T.C.

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INSTITUTE OF GRADUATE STUDIES

HAPTIC BODY POSITION IMPROVER DURING A WORKOUT

MASTER'S THESIS

Faycal BOUZOUIDJA

Department of Mechanical Engineering
Mechanical Engineering Program

APRIL, 2023

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DECLARATION

I hereby declare with respect that the study “HAPTIC BODY POSITION IMPROVER DURING A WORKOUT”, which I submitted as a Master thesis, is written without any assistance in violation of scientific ethics and traditions in all the processes from the Project phase to the conclusion of the thesis and that the works I have benefited are from those shown in the Bibliography. (14/04/2023)

Faycal BOUZOUIDJA

FOREWORD

I would like to thank my thesis advisor Dr. Öğr. Üyesi Rıza İLHAN for his endless help while completing my study.

I would also want to express my sincere thanks to my family, friends, for their support and encouragement during the course of my years of education as well as the process of conducting research for and writing my thesis. Without them, this feat would not have been possible.

April, 2023 Faycal BOUZOUIDJA

HAPTIC BODY POSITION IMPROVER DURING A WORKOUT

ABSTRACT

Fitness is one of the popular physical activities performed individually most of the time. While doing an activity, if the proper posture is not adopted, it can result in major injury that makes it difficult to lead a healthy life. By adopting wearable technology and haptic technology not only correct motion could be achieved but also damages due to wrong motion could be prevented. In this article we introduce a simple and convenient wearable device that can sense the position of the body during the exercise and provide haptic feedback if an improper motion was performed. The wearable system includes four gyroscopes and four-coin types of vibration motors. The body position was recorded using gyroscopes and haptic feedback was applied using vibration motors. To test the system three positions were chosen and tested on five participants. The results show that the device can be used by people to have an injury-free activity where a coach is not available. Using wearable technology accompanied by the haptic feedback will improve the skills and will lead to an injury free exercise.

Keywords: Haptic, Sport, Wearable devices

ANTRENMAN SIRASINDA DOKUNUŞLU VÜCUT POZİSYONU İYİLEŞTİRME

ÖZET

Fitness, çoğu zaman bireysel olarak gerçekleştirilen popüler fiziksel aktivitelerden biridir. Fitness, bir aktiviteyi yaparken çoğu zaman bireysel olarak gerçekleştirilen popüler fiziksel aktivitelerden biridir. Bir aktivite yapılırken doğru duruş benimsenmezse sağlıklı bir yaşam sürmeyi zorlaştıran büyük yaralanmalara neden olabilir. Giyilebilir teknoloji ve dokunsal teknoloji benimsenerek doğru hareket elde edilebileceği gibi yanlış hareketten kaynaklanan zararlar da önlenebilir. Bu yazıda, egzersiz sırasında vücudun pozisyonunu algılayabilen ve yanlış bir hareket yapıldığında dokunsal geri bildirim sağlayan basit ve kullanışlı bir giyilebilir cihazı tanıtıyoruz. Giyilebilir sistem, dört jiroskop ve dört madeni para tipi titreşim motoru içerir. Vücut pozisyonu jiroskoplar kullanılarak kaydedildi ve titreşim motorları kullanılarak dokunsal geri bildirim uygulandı. Sistemi test etmek için üç pozisyon seçildi ve beş katılımcı üzerinde test edildi. Sonuçlar, cihazın bir koçun bulunmadığı yerlerde yaralanmasız bir aktiviteye sahip olmak için insanlar tarafından kullanılabileceğini göstermektedir. Dokunsal geri bildirim eşliğinde giyilebilir teknolojiyi kullanmak, becerileri geliştirecek ve yaralanmasız egzersize yol açacaktır.

Anahtar Kelimeler: Haptik, Spor, Giyilebilir cihazlar

TABLE OF CONTENT

ABBRIVIATIONS

DMP : Digital Motion Processor

HFB : Haptic Feedback

VM : Vibration Motors

WT : Wearable Technology

LIST OF TABLES

LIST OF FIGURES

I. INTRODUCTION

Haptics is a rapidly growing and advancing field of technology that focuses on providing a sense of touch in the digital world. This technology is based on the science of mechanics and physics, which allows people to interact with virtual environments and machines by providing tactile feedback. This is done through the use of haptic devices, which can be used to create a realistic, artificial sense of touch. Haptic word is originated from the Greek word "haptós" (tangible) (Hatzfeld & Kern, 2014a; URL-1), "haptikós" (appropriate to touch) (URL-1) or "haptesthai" (to touch) (Hannaford & Okamura, 2008). Haptic technology can be used in a variety of applications, from gaming and virtual reality to medical and industrial applications. Haptic technology has the potential to revolutionize how people interact with computers and other devices by providing an intuitive and immersive experience that goes beyond what traditional displays can provide.

A. Human Haptic System

Haptic signals formed in the muscles, tendons, joints and skin reach the brain via the human nervous system. With the help of these signals reaching the brain, it senses the speed of the moving body, the position of the body, arms and legs and if it is in contact with an object, the temperature, weight, surface properties of that object. In short, its geometry and material properties. The haptic interaction that creates the sensory signals to the brain is divided into two types (Lederman & Klatzky, 2009);

1- Cutaneous perception
2- Kinesthetic perception

Cutaneous perception is the perception of heat, pressure, vibration, slip and skin deformations that give the feeling of pain. Tactile perception signals are generated by cutaneous (or tactile) receptors. The types of cutaneous receptors found in the whole skin with or without hair (Lederman & Klatzky, 2009) and in different layers of the skin (Lederman & Klatzky, 2009) are as follows;

1. Mechano-receptors; They are receptors that detect pressure, vibration, stinging sensations.
2. Thermo-receptors; They are receptors that detect temperature changes in the skin.
3. Noci-receptors; They are receptors that detect the sensation of pain.

The type of a mechano-receptor varies according to the stimulus area and the speed of adaptation to the constant stimulus (Hatzfeld, 2014b). It is indicated by a small I or a large II depending on the area. If the rate of adaptation is slow, it is indicated by SA, and if it is high, it is indicated by RA (or FA) (Hatzfeld, 2014b). Merkel disc responds to pressure at 0-10 Hz, Meissner corpuscle responds to light tapping at 3-50 Hz, Ruffini body responds to skin stretching or joint movements at 0-10 Hz, and Pacinian corpuscle responds to rapid vibration within 100-500 Hz (MacLean, 2008). Mechano-receptors are more concentrated in hairless body regions. In regions with high density, hairless body regions can perceive finer details than hairy body regions (MacLean, 2008).

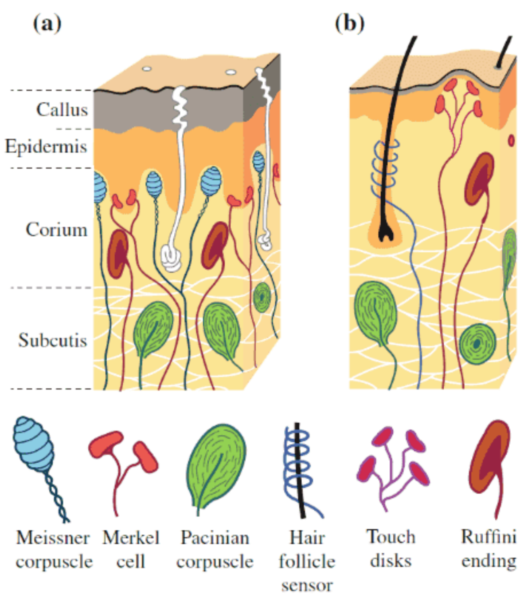

Figure 1.1 (a) Hairless and (b) Hairy skin mechano-receptors (Hatzfeld, 2014b).

Kinesthetic (proprioceptive) perception is spatial perception. It is the internal perception of body position and displacements through muscles, tendons, and joints. Kinesthetic perception signals are generated by two groups of kinesthetic receptors called Golgi tendon organ and Neuromuscular spindles (Nuclear bag fibers and Nuclear chain fibers) (Hatzfeld, 2014b). The accuracy of kinesthetic receptors varies according to the properties of the joint they are located in. For example, while the receptors in the shoulder joint detect a difference of 1° (Alur, Shrivastav, & Jumde, 2014), the receptors in the hip joint can detect a minimum difference of 0.22°, and this value increases up to 4.4° in the finger joints (Hatzfeld, 2014b).

