INNOVATE THE DEVICE THAT IMPROVES FOCUS FOR ADHD CHILDREN'S BY CONTROLLING TOY CAR USING BETA WAVE

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SEPTEMBER 2017

ENDORSEMENT

I hereby acknowledge that I have read this report and I find that its contents meet the requirements in terms of scope and quality for the award of the Bachelor of Electronic Engineering Technology (Medical Electronic) With Honours

Signature : .....

Name of Supervisor : .....

Date : .....

DECLARATION

I hereby declare that the final year project book is an authentic record of my own work carried out of one year Final Year Project for the award of Bachelor of Electronic Engineering Technology (Medical Electronic) With Honours, under the guidance of Rusnani Binti Yahya from 5 September 2016 to 29 May 2017.

Signature : .....
Name : AZWAN BIN ABBAS
Registration No. : 08UEU15F3003
Date : .....

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ABSTRACT

Attention Deficit Hyperactivity Disorder (ADHD) is a neurological condition (abnormality of the nervous system) that causes problems with inattention, hyperactivity-impulsivity. ADHD can diagnose by using Electroencephalography (EEG). EEG is a device that can use to detect abnormalities in brain waves, or the electrical activity of brain. Nowadays, have a similar device that same function with EEG that is Mindwave mobile. Mindwave mobile use to detect brainwave activity. This project is design a device that use to observe differences level of focus for ADHD and normal children. The device also use to train ADHD children to increase their focus similar like a normal children. The device is a combination toys car that control by using beta wave that produce from Mindwave mobile. This device use Arduino Uno as a microcontroller to operate the circuit of the device. This project prove that normal children's have a high concentration than ADHD children's, which percentage of focus normal children's range between 20% - 80%. However, for ADHD children's, their percentage between 15% - 27%. By using this device, we can observed a differences level of focus normal and ADHD children, this device can use as a tool to increase and improve focus of ADHD children's.

Keywords—Attention Deficit Hyperactivity Disorder (ADHD), Electroencephalography (EEG), Mindwave mobile.

ABSTRAK

Attention Deficit Hyperactivity Disorder (ADHD) adalah satu keadaan neurologikal (sistem saraf yang tidak normal) yang menyebabkan masalah dengan kurang memberi tumpuan, impulsivity-hyperactivity. ADHD boleh dikesan (diagnose) dengan menggunakan electroencephalography (EEG). EEG adalah alat yang boleh digunakan untuk mengesan kelainan pada gelombang otak, atau aktiviti elektrik dalam otak. Pada masa kini, terdapat peranti yang mempunyai fungsi yang sama dengan EEG iaitu Mindwave. Mindwave digunakan untuk mengesan gelombang otak, atau aktiviti elektrik dalam otak. Projek ini direkabentuk adalah untuk digunakan untuk melihat tahap perbezaan tumpuan ADHD dan kanak-kanak normal. Peranti ini juga digunakan untuk melatih kanak-kanak ADHD untuk meningkatkan tumpuan mereka sama seperti kanak-kanak normal. Peranti ini adalah kombinasi kereta mainan yang di kawal dengan menggunakan gelombang beta yang dihasilkan dari Mindwave. Peranti ini menggunakan Arduino Uno untuk mengendalikan litar peranti. Microsoft word excel digunakan untuk melihat hasil perbezaan kanak-kanak normal dan kanak-kanak ADHD dan juga untuk melihat peningkatan kanak-kanak ADHD selepas sesi latihan dilakukan dalam bentuk graf. Projek ini membuktikan bahawa kanak-kanak normal mempunyai daya tumpuan yang tinggi berbanding kanak-kanak ADHD, peratusan tumpuan kanak-kanak normal adalah antara 20% - 80%. Walau bagaimanapun, untuk kanak-kanak ADHD ini, peratusan daya tumpuan mereka antara 15% - 27%. Dengan menggunakan peranti ini, kita boleh diperhatikan tahap perbezaan tumpuan kanak-kanak biasa dan ADHD, peranti ini boleh digunakan sebagai alat untuk meningkatkan dan meningkatkan tumpuan ADHD kanak-kanak. Dengan menggunakan peranti ini, kita dapat melihat tahap perbezaan tumpuan kanak-kanak biasa dan ADHD, juga peranti ini boleh digunakan sebagai alat untuk meningkatkan daya tumpuan kanak-kanak ADHD.

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CHAPTER 1

INTRODUCTION

1.1 BACKGROUND OF STUDY

In the year 2007, Attention Deficit Hyperactivity Disorder (ADHD) has been a widely accepted that the disorder is common. It was estimated that Among the 3 and 5 percent of diagnosed with ADHD (Barkley, 1997; White, 1999).[1] This means that, in a classroom of 25-30 children, it is as possible that at least one would have ADHD. ADHD is diagnosed more often in boys than girls. Dr. Heinrich Hoffman is people who describe ADHD. Dr. Hoffman, a physician who wrote books on medicine and psychiatry has written a book of poems, complete with illustrations, about children and their characteristics. "Acts of Philip Restless" is the right description of a boy who had attention deficit hyperactivity disorder. There are previous studies involving children aged 5 to 15 years indicates that 4.3% from children have ADHD characteristics. Most of boys, but the cause cannot be identified although genetic factors and an imbalance of chemicals in the brain may contribute to this gap.[2]

Attention Deficit Hyperactivity Disorder (ADHD) is a neurological condition (abnormal nervous system) causes issues with your inattention, hyperactivity-impulsivity. ADHD consists of two main categories, namely a lack of concentration and hyperactivity-impulsivity. The first category of ADHD lack of concentration can be defined as the failure to pay attention to details, make careless mistakes, and avoid or dislike tasks that require mental effort. The second category of hyperactive-impulsive

ADHD can be defined as anxiety, difficulty staying seated or play quietly and difficulty participating in tasks that require taking turns.[3]

In this project is to innovate the device that improves focus for ADHD children's by controlling toy car using beta wave. This project also to identify the differences the concentration level between normal children and ADHD children. Furthermore, use as tool for train ADHD children's to increase their focus.

1.2 PROBLEM STATEMENT

ADHD or recognized as Attention Deficit Hyperactivity Disorder is a disorder that is on the development of the human brain that causes the sufferer to be hyperactive-impulsive, and difficulty concentrating. In this case, teachers only can see and monitor the ADHD children's concentration by the naked eye only with no equipment that can measure the concentration levels of the child accurately. Nowaday, its very difficult to find the device that can use to improve the concentration for ADHD children.

1.3 OBJECTIVES

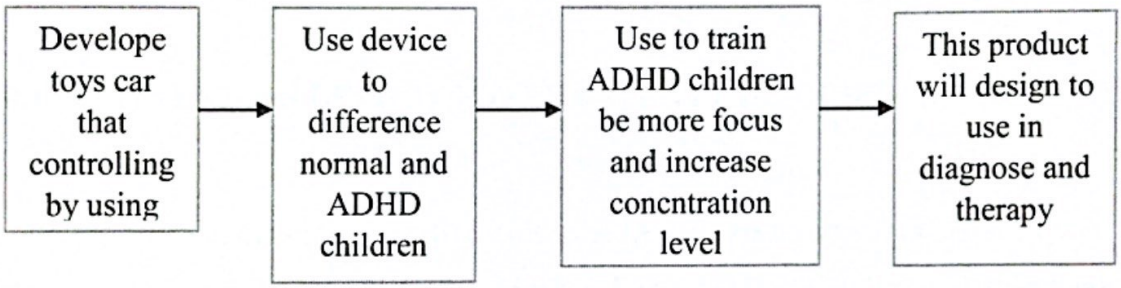
1. To innovate the device that improves focus for ADHD children's by controlling toy car using beta wave.
2. To study the differences of the concentration level between a normal child and ADHD child.
3. To train ADHD children be more focus and improve the concentration level.

1.4 SCOPE OF THE PROJECT

This project is to innovate the device that improves focus for ADHD children's by controlling toys car using beta wave. This project using survey form question to get information about the ADHD children and from the collecting data, do some analysis

to get the result. After innovate the device done, then get the subject. The target or subject for this survey is normal children's and AHD children's. The range of age between 7 - 10. Testing the device on the subject and analyse the result. Using this device, train the ADHD children's to more focus and improve the level of concentration same as normal children's.

1.5 SIGNIFICANT



CHAPTER 2

LITERATURE RIVIEW

2.1 ATTENTION DEFICIT HYPERACTIVITY DISORDER (ADHD)

Attention deficit hyperactivity disorder (ADHD) is an abnormal nervous system that cause disorder characterized by inattentiveness, hyperactivity, and impulsivity. Attention Deficit Hyperactivity Disorder (ADHD) is a condition that happened to some children's preschool and early the school or emerge before the age of 12. There are 3 characteristics of ADHD.[2][4]

The first characteristics is that Inattention Children's hard to give his full attention and get bored easily with assigned tasks. Focus and attention in earnest to prepare and equip task or learning something new is very difficult for children with ADHD. ADHD children are also forgetful with the tasks assigned and often lose things that they have.[2]

The second characteristics is hyperactive, which is constantly in motion and difficult to sit still, they are playing with whatever is in sight regardless of the danger of a thing, and talk incessantly. Sitting still during lessons at school is a difficult task for these children. They are always in a state of restless.[2]

The third characteristics is that Impulsive not think before they act. They often speak without thinking and often inappropriate to comment. ADHD children do not take into consideration consequences of their actions. Impulsivity it is difficult for them to wait for what they want the child or hit when they were as disappointed.[2]

2.1.1 What Cause Attention Deficit Hyperactivity Disorder (ADHD)

ADHD is traditionally be viewed as the problem associated with attention, which are attributable to the inability of the brain to filter out competing sensory inputs such as sight and sound. But, it is still unclear what the direct and immediate causes of ADHD, although scientific and technological advances in the field of neurological imaging techniques and genetics promise to clarify this issue in the near future. Researchers suspect that the cause of ADHD is genetic or biological Apart from the environment.[3]

In addition, some non-genetic factors have been linked to ADHD including premature birth, maternal alcohol and tobacco use, high levels of exposure to lead, and prenatal neurological damage. Although some of people claim that the food additives, sugar, yeast, or poor child a way to bring to ADHD, there is no conclusive evidence to support this belief (Barkley, 1998a; Neuwirth, 1994; NIMH, 1999).[3]

2.1.2 ADHD Cognitive Rehabilitation Exercises (Brain Training)

Cognitive Rehabilitation Training (Brain Training) may improve attention and concentration and other intellectual functions and self-control. Cognitive Rehabilitation exercises are often used to help those victims of stroke or head injury that have a significant defect in attention and concentration to improve their ability to concentrate and pay attention. This approach also has been used for children with attention deficit disorder and success. Repeated use

of a simple concentration exercises can help children to train their brain to focus and pay attention for longer periods of time.[5][6]

One of the ADHD Cognitive Rehabilitation Exercises (Brain Training) is using computer as a tool to training children's with a range of age between 7 – 11 year olds. Kerns found that direct interventions aimed at improving attention may be a valuable treatment option for improving cognitive efficiency in children with ADHD and warrant further investigation.[7]

In a training program for working memory, Klingberg found that working memory can improved ADHD focus and concentration. This training also improves response inhibition and reasoning and resulted in a reduction of the inattentive symptoms of ADHD. Cognitive rehab exercises in the form of games designed also can improve attention, concentration, memory and executive functioning through repetitive practice. [5]

2.2 BRAINWAVE

Generally, the human brain has the same structure as the other mammals. The brain is the most complex part of the human body. Activity in the brain is measured in Hertz (Hz). This is a very important organ for intelligence, senses, body movements and behaviours that depend on it. Brainwave divide into 4 type, namely Delta (1–4 Hz), Theta (4Hz-8HZ), Alpha (8–12 Hz) and Beta (12–30 Hz). Alpha waves are associated with the relaxed and calm state while associated with the Beta wave thoughts busy, focused and alert. Delta waves are the slowest band of brainwaves, which are associated with deep sleep and Theta waves are associated with deep relaxation.[8] Brain waveform is shown in figure 2.1.

