# MECHATRONICS FIANL PROJECT

## Measurement of human body orientation for analyzing posture in Yoga

Project Guide: Dr.Vikram Kapila

Team: Arihant Sethi
Ashish Singh
Samanth Hosadurga Chinivar

# OUTLINE

- Introduction
- Used Hardware and software
- Circuit Diagram
- Explanation of process
- Homogenous transformation
- Plots.

# INTRODUCTION

- The developed countries use the technology of measuring correct body orientation in various fields such as sports, medicine , physical therapy etc,  to maximize the output of a person in this field
- We have proposed a low cost, robust system that can be used in yoga to detect various yoga positions, in sports for stroke and technique analysis like in cricket, tennis (serve analysis), Badminton, Javelin Throw etc., for military purposes like proper positioning of hand and body while shooting
- In our project we are measuring orientation of Yoga postures.

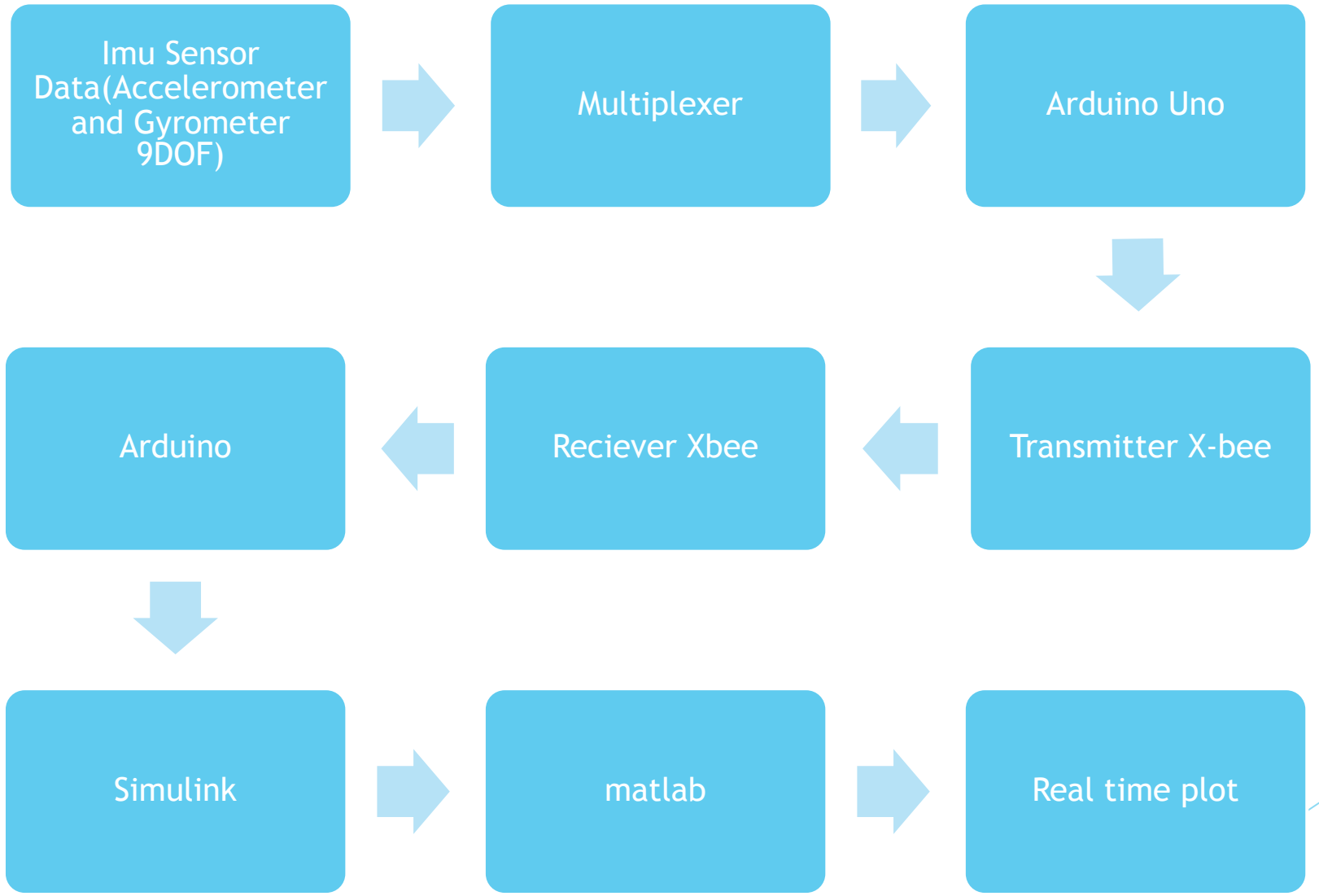
# Hardware Used

- Arduino Uno microcontroller
- Xbee Serial 1 module
- Xbee adapter for Arduino
- Bno055 IMU sensor
- FTDI cable
- TCA9548A multiplexer
- Jumper wires
- Bread Board