Kinesthetic and cutaneous perception are used for object recognition. Especially when the sense of sight is not available. There are four types of haptic perception used in object discovery: tactile (cutaneous) active perception, tactile (cutaneous) passive perception, kinesthetic active perception and kinesthetic passive perception. Moving our finger over the surface to explore the surface texture on a fixed surface is a good example of tactile active perception (Rodríguez, et al., 2019). The vibration motor of a smart watch, which is a wearable tactile device, vibrating our wrist is an example of tactile passive perception.

B. Haptic Interfaces

Interaction with the surrounding is done using visual and tactile information. Haptic interaction can be done by a human hand or by a machine. Haptic interaction could take place places in real environments as well as environments built on virtual reality. These machines and devices used to enter haptic communication in virtual reality or real environments are called haptic interfaces. The haptic interface can be integrated in to simple systems such as a computer keyboard and mouse, or complex systems such as a haptic feedback robot used for surgery. The common feature of all haptic interfaces is that they must be programmed in the computer environment in accordance with the haptic interaction to be created. Today, haptic interfaces are found in a wide range of applications such as education, military and surgical applications. Research and studies carried out in line with the needs of these diverse uses have contributed to the development of haptic interfaces.

1. Since the body and system elements used in the design of haptic interfaces vary according to the desired needs, haptic interfaces can be grouped based on their input

and output (Impedance and Admittance controlled systems) (Hannaford & Okamura, 2008); (Van der Linde, Lammertse, & Erwin, 2002) , Interaction type and Interaction device. Examples of some of haptic devices are seen in following figures.

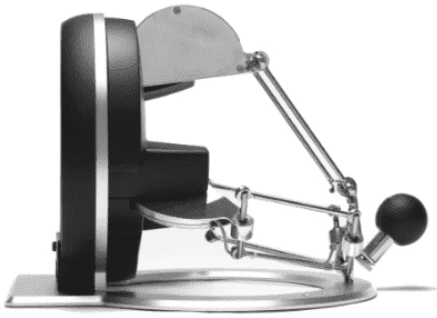

Figure 1.2 Force Dimension - Omega 3 parallel haptic device (URL-2).

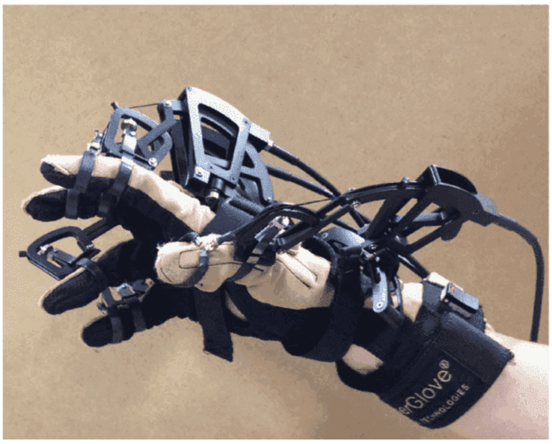

Figure 1.3 Cybergraps wearable haptic glove (Otaduy, Garre, & Lin, 2013).

Figure 1.4 FEELEX 1 active surface haptic system (Iwata, Yano, Nakaizumi, & Kawamura, 2001)

II. BACKGROUND

There is no doubt that regular physical activity and exercise improve both physical and mental health. Exercise has several well-known health advantages, including helping people manage their weight, preventing diseases, enhancing mental stability, and promoting better sleep. However, doing the wrong move can cause serious injury. The fast-paced world has come to a complete stop due to the COVID-19 pandemic in recent years. The pandemic's effects are severe, and social segregation is the only method for slowing the disease's rapid spread. The imposed lockdown has hampered many aspects of people's lives, including routine fitness activities of fitness freaks, which has led to a variety of psychological issues and serious fitness and health concerns (D'Aurizio et al., 2020). Therefore, people have to perform fitness tasks individually that will impose their bodies at a risk.

Getting hurt in fitness is very common. Muscle pull, Shoulder damage, Knee dislocation, etc. are examples of these damages. There are some guidelines to avoid injury such as warming up, stretching, cooling down, and adjusting duration, time, and frequency. However, even if a person performs all these items, there is still a chance of getting hurt due to the wrong motion. Especially when there is no coach to control these parameters, the possibility of getting damaged increases. According to the study by Gray et al. (Gray & Finch, 2015) which was performed on 2,873 cases, it was identified that injuries due to overexertion were the most common (36.2% of all cases) among all the injuries. To control these damages new technologies such as wearable and haptic technologies could be adopted.

Wearable technology has gained popularity across the globe, whether in the shape of a device or accessory. As its name suggests, is a technology that a person can wear. This could be a clip-on item, or it could be the clothes themselves. They remain close to the wearer and capture information about the body. Despite the negative repercussions of utilizing these technologies, some of them are becoming more focused on enhancing human health (Trabal, 2008). These tools are made to assist users in planning their activities and making better decisions. These devices' interfaces provide users the ability to browse through daily data and monitor their development. Due to their greater accessibility and availability in places where healthcare professionals are not always present, wearable gadgets are finding widespread use in rehabilitation therapy programs.

Besides wearable devices, haptic science grabs much more attention when they are combined with wearable technology for physical therapy. Haptic feedback is computer-controlled feedback that the human body perceives as a sense of touch (Lécuyer et al., 2004). This feedback and its effect are achieved by a device that transfers different modalities like the vibration from a computer to a user.

A. Haptic in Sport

Fitness is one of the most popular sports in society and its popularity growing over the years. According to the statistics working out with weights ranks first in the USA (Wallace et al., 2022) over the past 12 months. However, lifting strategies may cause injury in the body which mostly occurs in the lower back and shoulders. Results are acute and traumatic which require hospital treatment (Kerr et al., 2010). Due to a lack of supervision, a technological solution must be utilized to prevent these injuries.

Several studies address using technological advancement for rehabilitation, motor learning, and position awareness (van Erp et al., 2006), (Alahakone & Senanayake, 2009), (Van Breda et al., 2017). Kim et al. (Kim et al., 2018) developed the ErgoTac device to improve human ergonomics in the execution of heavy or repetitive industrial tasks. The developed wearable device was tested on ten subjects. The results showed that the physical overloading could be reduced using ErcoTac. In another application, a gadget was introduced by Visser et al. (Visser & Mader, 2018) for posture correction. To correct the posture of the user, haptic feedback is applied at the back. The provided tactile feedback keeps the body positioned up straight. Ghasemzadeh et al. introduced a golf swing training system that incorporates wearable motion sensors to obtain inertial information. A model was developed which was later used to evaluate the effectiveness of the proposed solution (Ghasemzadeh et al., 2009).

In some applications Electrical Muscle Stimulation (EMS) were used to guide the body to the desired position. Let Your Body Move toolkit was developed by Pfeiffer et al. (Pfeiffer et al., 2016; Schneegass et al., 2016) using EMS. Tactile feedback was felt at the position at which the current is applied. The perceived strength depends on the amount of current, pad size, and density of receptors in the skin. The system showed potential in areas like learning movements, recognition, and recall. EMS has also been used to create heavy object feeling in virtual reality in which haptic EMS effects were used to demonstrate the effectiveness of the solution (Lopes et al., 2017). Besides, electrical stimulation was utilized in a study by Wiesener et al. (Wiesener et al., 2020) to control people with lower back damage while swimming. Waterproof electrodes and inertial measurement units (IMUs) were used for training and conditioning. In some studies, the Trackstar motion capture system was adopted by the researchers. Although this device provides the possibility to capture the body motion it is expensive and bulky to implement in real life (Kapur et al., 2010), (Bark et al., 2011).