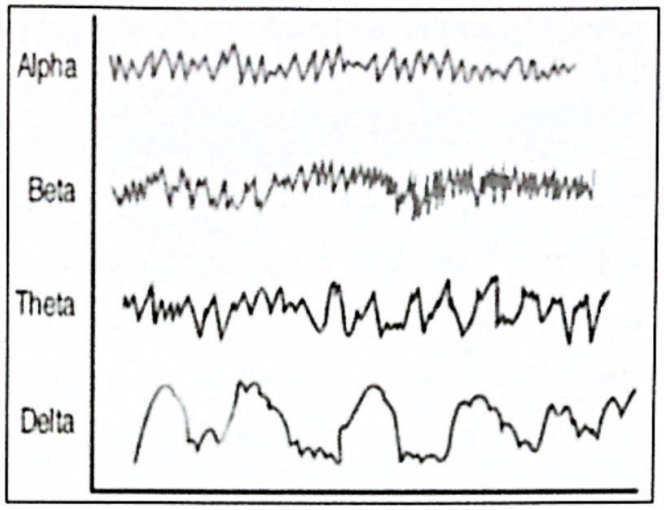


Figure 2.1: Brainwave waveform

2.2.1 Betawave

Beta is the highest frequency band with the lowest amplitude. It is the normal frequency of waking consciousness, taking and evaluate data received through the senses, and active thought process. It is also associated with a concentration, stimulation, alertness, motivation, survival, problem solving and cognition. Beta binaural beats is used to increase energy, improve decision making, give you motivation, and better intelligence.[8]

2.2.2 Benefit of Increase Beta Wave

Harold Russell, Ph.D. was reported on a new one research which showed that the beta frequencies (18 -21 Hz) able to improved cognitive function in ADHD (Attention Deficit Hyperactive Disorder) children. Russell and John Carter have found that exercise cortical hemisphere low-performing students showed differences in education. Test improved performance significantly. Thus, if the student showed a less Verbal score, given stimulation with a primarily beta frequencies more to the left hemisphere, he will be improved considerably on this subscale after 40 sessions of 30 minutes.[9]

When a person is high in beta brain waves, they able to think faster, create the new ideas quickly, and live in a high state of functioning. Quick thinking and mental processing definitely help when applying for a job in the century and preparing for exams. Studies have indicated that people who think fast feel much more confident, happier, and actually live longer than a slow thinker. Beta brainwave range naturally increases when a person talked. Increasing beta wave a person becoming more social, improvement in beta brainwaves able to become a ticket. In many people, the increase in beta activity boosts energy of the conversation and the ability to continue the conversation. Brainwaves may be the ticket to changing that around. Stimulant for people with ADD and ADHD are usually given, which able to help beta brainwave activity in their brains to improve. Thus, increasing the ability to focus on something, get things done, and all other things associated with beta waves. The study was conducted and showed that people who had higher beta brainwave has higher I.Q.s than the average population.[10]

2.3 EEG

Electroencephalography (EEG) is one method of electrophysiological monitoring for recording the electrical activity of the brain. In general, it is a non-invasive method which place the electrodes along with scalp, although invasive electrodes are sometimes used in certain applications. EEG measures the voltage fluctuation resulting from the ionic current in the neurons of the brain. In the clinical context, EEG recording of spontaneous electrical activity at a period of time, as recorded from multiple electrodes were placed on the scalp. EEG used to diagnose epilepsy, which causes abnormalities in EEG readings and also used to diagnose the sleep disorders, coma, and brain death. [11]

Electroencephalography (EEG) can use to diagnose ADHD.[12] Reporting a slowing of the EEG rhythms at front-central sensors, a putative indicator of abnormal brain function in a group of "behaviour problem children" described as hyperactive,

impulsive, and highly variable.[13] Underscores the potential for clinical utility of EEG. EEG metrics have potential for application in diagnosis of ADHD.

2.3.1 Use EEG for Beta training in ADHD children

EEG-based biofeedback (neurofeedback) can used as an alternative treatment for reducing symptoms of ADHD. The protocols of neurofeedback were based on an empirical observation of slowing EEG rhythms in ADHD children. This slowing is represented by increase of EEG power in theta band and corresponding decrease of EEG power in beta band. In recent multi-center studies, theta/beta ratio measured at Cz was found highly sensitive for discriminating ADHD children from the mentally healthy population.[14]

In ADHD, a conventional neurofeedback protocol for reducing inattention and impulsivity consists of operant enhancement of beta activity and suppressing theta activity. To reduce hyperkinetic symptoms, enhancement of sensory motor rhythm, SMR (low beta 12-15 Hz activity), is sometimes used in addition to the beta protocol.[14]

2.4 EXISTING WEARABLE WIRELESS EEG DEVICES.

Nowadays, many device that have same function with EEG. That is used to measure the brain activity for diagnose the abnormal in brain. Other than that, also use for help doing therapy and treatment to see the improvement of our health. The device that have a similar function of EEG which is Mindwave mobile (Neurosky), Emotiv Epoc Neuroheadset, g.Nautilus, quasar, etc.

2.4.1 Mindwave Mobile

Mindwave Mobile (Neurosky's) product range is based on a 1-channel measurement platform with dry electrodes. The principle of operation is quite simple. Two dry sensors are used to detect and filter the EEG signals. The sensor tip used to detects electrical signals from the forehead of the brain. At the same time, the sensor pick up ambient noise generated by human muscle, computers, light bulbs, electrical sockets and other electrical devices. In addition, ear clip as grounds and reference, which allows thinkgear chip to filter out the electrical noise. The device measures the raw signal, power spectrum (alpha, beta, delta, gamma, theta), attention level, mediation level and blink detection. Data is wirelessly transmitted to a PC or a smartphone using Bluetooth.[15][16]

Figure 2.2: Mindwave mobile

2.4.2 Emotiv Epoc Neuroheadset

The Epoc (Emotive) is amongst the most widely available and used devices. With 14 channels scattered around the head and low cost, it provides a flexible and versatile research platform. Data transmitted using wireless through a proprietary radio link. The system allows for 12 hours continuous

transmission. With a very attractive price-tag, the Epoc also targets the low-end consumer space. However, a substantially more expensive license is needed to get access to the raw EEG data and use the Epoc as a research vehicle. [17][18]

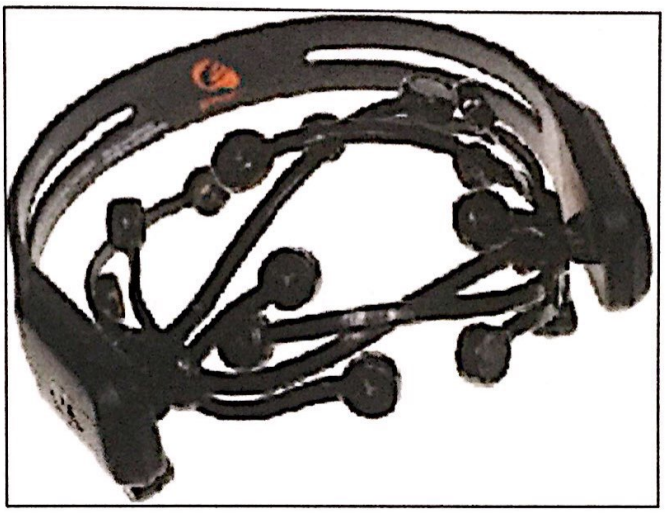


Figure 2.3: Emotiv Epoc Neuroheadset

2.4.3 g.Nautilus

A recent development is g.tec's g.Nautilus platform. It can be combined with a cap system with active dry electrodes (g.Sahara) which allows for recordings according to the International 10-20 System. Dry electrodes are fabricated with gold-plated pins. The data is wirelessly transmitted through a proprietary radio link. The device can operate continuously for 8 hours without charging. [19]

Figure 2.4: g.Nautilus

2.4.4 Quasar

Quasar's DSI 10/20 is an EEG headset with 21 channels. The aim of the system is ambulatory EEG recording and it includes mechanical and electrical mechanisms to reduce motion artifacts. Data is wirelessly transmitted through a proprietary system which requires a USB dongle. It allows continuous EEG transmission for 24 hours. The focus of this device seems to be on achieving the highest signal quality possible but with a high price-tag. [20]

Figure 2.5: Quasar

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

This section describes the investigative focus, research methodology and specific methods used in this study. The methodology used was a mixed method research framework encompassing both quantitative and qualitative method and measures. This section also explains the design and construction of the course as well as describing the measures which were used to provide informational perspectives toward gaining an understanding of it. This research study was conducted based on methodology. This methodology plays an important role in implementing this research study accordingly. This details of the methodology are explained in detail in this chapter.

This part will cover the explanation of methodology that is being used to make this project complete and working well. This method is use to achieve the objective of this project that will accomplish a good result. In order to evaluate this project, there are three major phase, which is planning, implementing and data analysis.

3.2 PLANNING

For this project will be start for collecting data. Data collect from questionnaire, and some research from journal, internet, research paper and etc. This data importance because to find the real problem statement for this project. Second step, from data collection requirement of hardware and software need. Lastly is informed consent process. This step important to do before start to analysis result.

3.2.1 Data collection

The questionnaires of data collection are distributed to the staff of Special Education Centre for children. By data collection, requirement for hardware and software can be plan as well. At this stage, project resources and requirement, literature studies and schedule to get more information in this study are planned. All materials are collected from journal, internet, and research paper and text books.

Refer appendix A for questionnaire form

3.2.2 Requirement of hardware and software

In this section, investigator will decide the components to use inside the hardware. To do this planning, hardware was designed by using proteus8. The purposes of doing product design are to get the better output in we planned well besides to save cost by just run the circuit by using application software.

3.2.3 Informed consent process

Teacher and Patient of Special Education Centre for children shall be informed of the study during their therapy visits. They will be requested to response to investigator if they are interested. An appointment will be made where the patient information sheet will be provided and explained to them. If they are willing to participate, the consent forms will be signed and dated. If they need to, they allowed to take information sheet home consult their family members and another day for getting consent arrange.

Refer appendix B for the consent form

3.3 IMPLEMENTING

This phase is where the making of hardware and software happened. To making the hardware there are including some step which is soldering, etc. After hardware and software done, it will be test on normal adult for technical testing to see the performance of the device. After technical testing is done and success, the device it will test on normal children's and ADHD children's as a subject for evaluate.

3.3.1 Mindwave Mobile

The Mindwave Mobile is the world's first EEG headset that can be used with Mac and PCs as well as all Apple iOS and Android platforms (smartphones, tablets etc.). It is therefore a truly mobile EEG headset. It features sensors on the forehead and at the earlobe to measure EEG data (electrical activity of the brain). The Mindwave Mobile transmits EEG data via a Bluetooth interface to the user's device. It safely measures brainwave signals and monitors attention and relaxation levels while interacting with different apps and games.

Figure 3.1: Mindwave (brainwave sensor)

3.3.2 Arduino Uno

Arduino Uno is a microcontroller kit other than PIC. The module is equipped with a variety of things that are needed to support the microcontroller to work, just plug in the power supply or connect via USB cable for Arduino Uno PCMU was ready. Arduino Uno has a 14 pin digital input / output, 6 analog inputs, 16MHz ceramic resonator, USB connection, power input jack, ICSP header, and a reset button. As we have seen with our microcontroller to create a program to control various electronic components. The program that we created with the programming language that is downloaded to the microcontroller, then microcontroller will work according to the program that we created. And with the Arduino Uno itself more to help the user to make various things related to the microcontroller, as it already is required by the microcontroller. Examples which may be made by Arduino, among others, to create robots, stepper motor control, temperature control, machine door gate, LCD display, and many other examples.