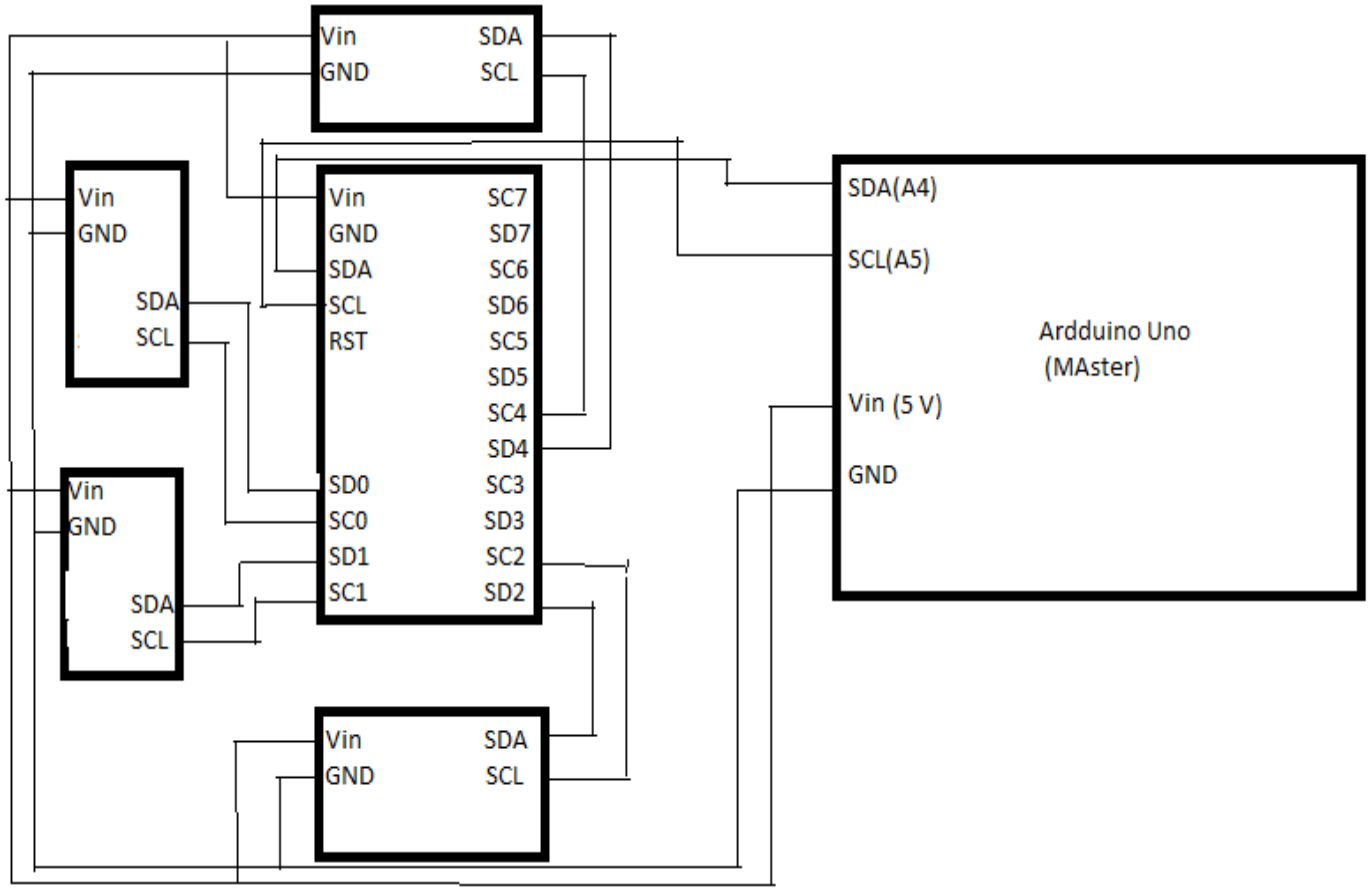
# Softwares Used

- Arduino Ide
- Matlab
- Simulink

# Flow Chart Of Process



# Circuit Diagram

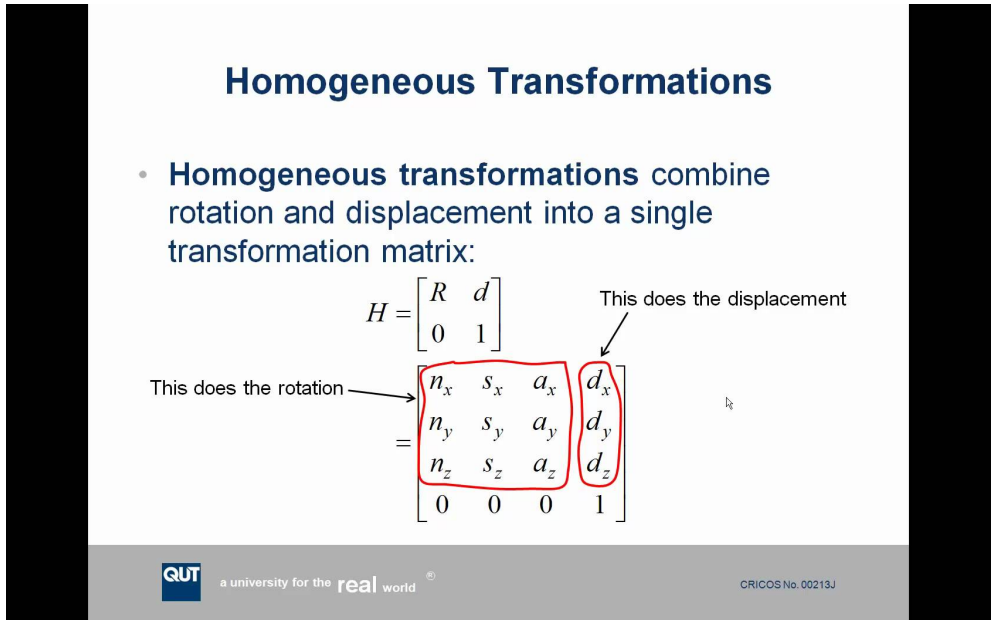


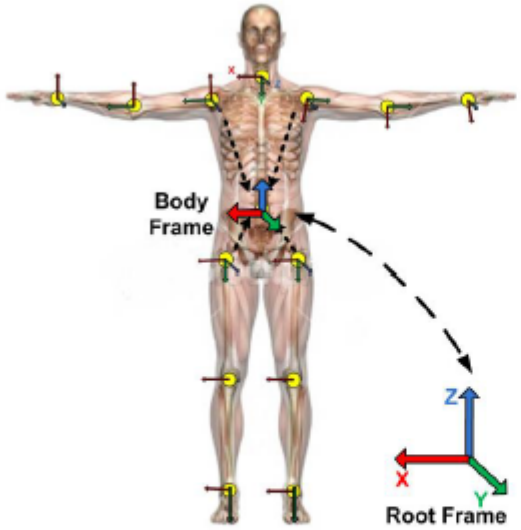
# Explanation Of Process

- Integrated 9- DOF Inertial measurement sensor to Arduino:  The 9-DOF IMU is programmed to get values as Roll pitch yaw. The roll pitch yaw value is then converted into transformation matrix with respect to base of the neck as a reference point.
- The output values is then accessed from matlab serial port monitor.
- Simulink receives serial data from Arduino microcontroller and stores in buffer for the matlab program.
- The roll pitch yaw value  we get from Arduino serial monior is then converted into transformation matrix with respect to base of the neck as a reference point.
- The data received by matlab from Simulink is used to plot real time graph.