The other application mostly emphasized on sensing than providing haptic feedback. These applications which rely on different innovations were summarized in (Chambers et al., 2015), (Jaramillo-Yánez et al., 2020), (Huang et al., 2017), (Chander et al., 2020). One of these applications was the assessment of foot kinematics during running to prevent injury in running. Biomechanics and errors in applied training loads are often cited as causes of running-related injuries (Willy, 2018). Foot-mounted inertial sensors were employed to assess foot kinematics in the steady state running (Bailey & Harle, 2014). Therefore, running-related mechanics were identified. In other studies such as (Roetenberg et al., 2007) and (Rouhani et al., 2012), wearable sensing device was integrated into a different position on the body for gait analysis and intervention (Shull et al., 2014).

In this paper, we use sensors and actuators to guide users who are lifting heavy weights in the gym. The device is composed of simple, affordable, easy-to-control parts that demonstrate the potential of using this method to prevent injuries in physical therapy.

III. METHODOLOGY

As stated earlier when performing a physical activity like lifting a heavy object, the body might be injured not only because of the excess weight but also because of the wrong motion. When lifting is done huge mechanical load is applied to the different parts of the body involved in the motion. In most cases, the hand is used to lift the object. This may result in shoulder pain, shoulder tendon injury, a twist, an unwanted load to the spinal cord, etc. For this reason, five positions related to the upper part of the body were selected for the study. They are Dabbling curl hammer, Biceps with dumbbells, Forearm with dumbbells, Shoulder press dumbbells and lateral shoulder.

A. Exercises

1. Dabbling Curl Hammer

The dumbbell hammer curl is an arm builder exercise and is used to develop arm thickness by affecting the arm's muscles. To perform this motion feet stand together about shoulder length apart with a slight bend in the knee. Elbows are kept slightly in front of the hips to make sure that the biceps are engaged during the motion. Dumbbells are raised 90 degrees and back down.

Figure 3.1 Shows Dabbling curl hammer dumbbell performed by a subject in correct and incorrect. In the correct position hands are straight with 90 degrees angle.

2. Shoulder Press Dumbbells

The shoulder press dumbbell is a shoulder exercise that not only trains shoulder muscles but also other muscles such as forearms. To perform this motion the subject is sat on an upright bench. Dumbbells are held above the shoulder where the palm is facing away from the body. The weight is pushed toward the ceiling until the elbows are reached a straight position. The weight should not slam together.

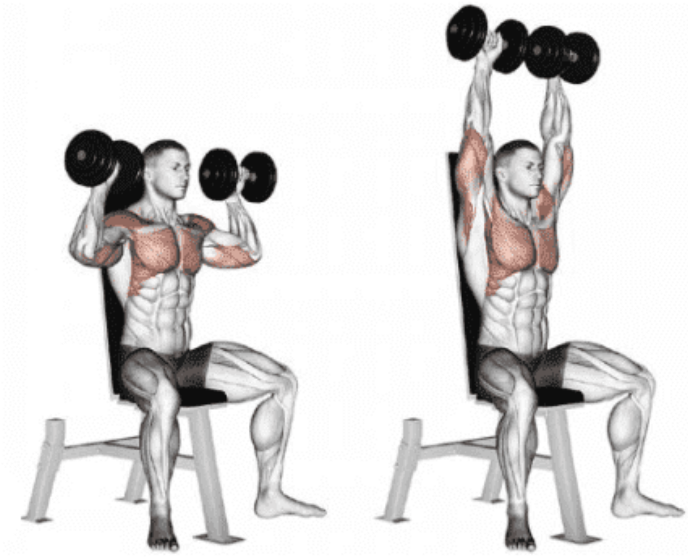

Figure 3.2 Shows Dabbling curl hammer dumbbell performed by a subject in correct and incorrect. In the correct position hands are straight with 90 degrees angle.

3. Lateral Shoulder

The shoulders are made of different muscles such as the anterior, the lateral, and the posterior deltoid. This motion is adopted to put pressure on the shoulder muscles. To perform this motion, the weights are held next to the side of the body about shoulder apart and with a slight bent in the elbows and knees. They are raised straight out to the sides.

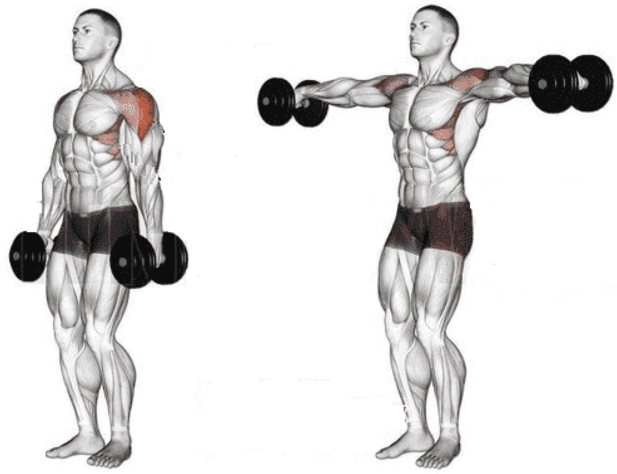

Figure 3.3 Shows Dabbling curl hammer dumbbell performed by a subject in correct and incorrect. In the correct position hands are straight with 90 degrees angle.

B. Measurements

The developed wearable gadget consists of two parts sensing and actuation. Both parts are cost-effective and easy to use. The sensing part is composed of four 6-axis MPU 6050 motion tracking devices. It can measure acceleration in x, y, and z direction and Roll, Pitch, and Yaw angle simultaneously. It has a small 4 mm × 4 mm size without an installation board which works based on the I2C communication protocol. It includes different full-scale ranges and sensitivity. In this application, ±20g and a sampling rate of 500 Hz were selected. For actuation, four coin-type vibration motors were chosen (Fig. 1). Both units were glued to a fabric pad and were wrapped around the hand using a Velcro fabric strip. They were fastened to a position close to the wrist and to the shoulder. The actuators will be activated if sensors detect deviation from desired locations. To control the system two Arduino UNO microcontroller for each hand was used. To select a specific motion program five switches were considered. When a switch was turned on, a dedicated program to that exercise was activated. The whole system was put in a bag for easy carrying and to avoid interfering a motion while doing an exercise.

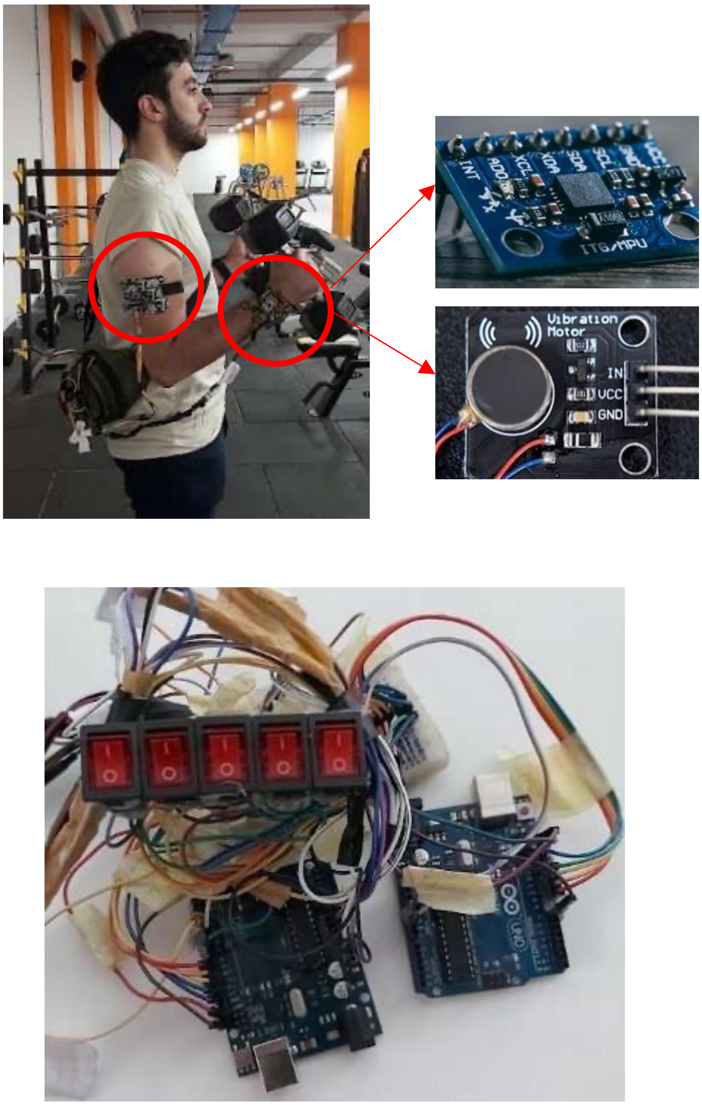

Figure 3.4 The system is composed of two Arduino boards. Four 6-axis MPU 6050 gyroscopes and four coin-type vibration motors. Five switches were integrated into the system to select the specific exercise. However, three motion was chosen. The whole system was carried in a bag which was fastened around the us

IV. EXPERIMENTAL EVALUATION

The data related to each motion were observed in two phases. In the first phase, the proper movement for each subject was recognized and acceleration data related to the motion were recorded. In the second section, participants were asked to perform arbitrary movements and check if they feel vibration feedback in their arms. All these procedures were performed in one session to have accuracy in recording and not missing sensors' proper locations. Note that only acceleration data were noticed and the orientation part was not considered.