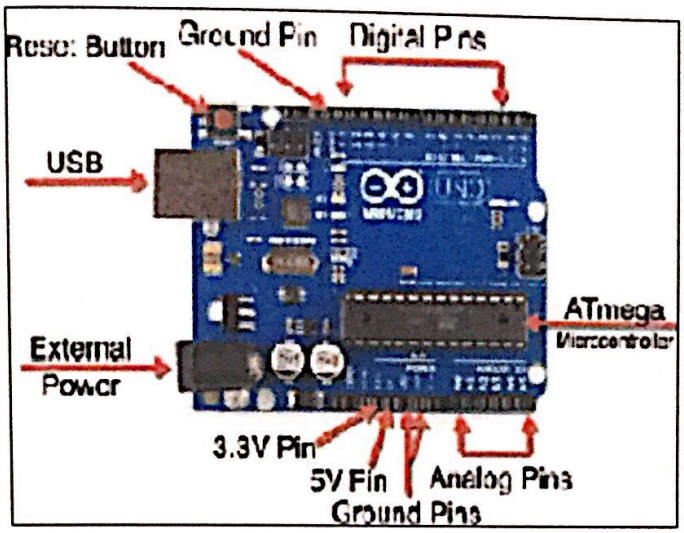


Figure 3.2: Arduino Uno

Table 3.1: Specification Arduino Uno

Microcontroller	ATmega328
Operating voltage	5V
Input voltage (recommended)	7-12V
Input voltage (limits)	6-20V
Digital I/O pins	14 (of which 6 provide PWM output)
Analog input pins	6
DC current per I/O pin	40mA
DC current for 3.3V pin	50mA
Flash memory	32kb (Atmega328) of which 0.5 kb used by bootloade
SRAM	2kb (Atmega328)
EEPROM	1kb (Atmega328)
Clock speed	16MHz

3.3.3 Bluetooth module (HC-05)

HC-05 Bluetooth module is a wireless communication module at 2.4GHz with connectivity options can be a slave or as a master. Very easy to use with microcontrollers to create wireless applications. Serial interface RXD, TXD, VCC and GND. Input voltages between 3.6 ~ 6V, do not connect with more resources than 7V. the current flow of about 30mA unpaired, and when paired (connected) at 10mA. 4 3.3V pin interface can be directly connected to a microcontroller (Arduino special, 8051, 8535, AVR, PIC, ARM, MSP430, etc). Within the effective range of 10 meters, although it can reach more than 10 meters, but the lower the quality of the connection.

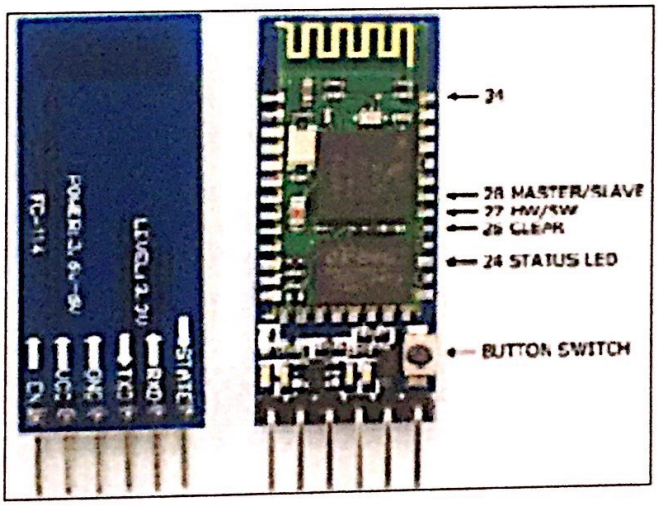


Figure 3.3: Bluetooth Module (HC-05)

3.3.4 Motor drive L298N

L298N motor driver is the most popular motor driver is used to control motor speed and direction of movement, especially online robot foller / line tracer. L298N motor driver advantages are sufficient accuracy in motor control. In addition, the surplus L298N motor driver is easy to control. Driver L298N to control the required 6-pin microcontrollers. Two of the Enable pin (one fruit for

the first motor and the second one for motors. Due to this L298N driver can control two DC motors). 4 to control the motor speed motor.

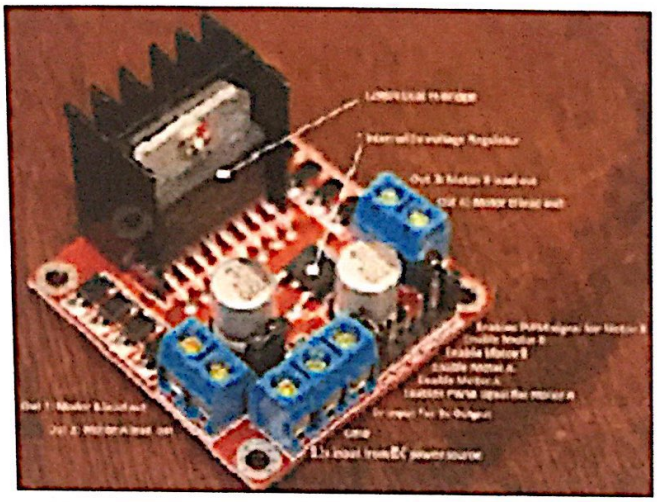


Figure 3.4: Motor driver (L298N Dual H-Bridge)

3.3.5 DC motor 3v-6v

The motor used in this project is 3-6V dc motor. This motor is used to move forward or backward.

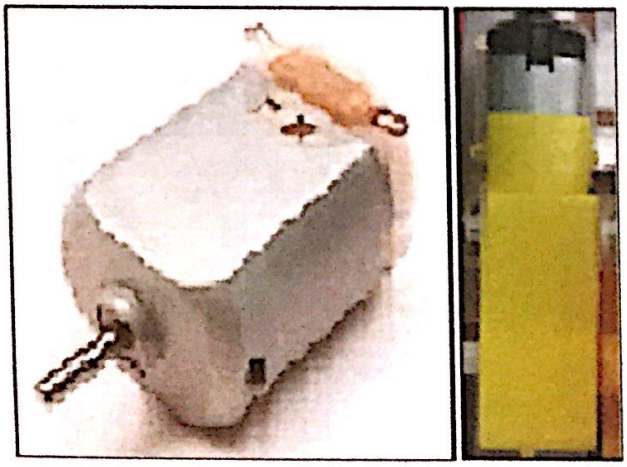


Figure 3.5: Dc Motor (3-6V)

3.3.6 Project testing

Project testing is done by the tested the Device. This project testing on normal children's and normal adult to see the performance of the device. During the testing, measurement taken according to comfortable and design. This measurement was taken by completing the evaluation form. To complete the evaluation form, only normal adult need to filling and answer the evaluation form. For normal children no need, because only to see whether children can use the device in a well without any problems.

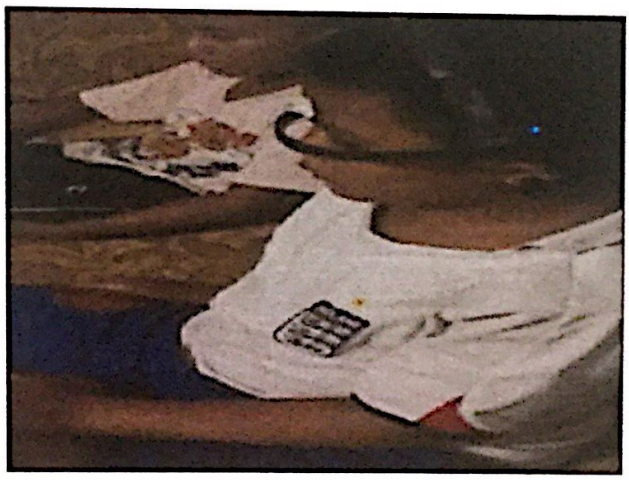


Figure 3.6: Testing project on normal children's

Figure 3.7: Test project on normal adult

3.4 SCHEMATIC DIAGRAM

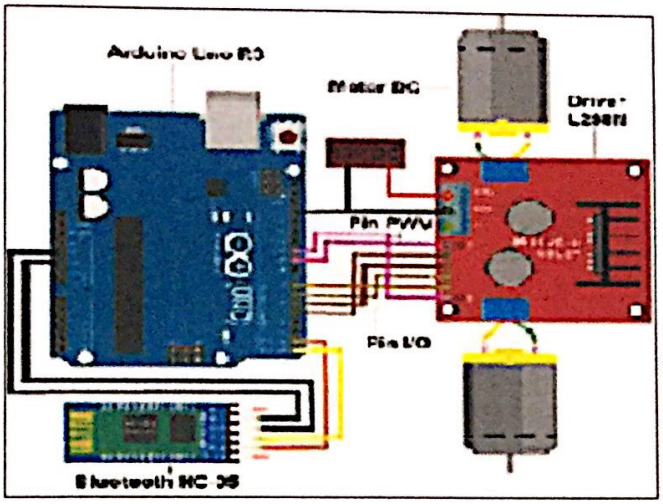


Figure 3.8: Schematic diagram (circuit for the toys car)

To build the circuit need some of component which is motor drive H-bridge (L298N), motor DC (3 -6V), Arduino Uno and Blutooth module (HC-05). All component is importance to success this hardware. All connection must connect to Arduino Uno. For the Bluetooth module, tx must connect to rx at the arduino uno. Supply for Bluetooth module need 3.6 volt. For motor driver, all pin at motor driver must connect to pin at Arduino Uno. Pin IN1-IN4 is to control rotation motor forward or backward and pin EN1 and EN2 is to control speed of motor. This circuit need two supply which is battery 9v to power up the Arduino Uno and Bluetooth module, and batter 5V (power bank) as a supply to on motor DC.

3.5 BLOCK DIAGRAM

The block diagram below shown how the project operation. First, human brain produces wave to get the wave signal. Therefore, use an equipment that is mindwave mobile. Mindwave mobile function as a brainwave sensors same like EEG that use to measure electrical activity of the brain. Data from the Mindwave mobile transmitted to bluetooth module. From the bluetooth, data transmit to Arduino uno. And then, data

link to the Arduino programming. The Arduino programming that make is to control move forward and the speed of the motor DC. The motor driver is used to control the speed of DC Motor.

