Project Overview

This project uses embedded systems and sensors to limit the angles of hip joints and upper half angles. A device issues warning audio when certain angles exceed a specific programmed limit. Limit angles involve rotation to the operation side, excessive adduction, cross-leg, and hip fixation. Our project aims to ensure successful outcomes and minimize postoperative complications. As a result, we prevent potential strain or damage to the surrounding tissues, particularly after procedures such as hip replacement surgery.

System Components

We have used multiple components to create our system and these components include:

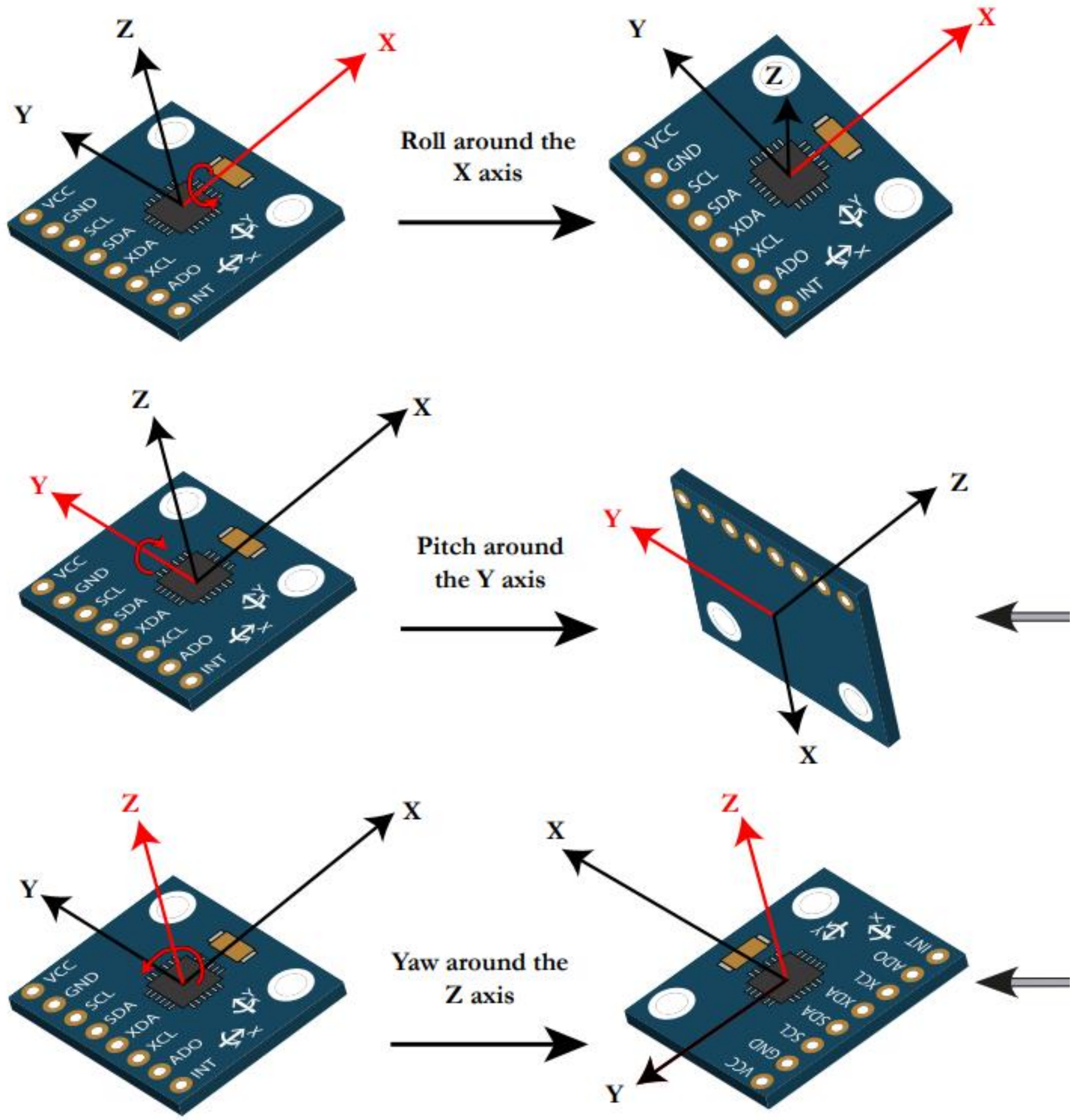
1- Micro-Controller:

- Microcontroller acts as the brain of our system it processes all the input information and data and controls the output devices.
- We have used ESP32 as our controller because it provides efficiency and reliability.