The performance of the system was evaluated on 5 participants. Four males and one female (Mean age 22.4 ±8.1, age range 20-30 years) participated in the study after signing a written informed consent. Three subjects had prior exercise experience in the gym. Each subject was requested to perform each motion in two sets and ten repetitions. In the end, they were required to answer the questions regarding their experience and rate it from one to ten. Where one is the lowest score and ten is the highest. Figure 2 shows the correct and incorrect motions when a subject performs all the exercises using the wearable gadget.

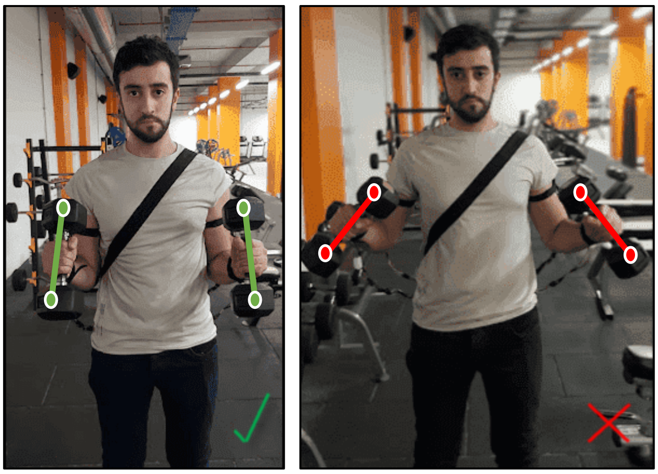

Figure 4.1 Shows Dabbling curl hammer dumbbell performed by a subject in correct and incorrect. In the correct position hands are straight with 90 degrees angle.

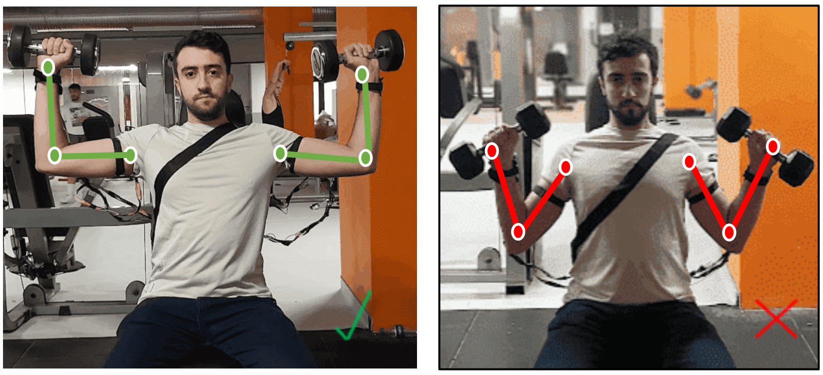

Figure 4.2 Shows Shoulder press dumbbell performed by a subject in correct and incorrect. Subject start from 90 degrees angle in the ankle and raise the weights.

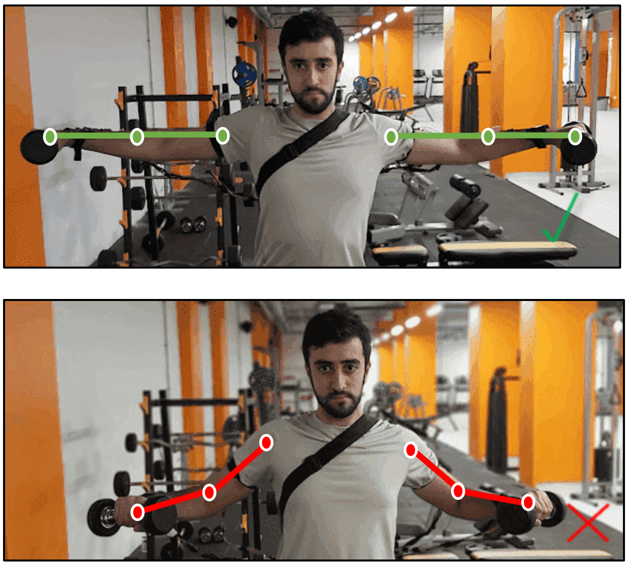

Figure 4.3 Shows Lateral shoulder performed by a subject in correct and incorrect positions. Subject tries to hold the weight in a straight position.

V. RESULT AND DISCUSSION

Table 1 was prepared according to the answers provided by the subjects. It could be inferred from this table that nearly all of the participants found the gadget useful and prefer to use it in the future. And also found the location of the sensor and actuator suitable for the experiment. However, most found the intensity of the vibration inadequate which requires increasing intensity. However, according to questions 1 and 2, they have been able to recognize the position of the vibration motors. Some participants suggested adjusting the vibration according to the occurred error. This means lower error between desired and current location will lead to a lower vibration rate and vice versa. This idea will be considered in the future.

Table 1 Following questions were asked from participants after performing an exercise

1	To what extent were you able to locate the vibrations generated by vibrations motors?	**7**
2	To what extent were you able to identify the location of the vibration along the hand?	8
3	How suitable are the vibration intensities for you?	6
4	How well did you feel the accelerometers and vibration motor were properly located?	9
5	To what extent did you need a training stage?	4
6	To what extent do you think the gadget?	6
7	How is useful as an add-on for sports?	9
8	How uncomfortable were the cables for you?	5

Based on the 5, most of the users indicated that no training was needed. This shows how easy to use and applicable the proposed system is. Besides cables were stated to be problematic for subjects which this point will be considered in the future development the more compact communication system will be developed.

VI. CONCLUSION

In this study, the wearable device capable of providing tactile feedback to a subject while doing an exercise was introduced. The provided haptic feedback was utilized to guide the user to correct the motion and avoid injury during the gym activity. The system is composed of a set of sensors and actuators to record the hand position and apply vibration. The performance of the proposed method was tested by five participants in a real case. The results show that haptic feedback could be used in sports as an essential tool to avoid injury.

VII. FUTURE WORK

The first point to consider in the future study is to develop a wireless system that will eliminate the wiring and will provide a better motion range. This could be archived by adding Bluetooth communication ports between the control point and destinations.

Another important point is to make the prototype an autonomous system. In this system, there is no need to save the specific position data for each user. Different techniques such as artificial intelligence could be used to recognize hand postures. This will allow the current system to respond in dynamic motion than the static position which limits the application of the current prototype.

The next step could be using muscle factors. Recording muscle conditions and combining this information with the current system will avoid athletes to use excessive loads.

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APPENDICES

APPENDIX-A. MPU 6050 Gyroscope – Accelerometer Connection

The MPU-6050 is a small electronic component that contains both an accelerometer and a gyroscope, along with additional features such as temperature sensing and a Digital Motion Processor (DMP). Both the accelerometer and gyroscope are used to measure the motion and orientation of an object in 3D space, but they work in slightly different ways.

The MPU-6050 sensor can be easily connected to an Arduino board through the I2C interface. Here are the steps to connect and use the MPU-6050 with an Arduino: Connect the MPU-6050 to the Arduino using four wires: VCC to 5V, GND to GND, SDA to A4, and SCL to A5.

Download and install the I2Cdev and MPU6050 libraries for Arduino. These libraries contain code that will allow you to communicate with the MPU-6050 using the I2C protocol.Open the Arduino IDE and create a new sketch. Include the MPU6050 library and I2Cdev library at the beginning of the sketch.