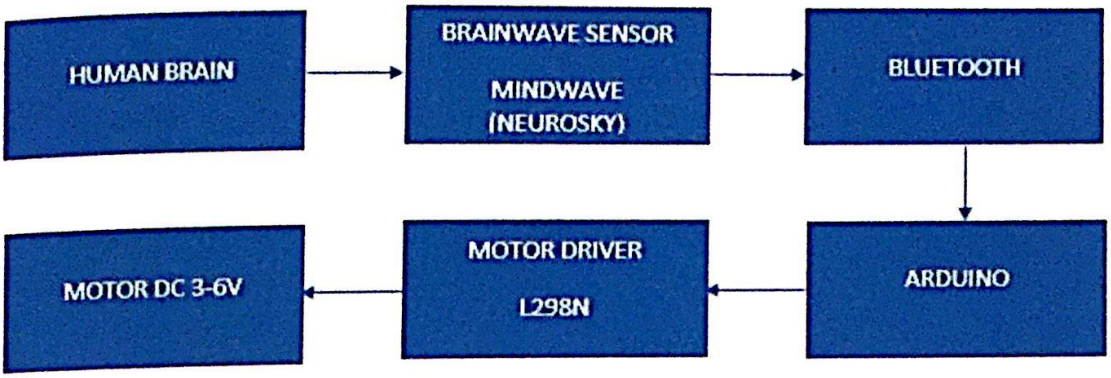


Figure 3.9: Block diagram of the device operation

3.6 FLOWCHART OF PROCEDURE RUNNING DEVICE

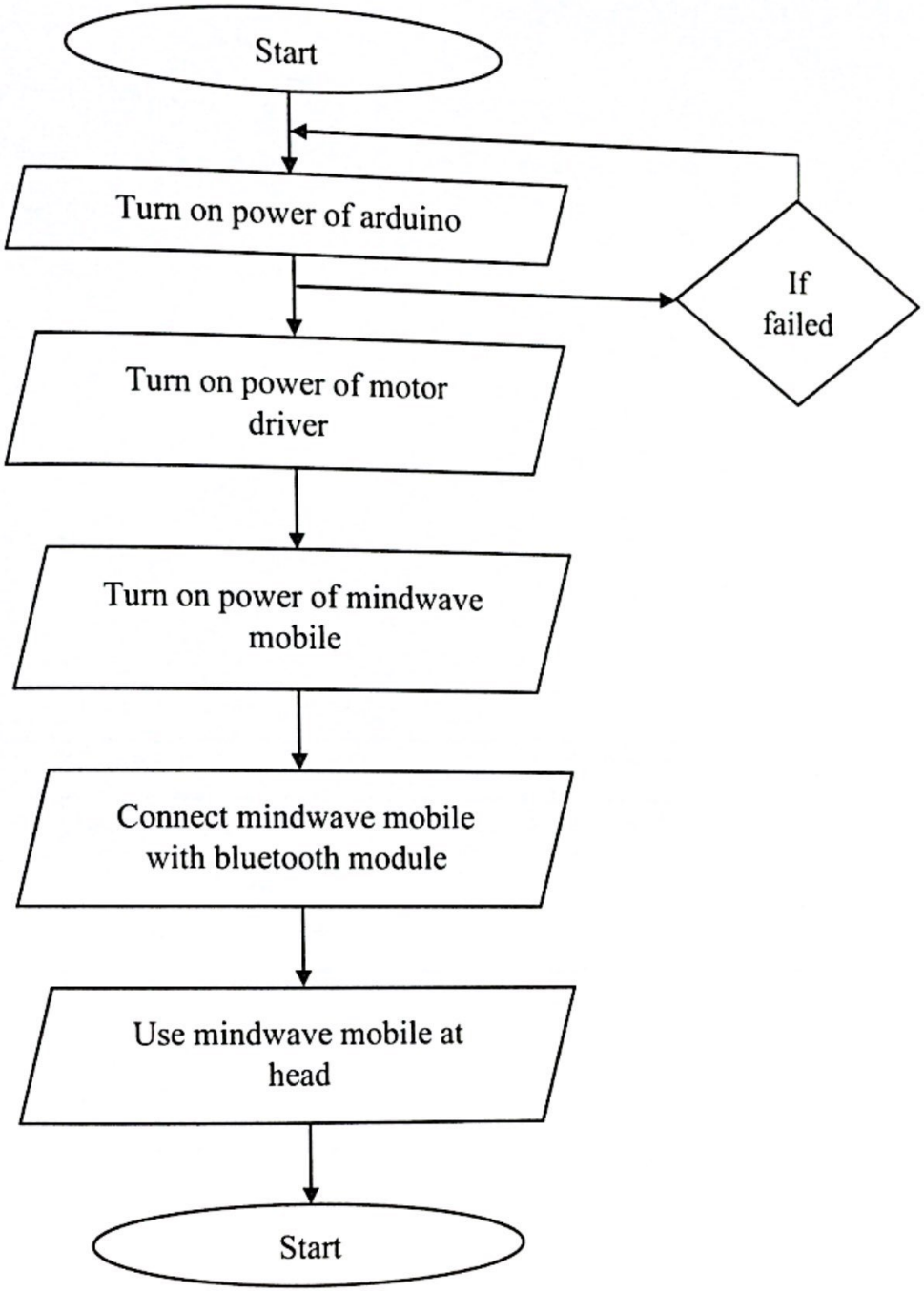


Figure 3.10: Flow chart of procedure running device

The figure 3.10 above show the flowchart of procedure running device. First step is turn on all the power which is power of arduino uno, power of motor driver and power of mindwave mobile. If the device not turn, check a capacity of battery or supply (change with a new battery). After the all the power is turn on, connect mindwave mobile with Bluetooth module. Then, the device can use.

3.7 DATA ANALYSIS

In data analysis consist 4 term. First is collect data using questionnaire to find the problem statement. Data collection give to the staff of Special Education Centre for children. Second is also use questionnaire form that use to analysis the usability consists comfortable and design. The questionnaire give to the people that use this device. Third is deference the normal children's and ADHD children's concentration and focus with the range of age is 7 - 10. Lastly, train one from three of ADHD children with device to increase the concentration and focus for 6 week. Do the train 1 time in one week.

3.8 THE TIMELINE OF STUDY

Table 3.2: time table of study

Stage	Progress	Duration
1	Collecting pre-processing data and interview to identify the problem statement	1 month
2	Process of design	2 months
3	Build up software	1 months
4	Product testing and data collection	3 months
5	Data analysis	2 weeks

3.9 FLOWCHART OF METHODOLOGY

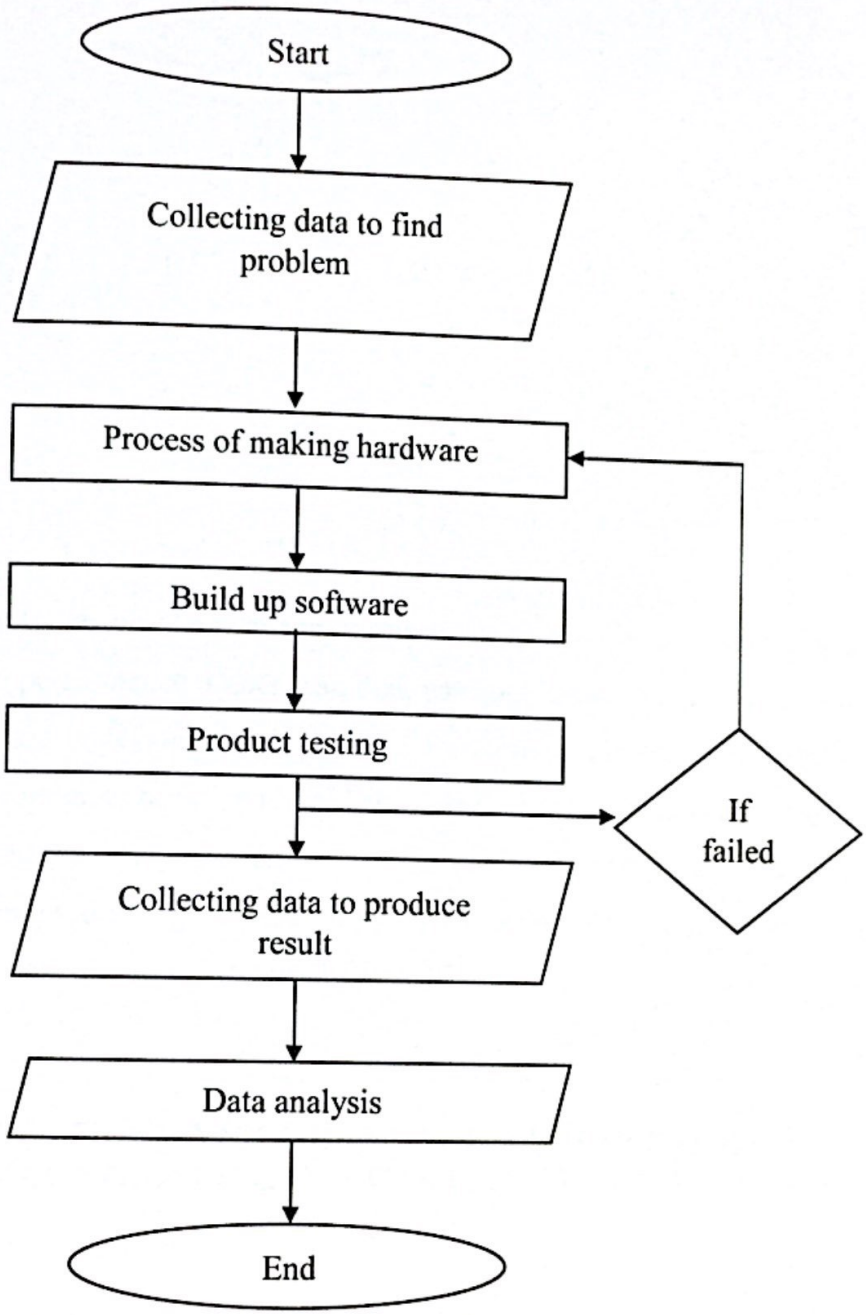


Figure 3.11: Flow chart of methodology

CHAPTER 4

RESULT AND DISCUSSION

4.1 INTRODUCTION

This chapter shown the result from our collected data such as technical testing to see the device performance. Other than that, use questionnaire to know the usability for comfortable and the design for this device. Furthermore, in this chapter also show the data of the differences between normal children with ADHD children. Besides that, also shown the result of the improvement ADHD children after training session. Lastly, all the data is analysed and generated graph by using Microsoft Excel. And then the result that analysed is discussed in this chapter.

4.2 INNOVATE THE DEVICE THAT IMPROVE FOCUS FOR ADHD KIDS BY CONTROLLING TOY CAR USING BETA WAVE

The figure 4.1 below is device that use to differences between normal children's and ADHD children's. This device provided 10 parameter which are 10, 20, 30, 40, 50, 60, 70, 80, 90 and 100 percent for detect focus. Besides that, this device also have count setting, which used to set the percent of focus to make the car move, the minimum is 10 percent and maximum 100 percent. For the collecting data, parameter that use is 60 percent of focus to move the toys car. This device only have one levels of speed, and the speed is 3 meter in 18 seconds.

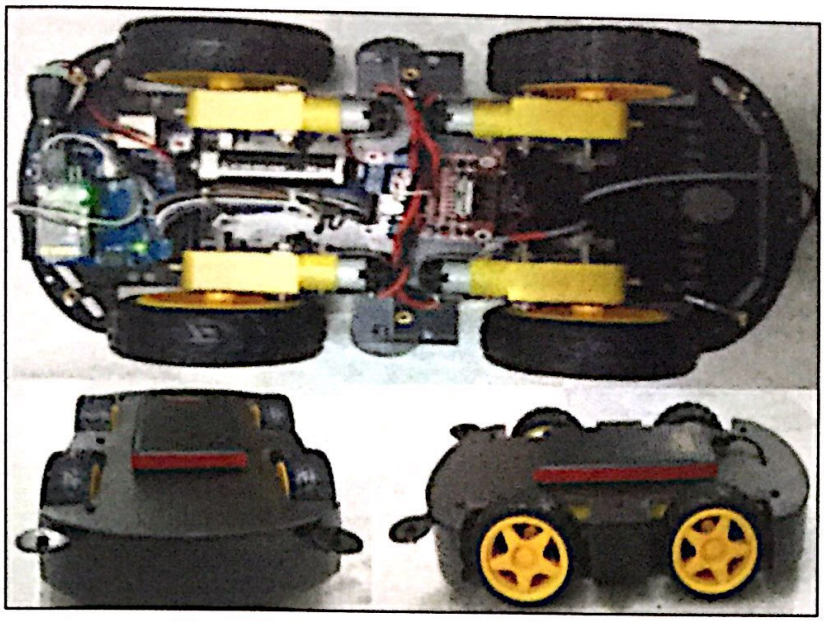


Figure 4.1: Device that Improve Focus for ADHD children's

Furthermore, this device has an easy installation, which the devices only need to install the DC rechargeable batteries (power bank) before use. Compared with the exiting devices, the exiting devices have a complex of installation before use.

This device has two main parts, which are toys car with the main circuit and Mindwave mobile. The toys car with the circuit contained ON/OFF button. This device used two batteries to operate the device which are 9V batteries and 5V DC rechargeable batteries (power bank). The 5V DC batteries used to control the DC motor movement and the 9V batteries used to power up the circuit.

4.2.1 Structure of Innovate the device to Improve Focus for ADHD Kids by Controlling Toy Car Using Beta Wave

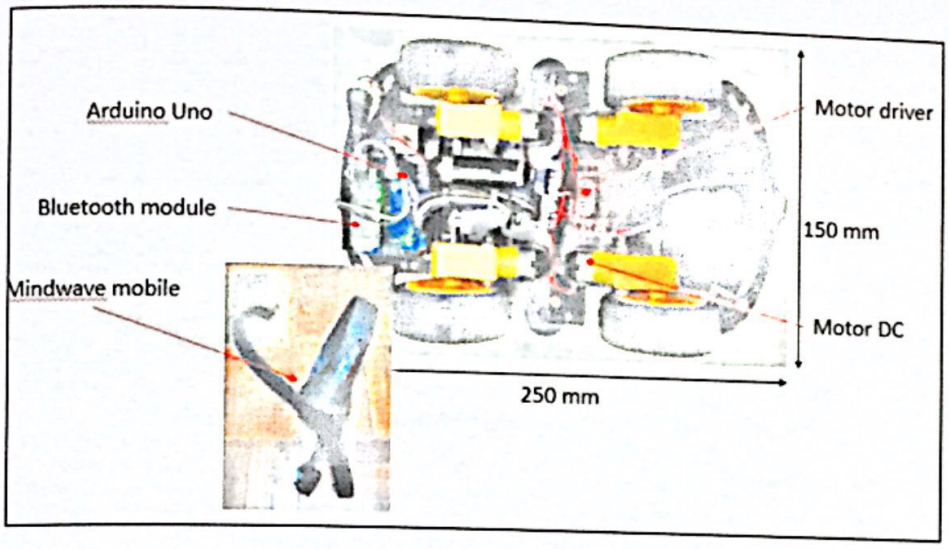


Figure 4.2: Structure of the device

Figures 4.2 had shown the view of the device, and the Table 4.1 shown the function of each part of the device.

