO COOPERATE WELL WITH A TEAM
- WIDE KNOWLEDGE IN SCIENCE-RELATED SUBJECTS

EDUCATIONAL QUALIFICATIONS

- PRIMARY SCHOOL (2008-2014)
  EM's Signal Village Elementary School
- JUNIOR HIGH SCHOOL (2014-2018)
  Taguig Science High School
- SENIOR HIGH SCHOOL (2018-Present)
  Taguig Science High School (Science, Technology, Engineering, and Mathematics Strand)

ACHIEVEMENTS

- Division Schools Press Conference (2019), 1st Place
- Regional Schools Press Conference (2018), 1st Place
- Division Schools Press Conference (2018) 1st Place

CHARACTER REFERENCES

- Ms. Wilhelmina C. Estrada
  English Teacher at Taguig Science High School
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- Mrs. RechieBula
  Economics Teacher at Taguig Science High School
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PERSONAL INFORMATION

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BIRTHDATE	:	JANUARY 23, 2002
RELIGION	:	ROMAN CATHOLIC
NATIONALITY	:	FILIPINO
CIVIL STATUS	:	SINGLE
LANGUAGE	:	FILIPINO, ENGLISH
SKILLS & INTEREST	:	PLAYING, MOVIES, TV-SERIES

SPECIAL SKILLS

- WELL-ORGANIZED
- MICROSOFT OFFICE
- GREAT AT PROBLEM SOLVING

EDUCATIONAL QUALIFICATIONS

- PRIMARY SCHOOL (2008-2014)
  Kapitan Jose Cardones Memorial Elementary School
- JUNIOR HIGH SCHOOL (2014-2018)
  Taguig Science High School
- SENIOR HIGH SCHOOL (2018-Present)
  Taguig Science High School (Science, Technology, Engineering, and Mathematics Strand)

ACHIEVEMENTS

- Mathematics Data Boot Camp – 3rd Place
- With High Honors
- Principal's Lister

CHARACTER REFERENCES

- Mrs. Florencia J. Capoquian
  Teacher and Grade 10 Chairman, Taguig Science High School
  0919-426-1211
- Mrs. Joana Feliza Guevara
  Teacher and ICT Chairman, Taguig Science High School
  0948-265-3829

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PERSONAL INFORMATION

GENDER	:	FEMALE
AGE	:	17
BIRTHDATE	:	DECEMBER 5, 2001
RELIGION	:	ROMAN CATHOLIC
NATIONALITY	:	FILIPINO
CIVIL STATUS	:	SINGLE
LANGUAGE	:	FILIPINO, ENGLISH
SKILLS & INTEREST	:	LISTENING TO MUSIC

SPECIAL SKILLS

- MEMORIZING
- LIP READING

EDUCATIONAL QUALIFICATIONS

- PRIMARY SCHOOL (2008-2014)
  Kapitan Jose Cardones Memorial Elementary School
- JUNIOR HIGH SCHOOL (2014-2018)
  Taguig Science High School
- SENIOR HIGH SCHOOL (2018-Present)
  Taguig Science High School (STEM)

ACHIEVEMENTS

- Elementary - Salutatorian
- Junior High - With Honors, Principal's Lister
- Grade 11 - With High Honors, Prinical's Lister

CHARACTER REFERENCES

- Ms. Wilhelminah C. Estrada
  English Teacher at Taguig Science High School
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GENDER	:	FEMALE
AGE	:	16
BIRTHDATE	:	NOVEMBER 13, 2002
RELIGION	:	ROMAN CATHOLIC
NATIONALITY	:	FILIPINO
CIVIL STATUS	:	SINGLE
LANGUAGE	:	FILIPINO, ENGLISH
SKILLS & INTEREST	:	LISTENING TO MUSIC

SPECIAL SKILLS

- KNOWLEDGE IN CIRCUITRY
- FIXING BROKEN EARPHONES
- GOOD SENSE OF PROGRAMMING LOGIC
-

EDUCATIONAL QUALIFICATIONS

- PRIMARY SCHOOL (2008-2014)
  Saint Francis of Assisi College
- JUNIOR HIGH SCHOOL (2014-2018)
  Taguig Science High School
- SENIOR HIGH SCHOOL (2018-Present)
  Taguig Science High School (STEM)

ACHIEVEMENTS

- Elementary - 3rd Honorable Mansion
- Junior High - With Honors, Principal's lister
- Grade 11 - With High Honors, Prinicpal's Lister

CHARACTER REFERENCES

- Ms. Wilhelminah C. Estrada
  English Teacher at Taguig Science High School
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GENDER	:	FEMALE
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BIRTHDATE	:	SEPTEMBER 21, 2001
RELIGION	:	ROMAN CATHOLIC
NATIONALITY	:	FILIPINO
CIVIL STATUS	:	SINGLE
LANGUAGE	:	TAGALOG, ENGLISH
SKILLS & INTEREST	:	SINGING, MEMORIZING

SPECIAL SKILLS

- SINGING
- DANCING
- SPOKEN WORD POETRY

EDUCATIONAL QUALIFICATIONS

- PRIMARY SCHOOL (2008-2014)
  Taguig Elementary School
- JUNIOR HIGH SCHOOL (2014-2018)
  Coliling National High School
- SENIOR HIGH SCHOOL (2018-Present)
  Taguig Science High School (STEM)

ACHIEVEMENTS

- Sabayang Pagbigkasng El Verdadero Decalogo 2.0 (2018) First Place (Group)
- Oral Communication Interclass Competition (Champion), 2018
- Batch Valedictorian –Taguig Elementary School

CHARACTER REFERENCES

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