Initialize the MPU-6050 by creating an instance of the MPU6050 class and calling the initialize () function. Read the sensor data from the MPU-6050 by calling the getMotion6() function. This will return the raw accelerometer and gyroscope data.

Convert the raw sensor data into meaningful values using the conversion factors provided in the MPU-6050 datasheet.

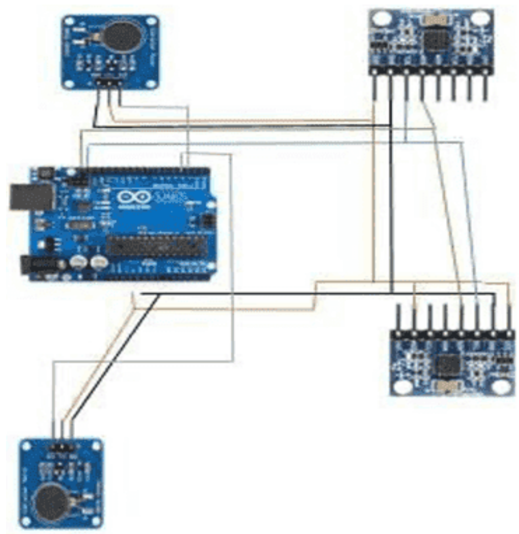

Figure A.1 Developed wearable system for right and left arm. An Arduino uno board were used as control unit.

APPENDIX-B. MPU 6050 Gyroscope - Accelerometer

The MPU-60X0 is the world's first integrated 6-axis MotionTracking device that combines a 3-axis gyroscope, 3-axis accelerometer, and a Digital Motion Processor™ (DMP) all in a small 4x4x0.9mm package. With its dedicated I2C sensor bus, it directly accepts inputs from an external 3-axis compass to provide a complete 9-axis MotionFusion™ output. The MPU-60X0 MotionTracking device, with its 6-axis integration, on-board MotionFusion™, and run-time calibration firmware, enables manufacturers to eliminate the costly and complex selection, qualification, and system level integration of discrete devices, guaranteeing optimal motion performance for consumers. The MPU-60X0 is also designed to interface with multiple noninertial digital sensors, such as pressure sensors, on its auxiliary I 2C port. The MPU-60X0 is footprint compatible with the MPU-30X0 family.

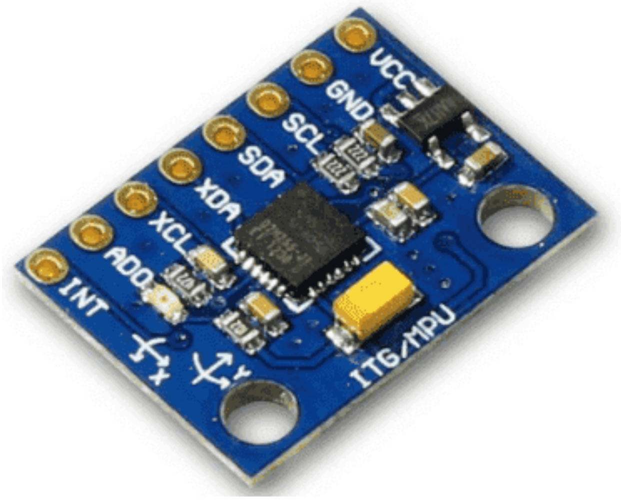

Figure B.1 MPU 6050 Gyroscope - Accelerometer https://invensense.tdk.com/wp-content/uploads/2015/02/MPU-6000-Datasheet1.pdf

APPENDIX-C. Vibration motors

In the haptic device, 4 coin type vibration motors with a diameter of 10 mm and a thickness of 3 mm, in the form of coins, without shaft were used.

Figure C.1 Coin type vibration motor (URL-3)

Inside these vibration motors is a moving disc. There are two coils on this disc and it contacts the 3-pole commutation circuit around a shaft with 2 brushes. This disk is on top of a magnet attached to the motor chassis, with which the coils on it come into contact. In the coils on the disc, the flux on the magnet interacts with the flux formed by the commutation circuit and the brushes, and thanks to this, the disc rotates. Vibration is obtained by the rotation of the disc with an off-center weight.

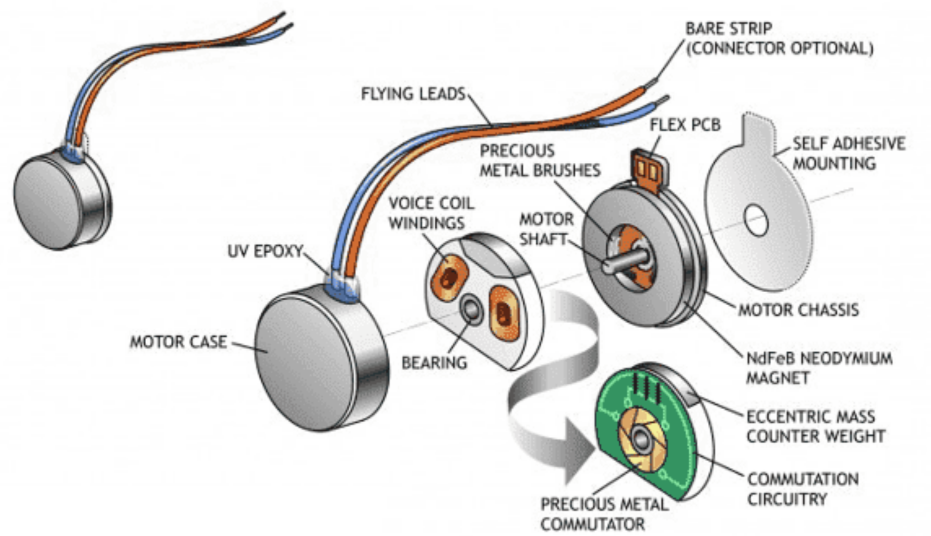

Figure C.2 Inside coin type vibration motor (URL-3).

During the experiement, the voltage of the vibration motor was kept constant as 3.5 V.