Table 4.1: Function for each part of the device

Parts	Function
L298N	To control the movement of dc motor
Arduino Uno	As microcontroller that control the operation for this device
Hc-05	Receive data from mindwave and transmit data to arduino
Motor dc	To move the toys car
Mindwave Mobile	Detect betawave (as a brainwave sensor)

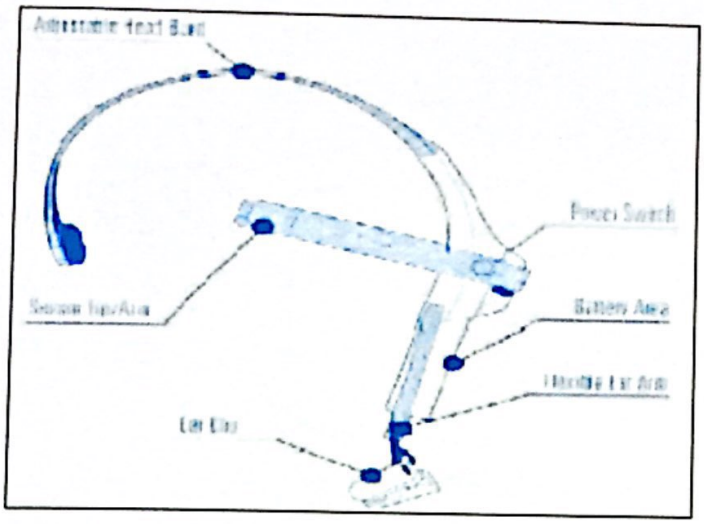


Figure 4.3: Mindwave Mobile (brainwave sensor)

Figures 4.3 had shown the Mindwave Mobile, and the Table 4.2 shown the function of each part of the device.

Table 4.2: Function for each part of mindwave

Parts	Function
Adjustable head band	Easy the patient to fix the Mindwave mobile to their head
Sensor tip	Detect the brainwave
Ear clip	As a ground source
Flexible ear arm	Easy to clip the ear clip to ear
Battery arena	Battery case
Power switch	To switch on and off the Mindwave Mobile

4.2.2 Track for toys car

The figure 4.4 below show the track for the toys car. The total length for this track is 302 cm or 3.02 meter. This track use to measure how long the toys car move.

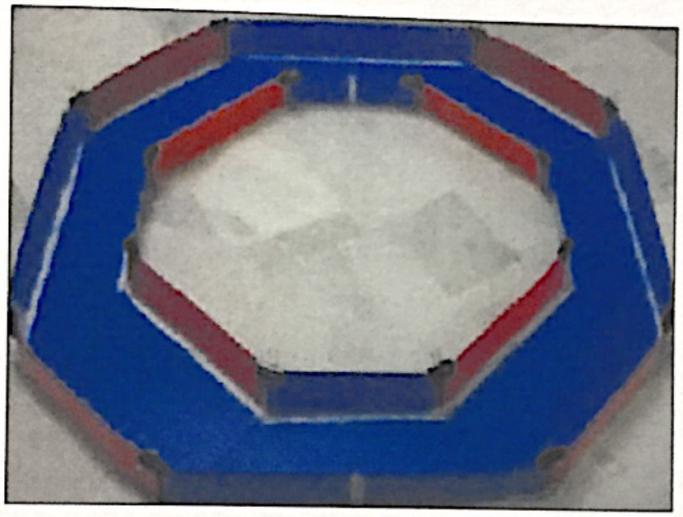


Figure 4.4: Track for toys car

4.3 TECHNICAL TESTING

In this section shown the technical testing for the performance of the device. Which is the speed of the device in 1 round (3 meter). Furthermore, this section also discuss error when using the device.

4.3.1 Speed of toys car

Table 4.3: Speed of the device

	Length of the track (meter)	Speeds (second)
First reading	3	17.88
Second reading	3	18.44
Third reading	3	18.05

The table above shown the technical testing about the speed of the device. There are three reading taken so see the speed of the toys can move. From the result, show each reading have a different time or speed. But the reading is not too much difference only in mili second of the difference of the speed. So we can conclude, the speed of the toys car move is 18 second in 3 meter.

4.3.2 Error of the device

Error occurs when the device is not in use in accordance with the correct procedure. For these device, need to use correct manner. Among the causes that can lead to error is caused by Mindwave not used properly. This happened because sensor tip is not installed correctly. Sensor tip has to be in contact with the skin on the forehead. Ear clip also important because functioning as a ground, need to clip to the ear perfectly.

The toys car does not move even in the middle of situations that focus. These things can happen in two matters that caused ear clip is not installed properly, the sensor tip is not in contact with the skin.

Fetching data, correct procedure using Mindwave mobile is importance things to get accurate data. This is because, if the sensor tip is detached or loose contact with the skin and at the time of the toys car in situations move, the toys car will take 3 seconds to stop. Should, if the sensor tip is not in contact with the skin, the toys car will stop. Therefore, to avoid the error occurred and to get the correct data, users needed to follow the correct procedures to avoid errors and incorrect data.

4.4 USABILITY TEST

During this usability testing, 5 normal adults subjects were tested, and questionnaires were distributed to them. Usability testing have consists of 2 main items which are Comfortability, and Design. These 2 main items data was collected through the usability test, which the subject have tested this device, then answered questionnaire.

4.4.1 Comfortability

The data of comfortability about the devices was takes. 4 questions are consisted in this part. Below is the table 4.4 that show of the comfortability.

Table 4.4: Data of Comfortability

	Strongly Disagree	Disagree	Neither Agree Nor Disagree	Slightly Agree	Strongly Agree
This device is easy to use	0	0	2	3	0
Easy to set all part of the device	0	5	0	0	0

Mindwave fit and comfortable use at head	0	0	2	3	0
Toys car move in good condition	0	0	1	4	0

From the table 4.4, the graph is generated by the Microsoft Excel, and the graph is shown in the figure 4.5.

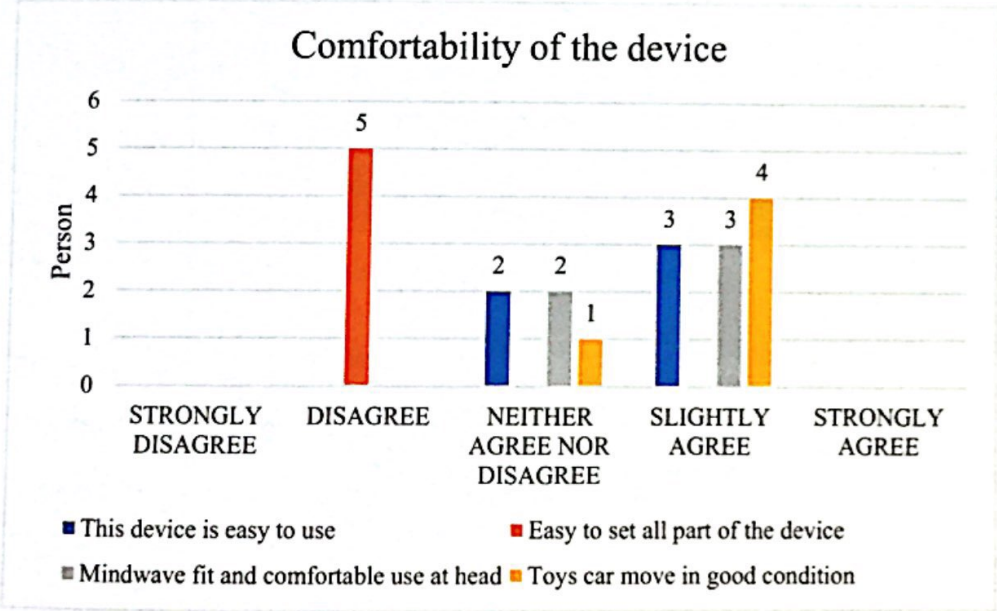


Figure 4.5: Graph of the Comfortability

From the figure 4.5, 3 subjects are slightly agree that this device is easy to use and 2 subjects were neither agreed nor disagreed. After that, 5 subjects were disagreed that easy to set all part of the device.

According the third question, 3 subjects are slightly agree that the Mindwave fit and comfortable use at head and 2 subjects were neither agreed nor disagreed. Besides that, 4 subjects were slightly agreed that the toy car move in good condition and 1 subject were neither agreed nor disagreed.

4.4.2 Design

The last main items are Design of the device. The table 4.5 shown the data collected from 5 person.

Table 4.5: Data of design

	Strongly Disagree	Disagree	Neither Agree Nor Disagree	Slightly Agree	Strongly Agree
The Design Is Suitable To Be Use In Everywhere	1	1	3	0	0
The Design Is Light In Weight	0	2	1	2	0
The Design Is Easily To Be Carried	0	1	2	2	0

From the table 4.5 above, the graph is generated by the Microsoft Excel, and the graph is shown in the figure 4.6.

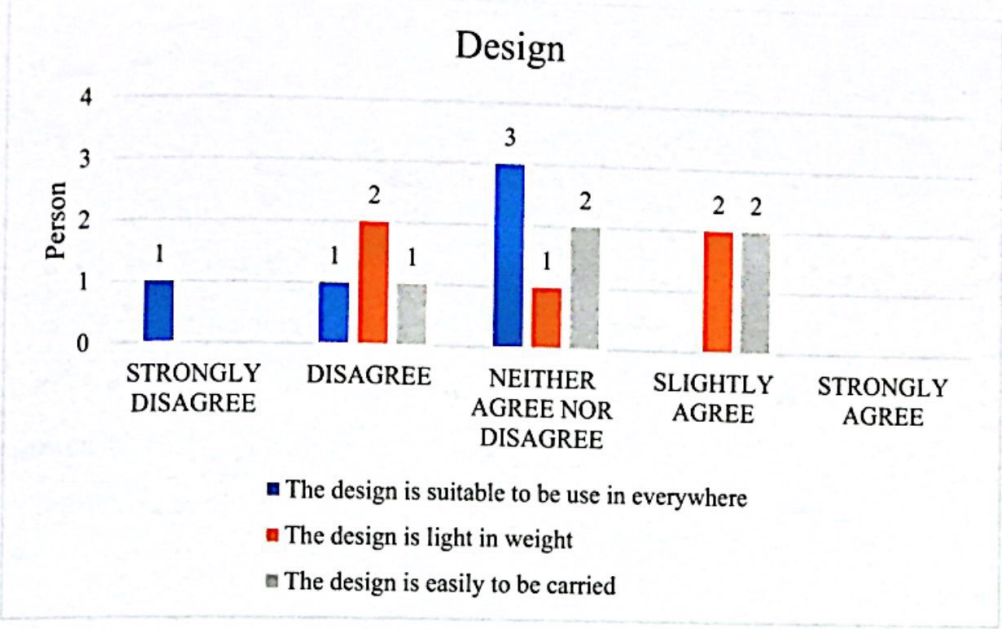


Figure 4.6: Graph of design

The figure 4.6 has shown the data of design which it collected the data about the design of the developed device. From this design items, there consists of 3 questions. From the 5 subjects, there 3 subject were neither agreed nor disagreed that the design of the device are suitable used in everywhere, there were also 1 subjects disagreed with it and 1 subjects strongly disagreed that the design suitable uses in everywhere.

After that, there were 2 of the subjects slightly agreed that the design is light in weight, 1 subject were neither agreed nor disagreed with it and 2 subject disagree. Lastly, the design is easily to be carried were slightly agreed by 2 subjects, and 2 subjects were neither agreed nor disagreed. And there were only 1 subjects disagreed with the statement.

4.5 DIFFERENCES OF NORMAL CHILDREN'S AND ADHD CHILDREN'S

For this section, the device use on normal children's and ADHD children's for deference's the level focus between normal and ADHD children's. Only 3 subject normal children's and 3 subject ADHD children's with range of age between 7 -9 are needed. There are 2 type of activity which is doing study and watching TV. Every activity requires three readings, or three times the data is retrieved, and data were collected in 5 minutes for every session.