2- Sensors:

- To measure angles, we have used a type of sensors that is called gyroscope and accelometer.
- A gyroscope typically has three degree of freedom which means it can measure three angles in three directions.

- These angles are called Roll, Pitch, and Yaw angles.
- We have used 2 MPU6050 gyroscope and accelerometer sensors.
- This sensor typically uses gravitation force and rotation change to operate and calculate angels.



3- Buzzer Device.

- A buzzer device is an electronic component or device that produces a buzzing or beeping sound as an alert or indication.
- We have used buzzer as our output device, and it produces the alarm due to angle limit exceed.
- We used a type of buzzers which is Passive Buzzer 3-24V.

4- Battery

- We used 9V battery to provide necessary power to our system.
- We have used **Energizer® 9V Battery Alkalin** as it provides reliable and sufficient power to the system.
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5- Necessary accessories:

A. Battery holder

   1- We used it to be able to connect the battery with our electronic circuit.

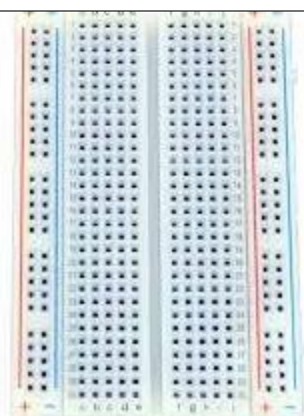
B. White board

   2- We used it to connect all the wires together.

C. Jumber Wires.

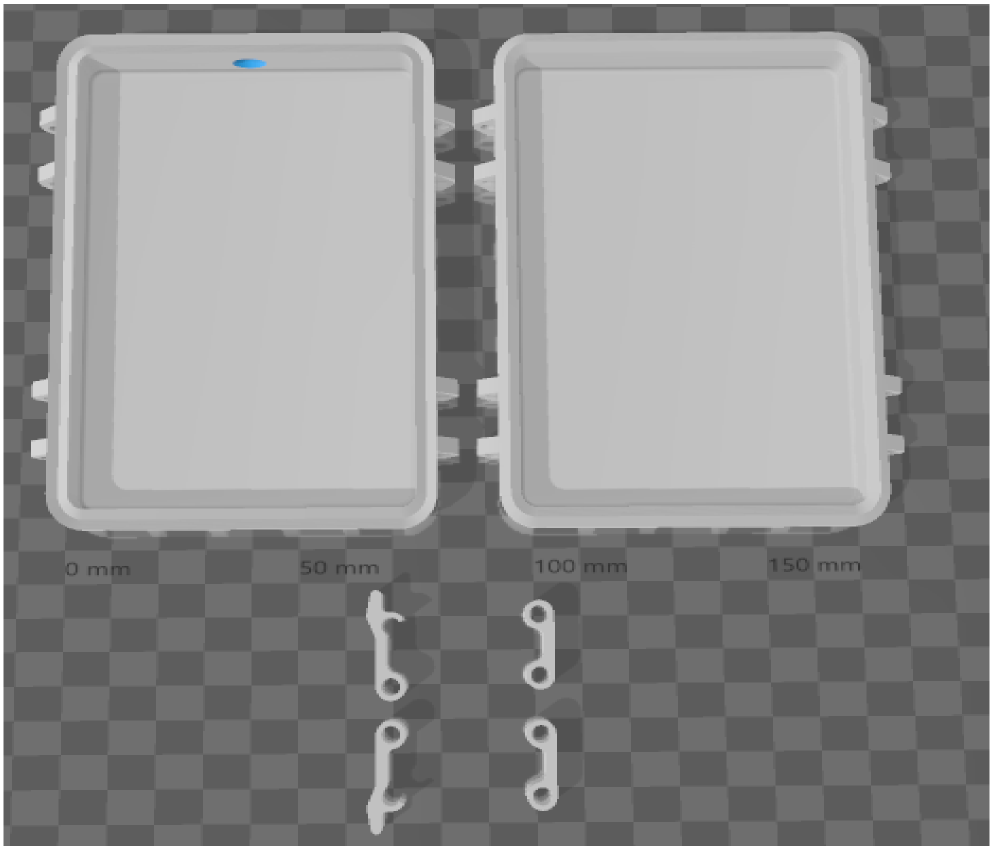
D. On/Off Switch.