APPENDIX-D. Codes

1 - CODE OF THE DEVICE SENSOR 1 AND 2

```
#include "Wire.h" // Arduino Wire library #include "I2Cdev.h" // Install these 2 bookstores #include
"MPU6050.h"
#include "math.h"

// AD0 low = 0x68 (default for InvenSense evaluation board)
// AD0 high = 0x69
MPU6050 accelgyro1(0x68);
MPU6050 accelgyro2(0x69);// We put 5v at the Ad0 pine of the sensor 2;

int16_t ax1, ay1, az1; // raw sensor measurements 1 int16_t gx1, gy1, gz1;

int16_t ax2, ay2, az2; // raw sensor measurements 2 int16_t gx2, gy2, gz2;

float angle1 = 0; float angle2 = 0;

int vibreur1= 7 ; int vibreur2= 6 ;

int position1= 13; int position2= 12 ; int position3= 11 ; int position4= 10 ; int position5= 9 ;

void setup () {Wire.begin(); //I2C bus Serial.begin(9600);

while (! Serial) {}

Serial.println("Initialisation I2C...");

accelgyro1.initialize(); accelgyro2.initialize();

pinMode(vibrator 1,OUTPUT); pinMode(vibrator2,OUTPUT);

pinMode(position1,INPUT); pinMode(position2,INPUT); pinMode(position3,INPUT);
pinMode(position4,INPUT); pinMode(position5,INPUT);

Serial.println("Device connection test...");

Serial.println(accelgyro1. Connection test ()? "MPU6050 n°1 Successful connection “: "MPU6050
n°1 Connection failure ");

Serial.println(accelgyro2. Connection test ()? "MPU6050 n°2 Successful connection “: "MPU6050
n°2 Connection failure ");

delay (1000);}

void loop () {

accelgyro1.getMotion6(&ax1, &ay1, &az1, &gx1, &gy1, &gz1);
angle1 = 0.98 * (angle1 + float(gy1) * 0.01 / 131) + 0.02 * atan2((double)ax1, (double)az1) * 180 /
PI;

accelgyro2.getMotion6(&ax2, &ay2, &az2, &gx2, &gy2, &gz2);
angle2 = 0.98 * (angle2 + float(gy2) * 0.01 / 131) + 0.02 * atan2((double)ax2, (double)az2) * 180 /
PI;
```

```
// Serial.print(ax1); // We are not needed of this value, because it is not our axis of rotation
//Serial.print("\t");

Serial.print(ay1); // This is the axis of our rotation, so we need these values Serial.print("\t");

// Serial.print(az1); // We are not needed of this value, because it is not our axis of rotation //
Serial.print("\t");

Serial.print("\n"); // Serial.print(ax2); // Serial.print("\t");

Serial.print(ay2); // We need these values for the 2nd sensor (articulation) Serial.print("\t");

// Serial.print(az2); // Serial.println("\t");

// Serial.print(ax3); // Serial.print("\t"); // Serial.print(ay3); // Serial.print("\t"); // Serial.print(az3); //
Serial.println("\t");

//delay(500);
if ( digitalRead(position1) == HIGH & digitalRead(position2) == LOW & digitalRead(position3) ==
LOW & digitalRead(position4) == LOW & digitalRead(position5) == LOW ) {

//if (ay1 <-13000) {digitalWrite(vibrator,LOW);} // hand position is vertical down //if (ay1 >13000)
{digitalWrite(vibreur,LOW);} // hand position is vertical upwards

if (ay1 <1000 & ay1 > 0) {digitalWrite(vibrator

1,HIGH);delay(50); digitalWrite(vibrator1,LOW); delay(15); } if ( ay1 <-15000 & ay1 > -16000) {
digitalWrite(vibrator 1,HIGH);delay(50); digitalWrite(vibrator 1,LOW); delay(15); }

//
if ( ay1 >-13000 & ay1 < -15000) { digitalWrite(vibrator 1,HIGH);delay(30); digitalWrite(vibrator
1,LOW); delay(20); }
if ( ay1 <3000 & ay1 > 1000) { digitalWrite(vibrator 1,HIGH);delay(30);
digitalWrite(vibrator1,LOW); delay(20); }

//

if ( ay2 >-12000 & ay2 < -10000) { digitalWrite(vibrator2,HIGH);delay(50);
digitalWrite(vibrator2,LOW); delay(15); }
//if ( ay2 <8000 & ay2 > 6000) { digitalWrite(vibrator2,HIGH);delay(40);
digitalWrite(vibrator2,LOW); delay(20); }

if ( ay2 >-10000 & ay2 < -8000) { digitalWrite(vibrator2,HIGH);delay(30);
digitalWrite(vibrator2,LOW); delay(20); }
if ( ay2 <-12000 & ay2 > -14000) { digitalWrite(vibrator2,HIGH);delay(30); digitalWrite(vibrator
2,LOW); delay(20); }

//if ( ay1 >-4000 & ay1 < -2000) { digitalWrite(vibrator,HIGH);delay(35);
digitalWrite(vibrator,LOW); delay(20); }
//if ( ay1 <4000 & ay1 > 2000) { digitalWrite(vibrator,HIGH);delay(35); digitalWrite(vibrator,LOW);
delay(20); }

//if ( ay1 >-2000 & ay1 < -1500) { digitalWrite(vibrator,HIGH);delay(40);
digitalWrite(vibrator,LOW); delay(20); }
//if ( ay1 <2000 & ay1 > 1500) { digitalWrite(vibrator,HIGH);delay(40); digitalWrite(vibrator,LOW);
delay(20); }
```

```
//if (ay1 <1500 & ay1 > -1500) { digitalWrite(vibrator,HIGH); } // The position of the hand is horizontal

}

if( digitalRead(position1) == LOW & digitalRead(position2) == HIGH & digitalRead(position3) == LOW & digitalRead(position4) == LOW & digitalRead(position5) == LOW ) {

//if (ay2 <-13000) {digitalWrite(vibrator 2,LOW);} // hand position is vertical down //if (ay2 >13000) {digitalWrite(vibrator 2,LOW);} // hand position is vertical upwards

if ( ay1 >-2000 & ay1 < -4000) { digitalWrite(vibrator 1,HIGH);delay(40); digitalWrite(vibrator 1,LOW); delay(20); }
//if ( ay1 <13000 & ay1 > 11000) { digitalWrite(vibrator 1,HIGH);delay(40); digitalWrite(vibrator 1,LOW); delay(20); }

if ( ay1 >0 & ay1 < -2000) { digitalWrite(vibrator 1,HIGH);delay(30); digitalWrite(vibrator 1,LOW); delay(20); } if ( ay1 <-4000 & ay1 > -6000) { digitalWrite(vibrator 1,HIGH);delay(30); digitalWrite(vibrator 1,LOW); delay(20); }

if ( ay1 >-2000 & ay1 < -4000 & ay2 >-2000 & ay2 < -4000) { digitalWrite(vibrator 1,HIGH);digitalWrite(vibrator 2,HIGH);delay(40); digitalWrite(vibrator 1,LOW);digitalWrite(vibrator 2,LOW); delay(20); }
if ( ay1 >-2000 & ay1 < -4000 & ay2 > 0 & ay2 < -2000 ) { digitalWrite(vibrator 1,HIGH);digitalWrite(vibrator 2,HIGH);delay(30);digitalWrite(vibrator 2,LOW);delay(10); digitalWrite(vibrator 1,LOW); delay(20); }

if ( ay1 >-2000 & ay1 < -4000 & ay2 <-4000 & ay2 > -6000) { digitalWrite(vibrator 1,HIGH);digitalWrite(vibrator 2,HIGH);delay(30);digitalWrite(vibrator 2,LOW);;delay(10); digitalWrite(vibrator 1,LOW); delay(20); }

if ( ay2 >-2000 & ay2 < -4000) { digitalWrite(vibrator 2,HIGH);delay(40); digitalWrite(vibrator 2,LOW); delay(20); }
//if ( ay2 <8000 & ay2 > 6000) { digitalWrite(vibrator 2,HIGH);delay(22); digitalWrite(vibrator 2,LOW); delay(20); }

if ( ay2 >-2000 & ay2 < -4000 & ay1 >0 & ay1 < -2000) { digitalWrite(vibrator 2,HIGH);digitalWrite(vibrator 1,HIGH);delay(30); digitalWrite(vibrator 1,LOW);delay(10); digitalWrite(vibrator 2,LOW); delay(20); }
if ( ay2 >-2000 & ay2 < -4000 & ay1 <-4000 & ay1 > -6000 ) { digitalWrite(vibrator 2,HIGH);digitalWrite(vibrator 1,HIGH);delay(30);digitalWrite(vibrator 1,LOW);delay(10); digitalWrite(vibrator 2,LOW); delay(20); }

if ( ay2 > 0 & ay2 < -2000) { digitalWrite(vibrator 2,HIGH);delay(30); digitalWrite(vibrator 2,LOW); delay(20); } if ( ay2 <-4000 & ay2 > -6000) { digitalWrite(vibrator 2,HIGH);delay(30); digitalWrite(vibrator 2,LOW); delay(20); }

//if ( ay2 >-4000 & ay2 < -2000) { digitalWrite(vibrator 2,HIGH);delay(35); digitalWrite(vibrator 2,LOW); delay(20); }

//if ( ay2 <4000 & ay2 > 2000) { digitalWrite(vibrator 2,HIGH);delay(35); digitalWrite(vibrator 2,LOW); delay(20); }

//if ( ay2 >-2000 & ay2 < -1500) { digitalWrite(vibrator 2,HIGH);delay(40); digitalWrite(vibrator 2,LOW); delay(20); }
//if ( ay2 <2000 & ay2 > 1500) { digitalWrite(vibrator 2,HIGH);delay(40); digitalWrite(vibrator 2,LOW); delay(20); }
```

```
//if (ay2 <1500 & ay2 > -1500) { digitalWrite(vibrator 2,HIGH); } // The position of the hand is
horizontal

}
if( digitalRead(position1) == LOW & digitalRead(position2)== LOW & digitalRead(position3) ==
HIGH & digitalRead(position4) == LOW & digitalRead(position5) == LOW ) {

if ( ay1 <-12000 & ay1 > -14000) { digitalWrite(vibrator 1,HIGH);delay(40); digitalWrite(vibrator
1,LOW); delay(20); }
//if ( ay1 <-15000 & ay1 > -16000) { digitalWrite(vibrator 1,HIGH);delay(40); digitalWrite(vibrator
1,LOW); delay(20); }

if ( ay1 <-14000 & ay1 >-16000 ) { digitalWrite(vibrator 1,HIGH);delay(30); digitalWrite(vibrator
1,LOW); delay(20); }
if ( ay1 <-12000 & ay1 > -10000) { digitalWrite(vibrator 1,HIGH);delay(30); digitalWrite(vibrator
1,LOW); delay(20); }

if ( ay2 >-16000 & ay2 < -14000) { digitalWrite(vibrator2,HIGH);delay(40); digitalWrite(vibrator
2,LOW); delay(20); }
//if ( ay2 <8000 & ay2 > 6000) { digitalWrite(vibrator 2,HIGH);delay(40); digitalWrite(vibrator
2,LOW); delay(20); }

if ( ay2 >0 & ay2 < 2000) { digitalWrite(vibrator 2,HIGH);delay(30); digitalWrite(vibrator 2,LOW);
delay(20); } if ( ay2 <-12000 & ay2 > -14000) { digitalWrite(vibrator 2,HIGH);delay(30);
digitalWrite(vibrator 2,LOW); delay(20); }

}

if(digitalRead(position1) == LOW & digitalRead(position2) == LOW & digitalRead(position3) ==
LOW & digitalRead(position4) == HIGH & digitalRead(position5) == LOW ) {

if ( ay1 <-8000 & ay1 > -6000) { digitalWrite(vibrator 1,HIGH);delay(40); digitalWrite(vibrator
1,LOW); delay(20); }
//if ( ay1 <-15000 & ay1 > -16000) { digitalWrite(vibrator 1,HIGH);delay(40); digitalWrite(vibrator
1,LOW); delay(20); }

if ( ay1 <-8000 & ay1 >-10000 ) { digitalWrite(vibrator 1,HIGH);delay(30); digitalWrite(vibrator
1,LOW); delay(20); }
if ( ay1 <-4000 & ay1 > -6000) { digitalWrite(vibrator 1,HIGH);delay(30); digitalWrite(vibrator
1,LOW); delay(20); }

if ( ay2 >-11000 & ay2 < -9000) { digitalWrite(vibrator 2,HIGH);delay(40); digitalWrite(vibrator
2,LOW); delay(20); }
//if ( ay2 <8000 & ay2 > 6000) { digitalWrite(vibrator 2,HIGH);delay(40); digitalWrite(vibrator
2,LOW); delay(20); }

if ( ay2 >-9000 & ay2 < -7000) { digitalWrite(vibrator 2,HIGH);delay(30); digitalWrite(vibrator
2,LOW); delay(20); }
if ( ay2 <-11000 & ay2 > -13000) { digitalWrite(vibrator 2,HIGH);delay(30); digitalWrite(vibrator
2,LOW); delay(20); }

}

if(digitalRead(position1) == LOW & digitalRead(position2) == LOW & digitalRead(position3) ==
LOW & digitalRead(position4) == LOW & digitalRead(position5) == HIGH ) {
```

```
if ( ay1 <-15000 & ay1 > -13000) { digitalWrite(vibrator 1,HIGH);delay(40); digitalWrite(vibrator
1,LOW); delay(20); }

//if ( ay1 <-15000 & ay1 > -16000) { digitalWrite(vibrator 1,HIGH);delay(40); digitalWrite(vibrator
1,LOW); delay(20); }

if ( ay1 <-15000 & ay1 >-16000 ) { digitalWrite(vibrator 1,HIGH);delay(30); digitalWrite(vibrator
1,LOW); delay(20); }
if ( ay1 <-11000 & ay1 > -13000) { digitalWrite(vibrator 1,HIGH);delay(30); digitalWrite(vibrator
1,LOW); delay(20); }

if ( ay2 >-11000 & ay2 < -13000) { digitalWrite(vibrator 2,HIGH);delay(40); digitalWrite(vibrator
2,LOW); delay(20); }
//if ( ay2 <8000 & ay2 > 6000) { digitalWrite(vibrator 2,HIGH);delay(40); digitalWrite(vibrator
2,LOW); delay(20); }

if ( ay2 >-14000 & ay2 < -13000) { digitalWrite(vibrator 2,HIGH);delay(30); digitalWrite(vibrator
2,LOW); delay(20); }
if ( ay2 <-9000 & ay2 > -11000) { digitalWrite(vibrator 2,HIGH);delay(30); digitalWrite(vibrator
2,LOW); delay(20); }

}
```