4.5.1 Normal children's data

Table 4.6: Data focus study and watching TV for normal children's

Days	day 1		day 2		day 3	
Activity	Study (%)	Watching TV (%)	Study (%)	Watching TV (%)	Study (%)	Watching TV (%)
Children 1	30.7	31.6	24.6	30.8	75.4	18.7
Children 2	35.4	45.8	42	49	43.4	82
Children 3	48.9	24.9	43.4	49	39.6	18

From the table 4.6 above, the graph is generated by the Microsoft Excel, and the graph is shown in the figure 4.7 and figure 4.8

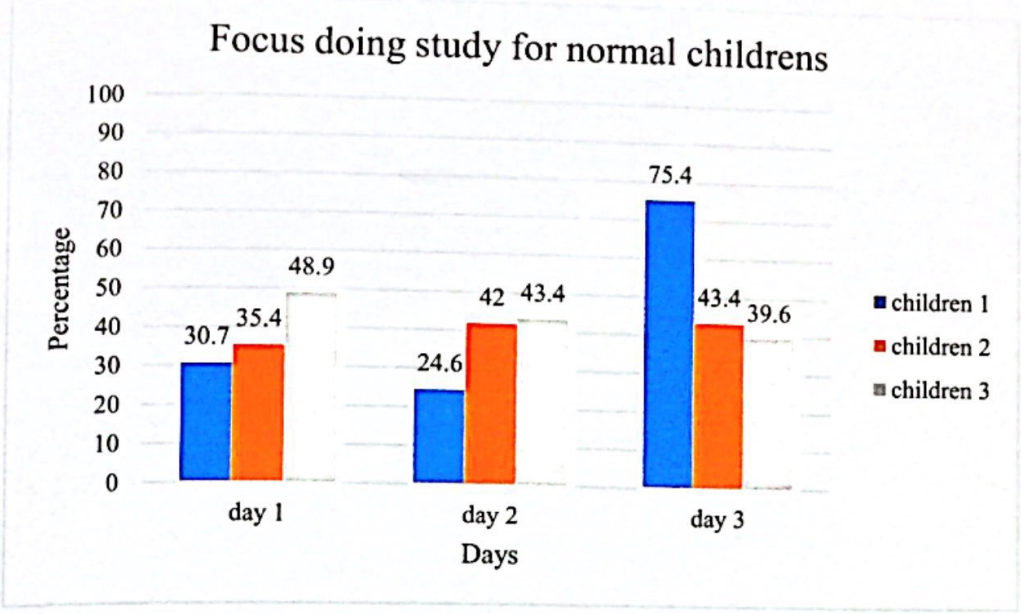


Figure 4.7: Graph of focus doing study for normal children's

The figure 4.7 has shown the data of focus doing study for normal children's. From this graph, there consists of 3 days collecting data. Range of age of the subject is 7 years old (children 1), 9 years old (children 2) and 10 years old (children 3).

Day 1, children 1 focus study in duration 5 minute is 30.7%, children 2 is 35.4% and children 3 is 48.9%. For the day 2, children 1 focus study in duration 5 minute decrease to 24.6%, children 2 increase to 42% and children 3 focus doing study decrease to 43.4%. For the last day, children 1 focus study in duration 5 minute increase extremely to 75.4%, children 2 also increase for a little bit from past day that is 43.4% and children 3 again decrease a focus of study to 39.6%.

From the graph, we can see the who that have reach the higher focus doing study in three day and the lower of focus doing study in three day. So, children that get the higher of focus doing study is children 1 and the lower also children 1. So we can conclude another children except children 1 have a stable focus doing study.

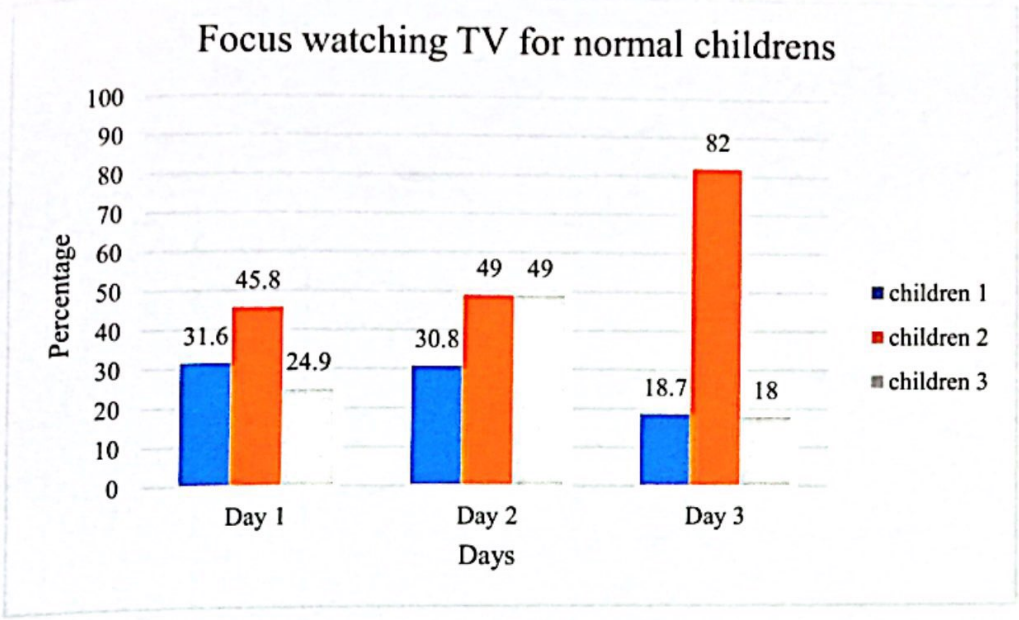


Figure 4.8: Graph of focus watching TV for normal children's

The figure 4.8 has shown the data of focus watching TV for normal children's. From this graph, there consists of 3 days collecting data. Range of age of the subject is 7 years old (children 1), 9 years old (children 2) and 10 years old (children 3).

Day 1, children 1 focus watching TV in duration 5 minute is 31.6%, children 2 is 45.8% and children 3 is 24.9%. For the day 2, children 1 focus watching TV in duration 5 minute is decrease to 30.8%, children 2 increase their focus to 49% and children 3 also increase like a denial that is 49%. For the last, children 1 focus watching TV in duration 5 minute decrease again to 18.7%, focus children 2 watching TV increase extremely to 82% but children 3 focus watching TV decrease to 18%.

From the graph, we can see the who that have reach the higher focus watching TV in three day and the lower of focus watching TV in three day. So, children that get the higher of focus watching TV is children 2 and the lower is children 3.

4.5.2 ADHD children's

Table 4.7: Data focus study and watching TV for ADHD children's

Days	Day 1		Day 2		Day 3	
Activity	Study (%)	Watching TV (%)	Study (%)	Watching TV (%)	Study (%)	Watching TV (%)
Children 1	17.9	22.1	14.5	19.4	20.1	23.4
Children 2	15.7	20.9	20.1	23	18.8	20
Children 3	24.3	25.7	20.9	26.8	23.3	20.5

From the table 4.7 above, the graph is generated by the Microsoft Excel, and the graph is shown in the figure 4.9 and figure 4.10.

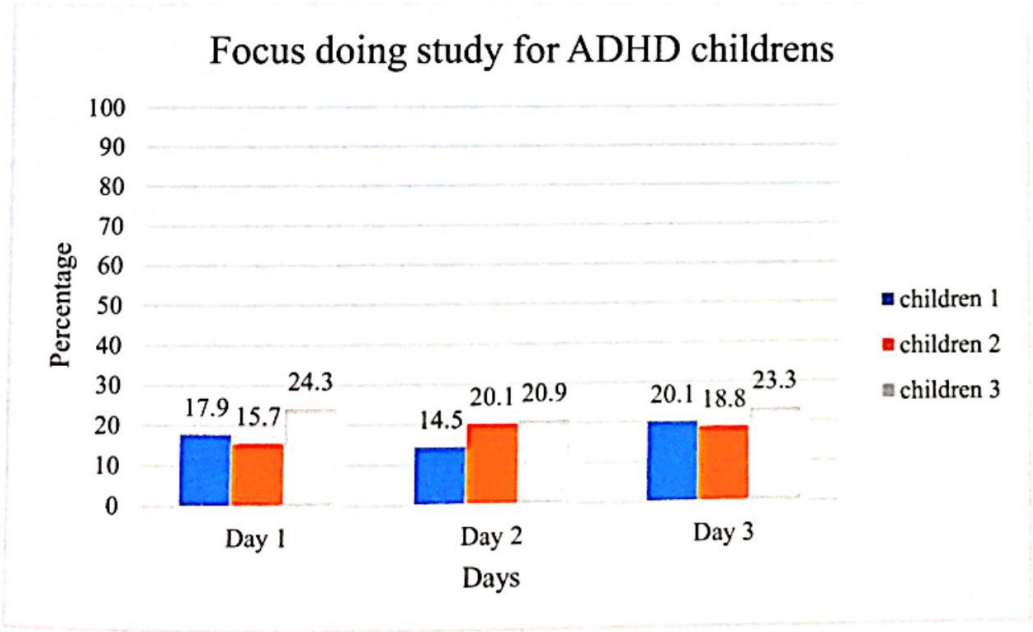


Figure 4.9: Graph of focus doing study for ADHD children's

The figure 4.9 has shown the data of focus watching TV for ADHD children's in percentage. From this graph, there consists of 3 days collecting data. Range of age of the subject is 7 years old (children 1), 9 years old (children 2) and 10 years old (children 3).

Day 1, children 1 focus study in duration 5 minute is 17.9%, children 2 is 15.7% and children 3 is 24.3%. For the day 2, children 1 focus doing study decrease to 14.5%, children 2 focus doing study increase to 20.1% but children 3 decrease 20.9%. The last days, children 1 focus doing study increase more than day 1 that is 20.1%, children 2 focus doing study decrease to 18.8% and children 3 increase focus doing study again to 23.3% after decrease in days 2. So we can conclude, focus for 3 ADHD children similar or same level, don't have a too much different.

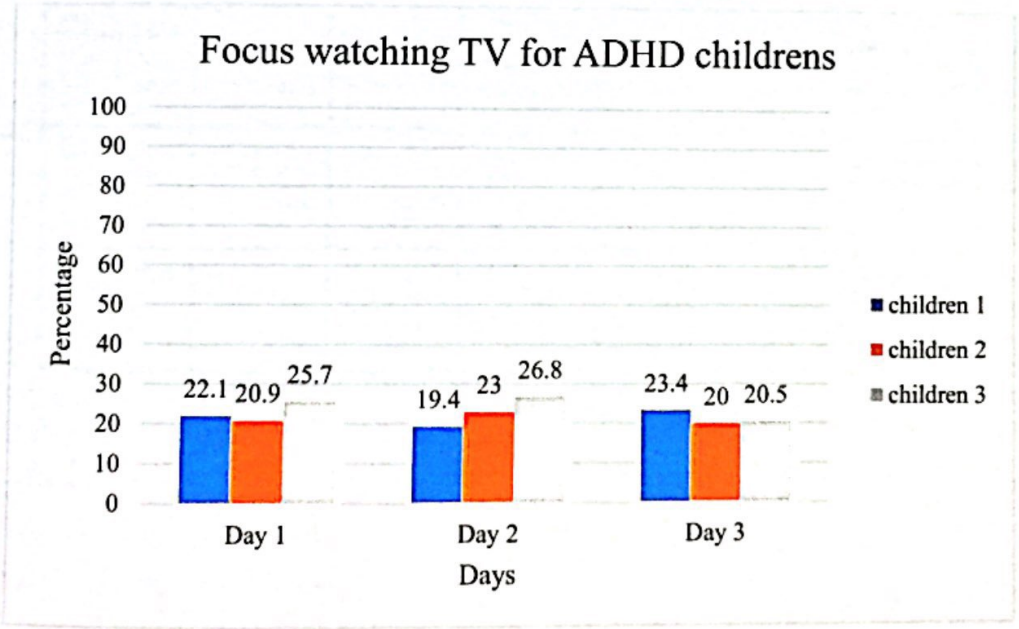


Figure 4.10: Graph of focus watching TV for ADHD children's

The figure 4.10 has shown the data of focus study for ADHD. From this graph, there consists of 3 days collecting data. Range of age of the subject is 7 years old (children 1), 9 years old (children 2) and 10 years old (children 3).