E. Shrink Cover.

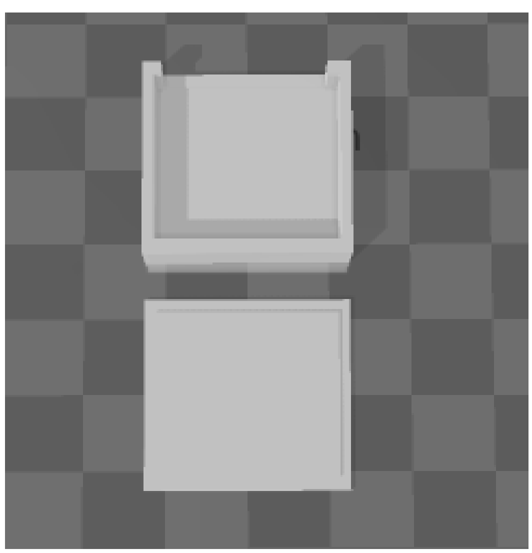
		
		

6- Hardware Enclosure Design:

3- Controller Circuit Enclosure:



4- Sensor Enclosure:



Sensors Sites:

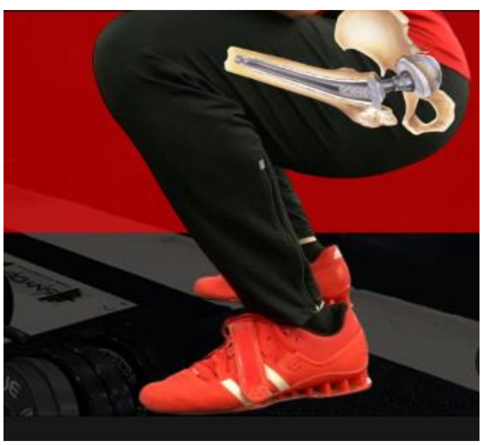
A. **Hip Sensor:**
   The sensor is mounted at the midpoint of the hip, positioned 10cm above the knee.
B. **Upper Segment Sensor:**
   The sensor is affixed horizontally, offset from the sagittal plane by approximately 2cm.

Ranges Of Motion:

Note: We have taken into consideration to warn patient before he exceeds the limit angle.

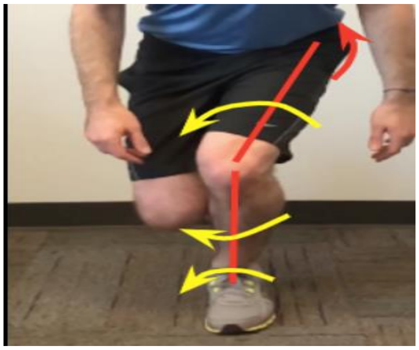
A. **Hip Sensor:**

1- Hip Fixation Angle (Pitch Angle): **75°**



2- Cross Leg Angle (Yaw Angle): **30°**

3- Excessive Adduction (Roll Angle): **10°**



B. Upper Segment Sensor:

1- Toward operation side angle (Yaw Angle): **10°**

2- Trunk Angle (Roll Angle): **35°**

System Limitations:

- **Hardware limitations:**

1- The gyroscope-accelerometer system may experience limitations in accuracy and precision due to variations in gravitational force across different geographical locations, which can affect the interpretation of sensor data and the estimation of orientation or motion. But usually this limitation is ignored if the geographical location difference is short.

2- Drift: Gyroscopes can experience drift over time, which means they may gradually deviate from their initial calibration due to factors such as temperature changes, mechanical stresses, or imperfections in the sensor itself. This drift can affect the accuracy of measurements, particularly over long periods. Because of that sometimes we need to restart our device and calibrate it again.

3- Calibration: Gyroscopes often require calibration to ensure accurate measurements. Changes in gravitational force can affect the orientation of the device during calibration procedures, potentially introducing errors. So that you will need to wait few seconds when starting the device.

4- Size and cost: High-performance gyroscopes with advanced features tend to be larger and more expensive, which can be a limitation in applications where space and budget constraints are significant factors.

- **Cost Limitations:**

We faced cost constraints that prevented us from purchasing high-priced components for our project. Additionally, the Egyptian market lacked availability of certain components essential for our project.

How should you correctly operate the device?

1- Securely place the controller enclosure.
2- Ensure the sensors are correctly positioned and mounted.
3- Activate the device using the switch and allow a brief period for sensor calibration.
4- Confirmation that the device has been operated correctly is indicated by two beeps from the buzzer.