2 - CODE OF THE DEVICE SENSOR 3 and 4

```
#include "Wire.h" // Arduino Wire library

 #include "I2Cdev.h" //Installer ces 2 librairies

}

#include "MPU6050.h"
#include "math.h"
// AD0 low = 0x68 (default for InvenSense evaluation board) // AD0 high = 0x69
MPU6050 accelgyro3(0x68);
int16_t ax3, ay3, az3; //mesures brutes capteur 3
int16_t gx3, gy3, gz3;

float angle3 = int vibreur3 = int position1= int position2= int position3= int position4= int position5=
void setup() {

0;
7; 13; 12 ; 11 ; 10 ; 9 ;

Wire.begin(); //I2C bus Serial.begin(9600);
while (! Serial) {
}
Serial.println("Initialisation I2C...");

accelgyro3.initialize(); pinMode(vibrator 3, OUTPUT);

pinMode(position1, INPUT); pinMode(position2,INPUT); pinMode(position3,INPUT);

pinMode(position4, INPUT);

pinMode(position5, INPUT);

// verify connection

Serial.println("Test de la conection du dispositif ...");

Serial.println(accelgyro3.testConnection()? "MPU6050 n°3 connection reussie”: "MPU6050 n°3
connection echec");

delay (1000);}
void loop() {

accelgyro3.getMotion6(&ax3, &ay3, &az3, &gx3, &gy3, &gz3);

Angle3 = 0.98 * (angle3 + float(gy3) * 0.01 / 131) + 0.02 * atan2((double)ax3, (double)az3) * 180 /
PI; // Serial.print(angle3);
// Serial.print("\t");
// delay (10);

// Serial.print(ax3); // We are not needed of this value, because it is not our axis of rotation
//Serial.print("\t");
```

```
Serial.print(ay3); // This is the axis of our rotation, so we need these values Serial.print("\t");
//Serial.print(az3); // We are not needed of this value, because it is not our axis of rotation
//Serial.print("\t");

// Serial.print("\n");

//delay (500);

if ( digitalRead(position1) == HIGH & digitalRead(position2) == LOW & digitalRead(position3) ==
LOW & digitalRead(position4) == LOW & digitalRead(position5) == LOW ){

if ( ay3 <0 & ay3 > -1000) { digitalWrite(vibreur3,HIGH);delay(40); digitalWrite(vibrator 3,LOW);
delay(20); }

if ( ay3 <16000 & ay3 > 15000) { digitalWrite(vibreur3,HIGH);delay(40); digitalWrite(vibrator
3,LOW); delay(20); }

if (ay3 >13000 & ay3 < 15000) { digitalWrite(vibrator 3,HIGH);delay(30); digitalWrite(vibrator
3,LOW); delay(20); }

if (ay3 <-1000 & ay3 > -3000) { digitalWrite(vibrator 3,HIGH);delay(30); digitalWrite(vibrator
3,LOW); delay(20); }

}

if ( digitalRead(position1) == LOW & digitalRead(position2) == HIGH & digitalRead(position3) ==
LOW & digitalRead(position4) == LOW & digitalRead(position5)== LOW ){

if (ay3 <12000 & ay3 > 10000) { digitalWrite(vibrator 3,HIGH);delay(40); digitalWrite(vibrator
3,LOW); delay(20); }

if (ay3 >12000 & ay3 < 15000) { digitalWrite(vibrator 3,HIGH);delay(30); digitalWrite(vibrator
3,LOW); delay(20); }

if ( ay3 <10000 & ay3 > 8000) { digitalWrite(vibrator 3,HIGH);delay(30); digitalWrite(vibrator
3,LOW); delay(20); }

}

if ( digitalRead(position1) == LOW & digitalRead(position2) == LOW & digitalRead(position3)==
HIGH & digitalRead(position4)== LOW & digitalRead(position5)== LOW ){

if ( ay3 <7000 & ay3 > 5000) { digitalWrite(vibrator 3,HIGH);delay(40); digitalWrite(vibrator
3,LOW); delay(20); }

if ( ay3 >9000 & ay3 < 7000) { digitalWrite(vibrator 3,HIGH);delay(30); digitalWrite(vibrator
3,LOW); delay(20); }

if ( ay3 <5000 & ay3 > 3000) { digitalWrite(vibrator 3,HIGH);delay(30); digitalWrite(vibrator
3,LOW); delay(20); }

}

if ( digitalRead(position1) == LOW & digitalRead(position2) == LOW & digitalRead(position3) ==
LOW & digitalRead(position4) == HIGH & digitalRead(position5) == LOW ){
```

```
if ( ay3 <14000 & ay3 > 12000) { digitalWrite(vibrator 3,HIGH);delay(40); digitalWrite(vibrator 3,LOW); delay(20); }

if ( ay3 >12000 & ay3 < 10000) { digitalWrite( vibrator 3,HIGH);delay(30); digitalWrite(vibrator 3,LOW); delay(20); }

if ( ay3 <16000 & ay3 > 14000) { digitalWrite(vibrator 3,HIGH);delay(30); digitalWrite(vibrator 3,LOW); delay(20); }

}

if ( digitalRead(position1) == LOW & digitalRead(position2) == LOW & digitalRead(position3) == LOW & digitalRead(position4) == LOW & digitalRead(position5) == HIGH ){

if ( ay3 <11000 & ay3 > 9000) { digitalWrite(vibrator 3,HIGH);delay(40); digitalWrite(vibrator 3,LOW); delay(20); }

if ( ay3 >11000 & ay3 < 13000) { digitalWrite(vibrator 3,HIGH);delay(30); digitalWrite(vibrator 3,LOW); delay(20); }

if ( ay3 <9000 & ay3 > 7000) { digitalWrite(vibrator 3,HIGH);delay(30); digitalWrite(vibrator 3,LOW); delay(20); }

}

// Serial.print(ax3); // We are not needed of this value, because it is not our axis of rotation
//Serial.print("\t");

Serial.print(ay3); // This is the axis of our rotation, so we need these values Serial.print("\t");
//Serial.print(az3); // We are not needed of this value, because it is not our axis of rotation
//Serial.print("\t");

// Serial.print("\n");

//delay (500);

if ( digitalRead(position1) == HIGH & digitalRead(position2) == LOW & digitalRead(position3) == LOW & digitalRead(position4) == LOW & digitalRead(position5) == LOW ){

if ( ay3 <0 & ay3 > -1000) { digitalWrite(vibreur4,HIGH);delay(40); digitalWrite(vibrator 4,LOW); delay(20); }

if ( ay3 <16000 & ay3 > 15000) { digitalWrite(vibreur4,HIGH);delay(40); digitalWrite(vibrator 4,LOW); delay(20); }

if (ay3 >13000 & ay3 < 15000) { digitalWrite(vibrator 4,HIGH);delay(30); digitalWrite(vibrator 4,LOW); delay(20); }

if (ay3 <-1000 & ay3 > -3000) { digitalWrite(vibrator 4,HIGH);delay(30); digitalWrite(vibrator 4,LOW); delay(20); }

}

if ( digitalRead(position1) == LOW & digitalRead(position2) == HIGH & digitalRead(position3) == LOW & digitalRead(position4) == LOW & digitalRead(position5)== LOW ){
```

```
if (ay3 <12000 & ay3 > 10000) { digitalWrite(vibrator 4,HIGH);delay(40); digitalWrite(vibrator
4,LOW); delay(20); }

if (ay3 >12000 & ay3 < 15000) { digitalWrite(vibrator 4,HIGH);delay(30); digitalWrite(vibrator
4,LOW); delay(20); }

if ( ay3 <10000 & ay3 > 8000) { digitalWrite(vibrator 4HIGH);delay(30); digitalWrite(vibrator
4,LOW); delay(20); }

}

if ( digitalRead(position1) == LOW & digitalRead(position2) == LOW & digitalRead(position3)==
HIGH & digitalRead(position4)== LOW & digitalRead(position5)== LOW ){

if ( ay3 <7000 & ay3 > 5000) { digitalWrite(vibrator 4,HIGH);delay(40); digitalWrite(vibrator
4LOW); delay(20); }

if ( ay3 >9000 & ay3 < 7000) { digitalWrite(vibrator 4,HIGH);delay(30); digitalWrite(vibrator
4,LOW); delay(20); }

if ( ay3 <5000 & ay3 > 3000) { digitalWrite(vibrator 4,HIGH);delay(30); digitalWrite(vibrator
4,LOW); delay(20); }

}

if ( digitalRead(position1) == LOW & digitalRead(position2) == LOW & digitalRead(position3) ==
LOW & digitalRead(position4) == HIGH & digitalRead(position5) == LOW ){

if ( ay3 <14000 & ay3 > 12000) { digitalWrite(vibrator 4,HIGH);delay(40); digitalWrite(vibrator
4,LOW); delay(20); }

if ( ay3 >12000 & ay3 < 10000) { digitalWrite( vibrator 4,HIGH);delay(30); digitalWrite(vibrator
4,LOW); delay(20); }

if ( ay3 <16000 & ay3 > 14000) { digitalWrite(vibrator 4,HIGH);delay(30); digitalWrite(vibrator
4,LOW); delay(20); }

}

if ( digitalRead(position1) == LOW & digitalRead(position2) == LOW & digitalRead(position3) ==
LOW & digitalRead(position4) == LOW & digitalRead(position5) == HIGH ){

if ( ay3 <11000 & ay3 > 9000) { digitalWrite(vibrator 4,HIGH);delay(40); digitalWrite(vibrator
4,LOW); delay(20); }

if ( ay3 >11000 & ay3 < 13000) { digitalWrite(vibrator 4,HIGH);delay(30); digitalWrite(vibrator
4,LOW); delay(20); }

if ( ay3 <9000 & ay3 > 7000) { digitalWrite(vibrator 4,HIGH);delay(30); digitalWrite(vibrator
4,LOW); delay(20); }

}
```