Day 1, children 1 focus watching TV in duration 5 minute is 22.1%, children 2 is 20.9% and children 3 is 25.7%. For the day 2, children 1 focus watching TV a little bit decrease to 19.4%, children 2 increase a little bit to 23% and children 3 also increase a little bit 26.8%. For the last days, children 1 focus watching TV in duration 5 minute increase to 23.4%, but children 2 decrease a focus watching TV to 20% and children 3 also decrease a their focus watching TV to 20.5%. From the graph, we can conclude focus for 3 ADHD children similar or same level, don't have a big different.

4.5.3 Normal children's VS ADHD children's

Table 4.8: Data focus doing study Normal VS ADHD children's

	Day 1		Day 2		Day 3	
	Normal	ADHD	Normal	ADHD	Normal	ADHD
Children 1	30.7	17.9	24.6	14.5	75.4	20.1
Children 2	35.4	15.7	42	20.1	43.4	18.8
Children 3	48.9	24.3	43.4	20.9	39.6	23.3

From the table 4.8, the graph is generated by the Microsoft Excel, and the graph is shown in the figure 4.11.

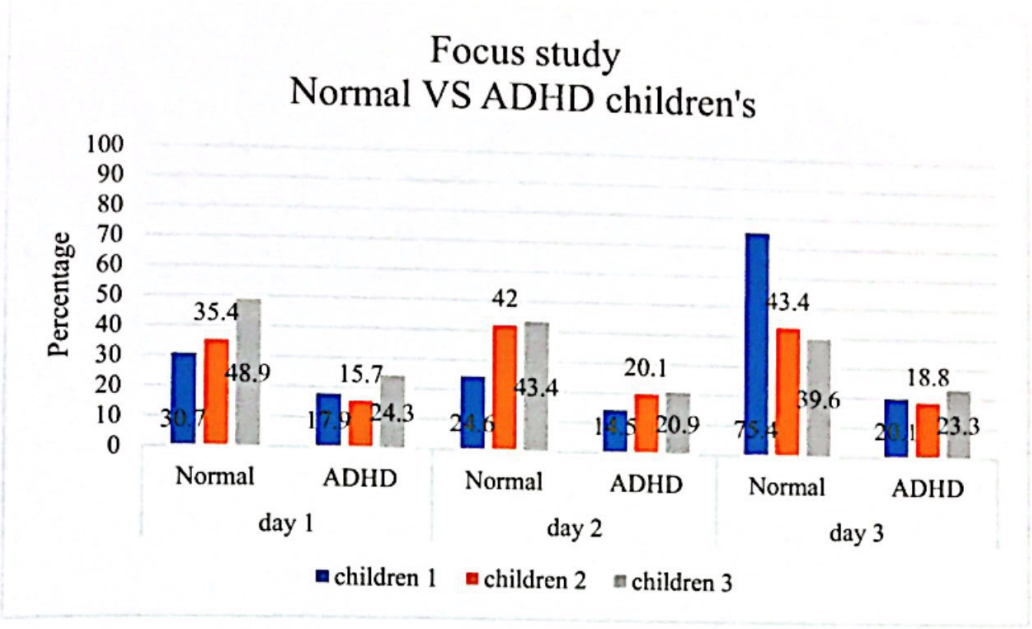


Figure 4.11: Graph focus study Normal VS ADHD children's

From the figure 4.11, we can see the graph is about the graph focus doing study. In this graph, we can conclude a normal children have a better level of focus then ADHD children. But the difference is not too much between normal children's and ADHD children's but still have a lower focus than normal children's.

Table 4.9: Data focus watching TV Normal VS ADHD children's

	day 1		day 2		day 3	
	Normal	ADHD	Normal	ADHD	Normal	ADHD
children 1	31.6	22.1	30.8	19.4	18.7	23.4
children 2	45.8	20.9	49	23	82	20
children 3	24.9	25.7	49	26.8	18	20.5

From the table 4.9, the graph is generated by the Microsoft Excel, and the graph is shown in the figure 4.12.

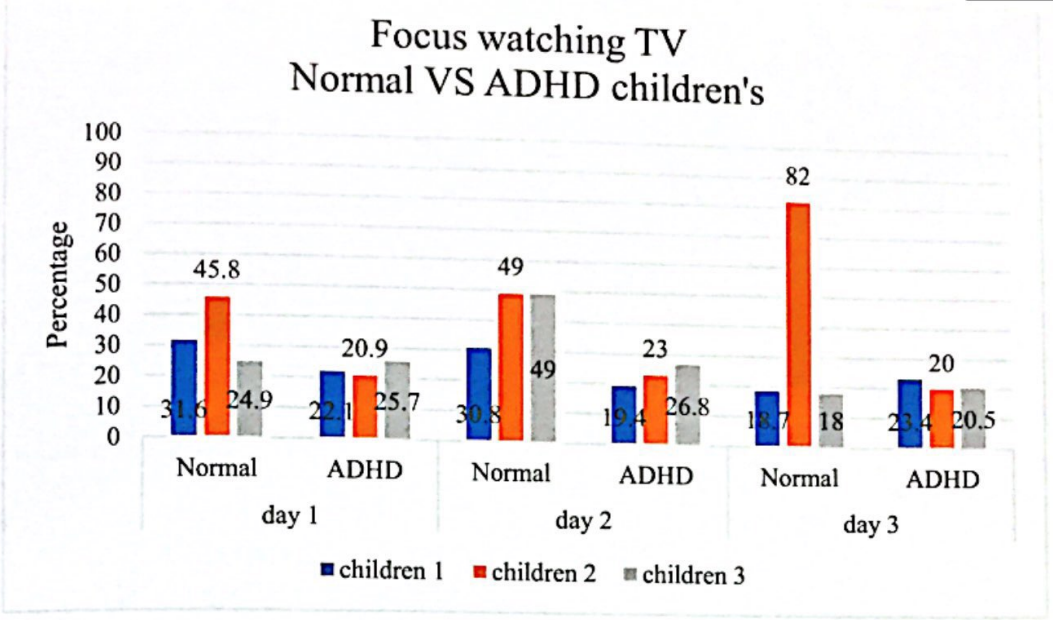


Figure 4.12: Graph focus watching TV Normal VS ADHD children's

For figure 4.12, we can see the graph is about the graph focus watching TV. In this graph, we can conclude a normal children also have a better level of focus then ADHD children. But the difference is still not have a big difference between normal children's and ADHD children's but still we can see a difference. In this case, we also conclude an ADHD children's is more focus when watching TV then doing study, but the difference is not too much

4.5.4 Minimum and maximum level focus doing study and watching TV for normal and ADHD children

The table 4.10 show the maximum level of focus and minimum level of focus for normal children and ADHD children doing study and watching TV.

Table 4.10: Maximum and Minimum level of focus for Normal and ADHD children's

	study	TV
Normal (max)	24.26	27.50
Normal (min)	7.92	6.02
ADHD (max)	7.83	8.98
ADHD (min)	4.67	6.51

4.6 CALCULATION LEVEL OF FOCUS FOR NORMAL CHILDREN'S AND ADHD CHILDREN'S IN PERCENTAGE

The calculation below show how to calculate the percentage of focus for a small group for this project

Percentage (calculation).

$$\text{Study} = \frac{\text{level (m)}}{\text{Normal (max)} + \text{Normal (min)}} \times 100\%$$

$$\text{Study} = \frac{\text{level (m)}}{24.26 + 7.92} \times 100\%$$

$$\text{TV} = \frac{\text{level (m)}}{\text{Normal (max)} + \text{Normal (min)}} \times 100\%$$

$$\text{TV} = \frac{\text{level (m)}}{27.50 + 6.02} \times 100\%$$

4.7 TRAIN ADHD CHILDREN'S

For this section, collect data only need 1 subject ADHD children's. This section need only 6 week to train the ADHD children's. Every week only need 1 time training, the training doing in 10 minute only. After that, 2 week need to see the improvement from the training. To see the improvement data collection use the same technic from the previous data, which is collect data to see the level of focus doing study and watching TV. For this training session we choose ADHD children's 3 to train.

Table 4.11 below shown a data and reading ADHD training to increase a betawave

Table 4.11: Training data ADHD children

Week	W5	W6	W7	W8	W9	W10
Situation	Focus on the toys car and try to move the toys car					
length (m)	60.18	56.60	55.48	51.98	64.26	59.88

From the table 4.11, the graph is generated by the Microsoft Excel, and the graph is shown in the figure 4.13.

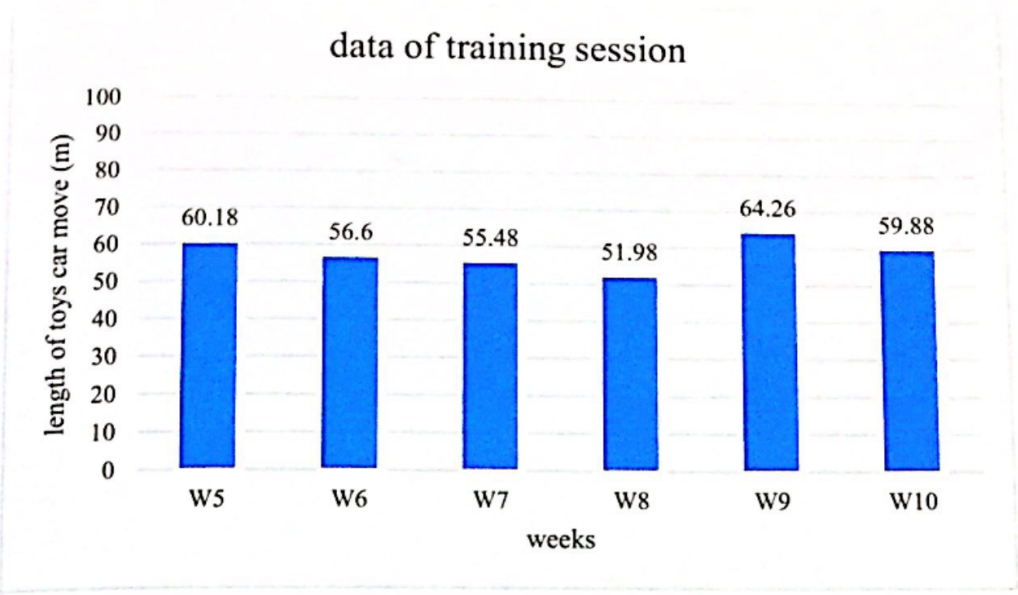


Figure 4.13: Graph of training session

The figure 4.13 shown the graph of ADHD (children 3) training session for 6 weeks. At the graph we can see, how long the ADHD children can stay focus on toys car to move the toys car in 10 minute duration. At the graph we can see level focus for ADHD children on the toys car decrease every week from week 5 to week 8. After that, level focus increase again at week 9 but decrease again at week 10. The increase and decrease level focus for 6 weeks, we can say it still have level focus that stable because increase and decrease is not too much.

4.7.1 Result after train

Table 4.12: Data improvement after the training

Days	Day 1				Day 2			
Improvement	before		after		before		after	
Activity	study	TV	study	TV	study	TV	study	TV
Level (%)	24.3	26.8	24.5	22.3	24.3	26.8	23.7	27.1

From the table 4.12, the graph is generated by the Microsoft Excel, and the graph is shown in the figure 4.14.

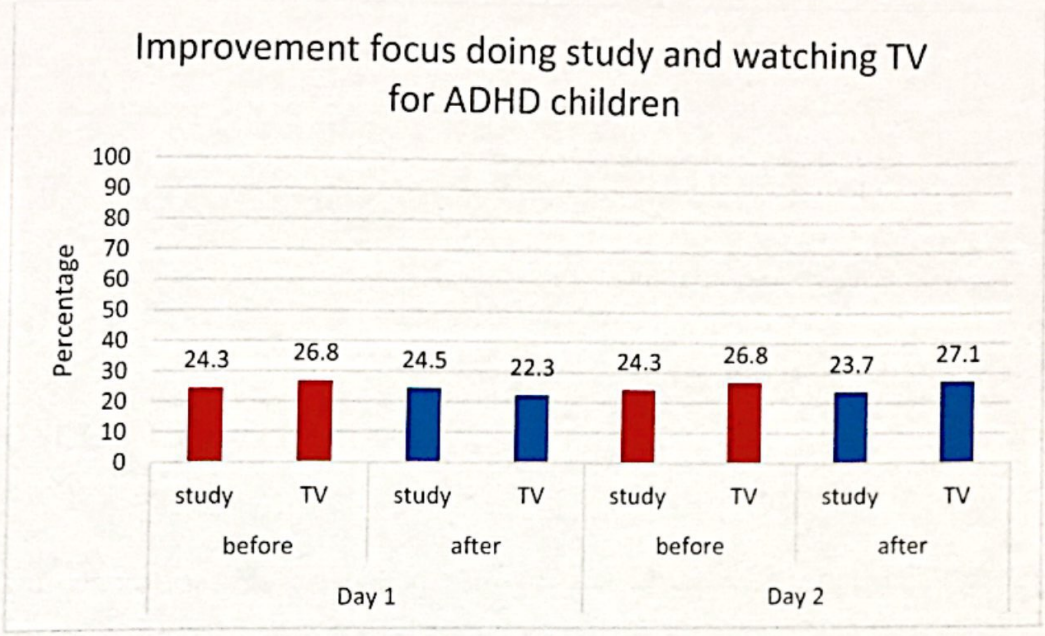


Figure 4.14: Graph of improvement focus doing study and watching TV for ADHD children

Figure 4.14 show the result of improvement focus for ADHD children's after 6 weeks training to increase focus (betawave). From the result, we can see before and after training still have a similar level before training that is the level focus still in range 15% above and below 27%. This is because training session need more time that is 6 month or 30 session of training.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

As a conclusion, the main focus of this studies is to innovate a device that improves focus for ADHD children's by controlling toys car using beta wave, and it have achieved the objective, which is to innovate the device that improve focus for ADHD children's by controlling toy car using Beta Wave. This project also prove that normal children's have a high concentration than ADHD children's, which percentage of focus normal children's range between 20% - 80%. However, for ADHD children's, their percentage between 15% - 27%. To train ADHD children's to be more concentrate and focus need more time to prove it.

Besides, a usability test was done in 5 normal adult subjects, a questionnaire was distributed to determine the user comfortability and user friendly of the device. After that, the data will be analysis by using Microsoft Excel. At the end, the result was prove the user comfortable during testing but it a bit difficult to set up the device.

5.2 RECOMMENDATION

There are a recommendation from staff of Special Education Centre for children which is suitable to use on all children's that have attention disorder just not only for ADHD children's and also recommend to multiply a toys such as helicopter, train, to grab attention of the children's to will be not bored. If this studies has given more time, which it better for prove this device was more reliable and has long term effect on enhance the focus of ADHD children's.

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POLITEKNIK Sultan Salahuddin Abdul Aziz Shah

BACHELOR OF ELECTRONIC ENGINEERING TECHNOLOGY (MEDICAL ELECTRONIC) WITH HONOURS

Survey Question About ADHD Children

NAME :.....

POSITION :.....

ADDRESS :.....

1 – VERY DISAGREE

2 – DISAGREE

3 – AVERAGE

4 – AGREE

5 – VERY AGREE

NO	QUESTION	1	2	3	4	5
1	Make Careless mistakes in shoolwork, at home or with other activities ?					
2	Has trouble holding attention on tasks or play activities ?					
3	Does not seem to listen when spoken to directly ?					
4	Does not follow through on instructions and fails to finish shoolwork ?					
5	Has trouble organizing tasks and activities ?					
6	Often avoids, dislikes, or is reluctant to do tasks that require mental effort over a long period of time (such as shoolwork or homework) ?					
7	Often loses things necessary for tasks and activities (e.g school material, pencil, tools, eyeglases, money) ?					
8	Often easily distrcted ?					
9	Often forgetful in daily activities ?					
10	Does not give eye contact to other people when speak?					

APPENDICE B: Consent form

Politeknik Sultan Salahuddin Abdul Aziz Shah
Persiaran Usahawan, Seksyen U1,
40150 Shah Alam,
Selangor Darul Ehsan.
Tel : 603-51634000 Fax : 603-55691903 Laman Web : www.psa.edu.my

Rujukan Kami:PSA/JKE/06/04/004 JLD 6 (39)
Tarikh: 26/1/2017

Kepada,

Guru besar,
Sekolah Kebangsaan Cenderawasih,
Peti Surat 60035,
91110 Lahad Datu,
Sabah

Tuan,

KEBENARAN UNTUK MELAKSANAKAN PROJEK TAHUN AKHIR PROGRAM IJAZAH SARJANA MUDA TEKNOLOGI KEJURUTERAAN ELEKTRONIK (ELEKTRONIK PERUBATAN) DILUAR

Dengan segala hormatnya adalah disahkan bahawa pelajar berikut merupakan pelajar Jabatan Kejuruteraan Elektrik, Politeknik Sultan Salahuddin Abdul Aziz Shah bagi Program Ijazah Sarjana Muda Teknologi Kej.Elektronik (Elektronik Perubatan) dengan kepujian, semester lima.

BIL	NAMA	NO.MATRIK
1.	AZWAN BIN ABBAS	08BEU15F3003

Pelajar tersebut dikehendaki menyiapkan kajian dan projek berkaitan dengan kursus seperti yang dinyatakan di bawah:

TAJUK PROJEK: Innovate The Device That Improve Focus For Adhd Kids By Controlling Toy Car Using Beta Wave
KOD/ KURSUS: BEU5173 & Project I

2. Sehubungan itu, kerjasama tuan adalah dipohon untuk membenarkan pelajar-pelajar tersebut mendapatkan maklumat yang berkaitan daripada organisasi tuan. Sekiranya terdapat sebarang pertanyaan, tuan boleh menghubungi Puan Rusnani Bt Yahya di talian 013-3673755.

3. Segala kerjasama dari pihak tuan didahului dengan ucapan ribuan terima kasih.
Sekian, terima kasih.

"BERKHIDMAT UNTUK NEGARA"

Saya yang menurut perintah,

(ROSHIDI BIN ZAKARIA)
Ketua Jabatan Kejuruteraan Elektrik

POLITEKNIK Sultan Salahuddin Abdul Aziz Shah

BACHELOR OF ELECTRONIC ENGINEERING TECHNOLOGY (MEDICAL ELECTRONIC) WITH HONOURS

Survey Question About Usability test the device that Improve Focus for ADHD Kids

NAME :.....

AGE :.....

OCCUPATION :.....

1 – VERY DISAGREE

2 – DISAGREE

3 – AVERAGE

4 – AGREE

5 – VERY AGREE

QUESTION	1	2	3	4	5
Comfortability					
This device is easy to use					
Easy to set all part of the device					
Mindwave fit and comfortable use at head					
Toys car move in good condition					
Design					
The design is suitable to be use in everywhere					
The design is light in weight					
The design is easily to be carried					

RECOMMENDATION

.....

```
#define LED 13
#define BAUDRATE 57600
#define DEBUGOUTPUT 0
#define powercontrol 10

// checksum variables
byte generatedChecksum = 0;
byte checksum = 0;
int payloadLength = 0;
byte payloadData[64] = {0};
byte poorQuality = 0;
byte attention = 0;
byte meditation = 0;

// system variables
long lastReceivedPacket = 0;
boolean bigPacket = false;
```

```
void setup()

{
 pinMode(7, OUTPUT);
 pinMode(8, OUTPUT);
 pinMode(9, OUTPUT);
 pinMode(5, OUTPUT);
 pinMode(6, OUTPUT);
 pinMode(10, OUTPUT);

 pinMode(LED, OUTPUT);
 Serial.begin(BAUDRATE);
}
```

```
byte ReadOneByte()

{
  int ByteRead;
  while(!Serial.available());
  ByteRead = Serial.read();

#if DEBUGOUTPUT
  Serial.print((char)ByteRead);
#endif

  return ByteRead;
}
```

```
void loop()

{
  // Look for sync bytes
  if(ReadOneByte() == 170)
  {
    if(ReadOneByte() == 170)
    {
        payloadLength = ReadOneByte();

        if(payloadLength > 169)                    //Payload leng
        return;
        generatedChecksum = 0;
        for(int i = 0; i < payloadLength; i++)
        {
        payloadData[i] = ReadOneByte();                    //Re
        generatedChecksum += payloadData[i];
        }

        checksum = ReadOneByte();                  //Read checks
        generatedChecksum = 255 - generatedChecksum;
```

```
        if(checksum == generatedChecksum)
        {
          poorQuality = 200;
          attention = 0;
          meditation = 0;

          for(int i = 0; i < payloadLength; i++)
          {
          switch (payloadData[i])
          {
          case 2:
            i++;
            poorQuality = payloadData[i];
            bigPacket = true;
            break;
          case 4:
            i++;
            attention = payloadData[i];
            break;
          case 5:
            i++;
            meditation = payloadData[i];
            break;
```

```
          case 0x83:
            i = i + 25;
            break;
          default:
            break;
          } // switch
        } // for loop
```

```
#if !DEBUGOUTPUT

        // *** Add your code here ***

        if(bigPacket)
        {
          if(poorQuality == 0)
            digitalWrite(LED, HIGH);
          else
            digitalWrite(LED, LOW);

          Serial.print("PoorQuality: ");
          Serial.print(poorQuality, DEC);
          Serial.print(" Attention: ");
          Serial.print(attention, DEC);
          Serial.print(" Time since last packet: ");
          Serial.print(millis() - lastReceivedPacket, DEC);
          lastReceivedPacket = millis();
          Serial.print("\n");
```

```
          switch(attention / 10)
          {
          case 0:
             digitalWrite(8, HIGH);
             digitalWrite(7, LOW);
             analogWrite(9, 0);
             digitalWrite(5, HIGH);
             digitalWrite(6, LOW);
             analogWrite(10, 0);
           break;
         case 1:
             digitalWrite(8, HIGH);
             digitalWrite(7, LOW);
             analogWrite(9, 0);
             digitalWrite(5, HIGH);
             digitalWrite(6, LOW);
             analogWrite(10, 0);
           break;
         case 2:
             digitalWrite(8, HIGH);
             digitalWrite(7, LOW);
             analogWrite(9, 0);
             digitalWrite(5, HIGH);
             digitalWrite(6, LOW);
             analogWrite(10, 0);
           break;
```

```
        case 3:
           digitalWrite(8, HIGH);
           digitalWrite(7, LOW);
           analogWrite(9, 0);
           digitalWrite(5, HIGH);
           digitalWrite(6, LOW);
           analogWrite(10, 0);
          break;
        case 4:
           digitalWrite(8, HIGH);
           digitalWrite(7, LOW);
           analogWrite(9, 0);
           digitalWrite(5, HIGH);
           digitalWrite(6, LOW);
           analogWrite(10, 0);
          break;
        case 5:
           digitalWrite(8, HIGH);
           digitalWrite(7, LOW);
           analogWrite(9, 0);
           digitalWrite(5, HIGH);
           digitalWrite(6, LOW);
           analogWrite(10, 0);
          break;
```

```
        case 6:
           digitalWrite(8, HIGH);
           digitalWrite(7, LOW);
           analogWrite(9, 160);
           digitalWrite(5, HIGH);
           digitalWrite(6, LOW);
           analogWrite(10, 160);
          break;
        case 7:
           digitalWrite(8, HIGH);
           digitalWrite(7, LOW);
           analogWrite(9, 160);
           digitalWrite(5, HIGH);
           digitalWrite(6, LOW);
           analogWrite(10, 160);
          break;
        case 8:
           digitalWrite(8, HIGH);
           digitalWrite(7, LOW);
           analogWrite(9, 160);
           digitalWrite(5, HIGH);
           digitalWrite(6, LOW);
           analogWrite(10, 160);
          break;
```

```
            case 9:
               digitalWrite(8, HIGH);
               digitalWrite(7, LOW);
               analogWrite(9, 160);
               digitalWrite(5, HIGH);
               digitalWrite(6, LOW);
               analogWrite(10, 160);
              break;
            case 10:
               digitalWrite(8, HIGH);
               digitalWrite(7, LOW);
               analogWrite(9, 160);
               digitalWrite(5, HIGH);
               digitalWrite(6, LOW);
               analogWrite(10, 160);
              break;
          }
        }
#endif
        bigPacket = false;
      }
      else {
        // Checksum Error
      }  // end if else for checksum
    } // end if read 0xAA byte
  } // end if read 0xAA byte
}
```