RESUME

Name – Surname

Faycal BOUZOUIDJA

Publications from Dissertation, Presentations and Patents

ilhan, rıza, & Bouzouidja,faycal . (2023). Haptic body position improver during a workout. International Journal of Engineering and Computer Science, 12(03), 25658–25664.

Education

Baccalaureate in science(September 2015-July 2016) Belkacem El-Ouzri High school Blida, Algeria.

Bachelor’s degree (Mechanical Construction) (June 2016-June 2019).At Saad Dahleb University BLIDA, ALGERIA).In progress of defending Thesis under the theme: (The Landing Gear of the plane) training at Algeria Airways in the aviation maintenance base.

Master’s degree (Mechanical Engineeing) (Since April 2023) At ISTANBUL Aydin University, ISTANBUL, TURKEY. In progress of defending Thesis under the Theme : (Hapatic Body Position Improver During a Workout).

Work Experience

Mechanical Technician At workshop’s Gökhan kalıp Türkiye Istanbul from (15/09/2022) to (15/05/2023).

Receptionist At Hanna Boutique and Turquie Istanbul Hotel. (May 2022-Septembe 2022).

Sales Associate At Bellavita Cosmetics Turquie Istanbul. (September 2020-May 2022).

Practical mechanical construction at the Aviation Maintenance base Algeria Airways. From March 2019 to May 2019 Algeria Airways.

Skills & Abilities

Languages

Arabic: native speaker.
English: very good.
French: excellent.
Turkish: good.

Skills

Welcoming guests.
Maintenance and Repair.
Multi-line phone systems.
Correspondence management.
Flexible and Adaptable

Computerans Software skills

MS Word.
MS Excel.
MS PowerPoint.
MS Outlook.
MS Project
Auto Cad (basic).