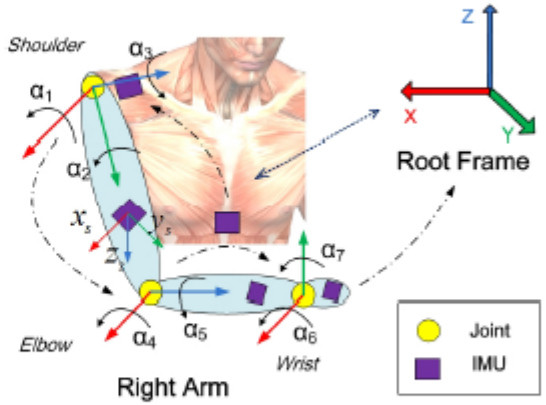
# Homogenous Transformation

$$
\begin{aligned}
&R_Y R_Z R_X \\
&= \begin{pmatrix} \cos B & 0 & \sin B \\ 0 & 1 & 0 \\ -\sin B & 0 & \cos B \end{pmatrix} \begin{pmatrix} \cos C & -\sin C & 0 \\ \sin C & \cos C & 0 \\ 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} 1 & 0 & 0 \\ 0 & \cos A & -\sin A \\ 0 & \sin A & \cos A \end{pmatrix} \\
&= \begin{pmatrix} \cos B \cos C & -\cos B \sin C & \sin B \\ \sin C & \cos C & 0 \\ -\sin B \cos C & \sin B \sin C & \cos B \end{pmatrix} \begin{pmatrix} 1 & 0 & 0 \\ 0 & \cos A & -\sin A \\ 0 & \sin A & \cos A \end{pmatrix} \\
&= \begin{pmatrix} \cos B \cos C & -\cos B \sin C \sin A + \sin B \sin A & \cos B \sin C \sin A + \sin B \cos A \\ \sin C & \cos C \cos A & -\cos C \sin A \\ -\sin B \cos C & \sin B \sin C \cos A + \cos B \sin A & -\sin B \sin C \sin A + \cos B \cos A \end{pmatrix}
\end{aligned}
$$



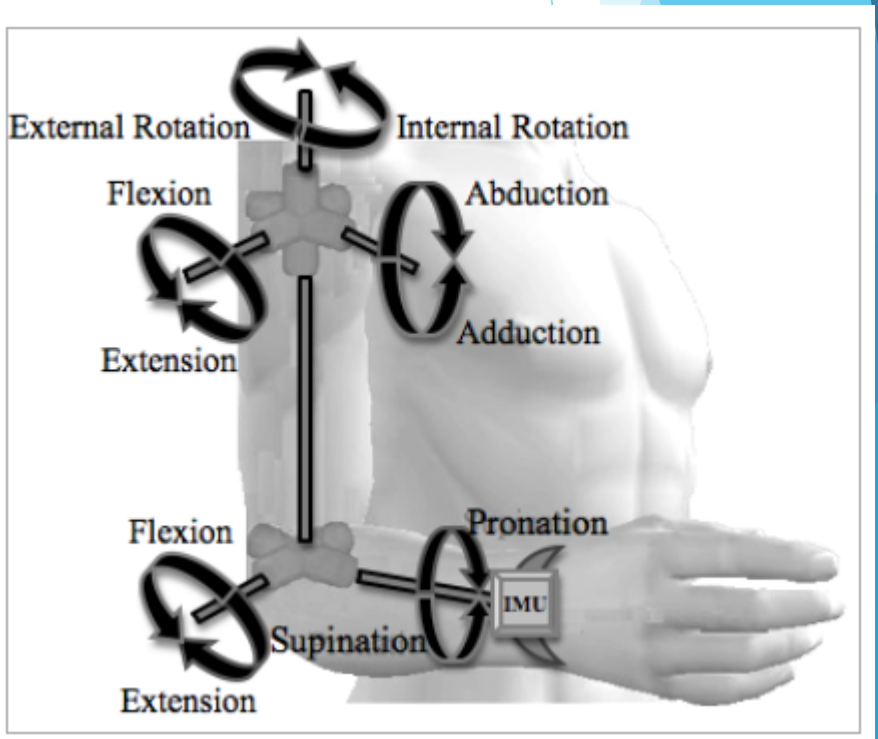



(a) Human full body model with joint coordinates



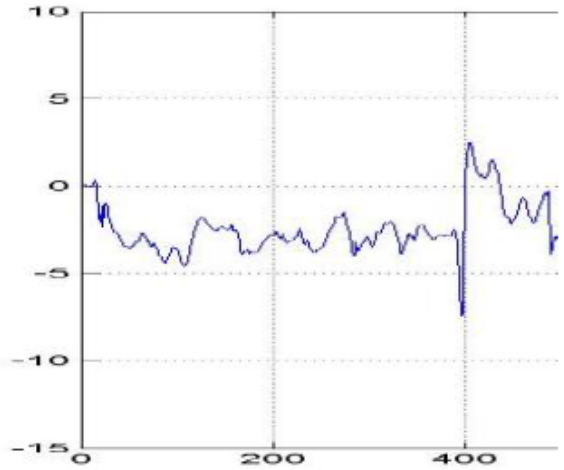

(b) Kinematic modeling of right arm with IMUs

**Figure 2.1:** Human body modeling

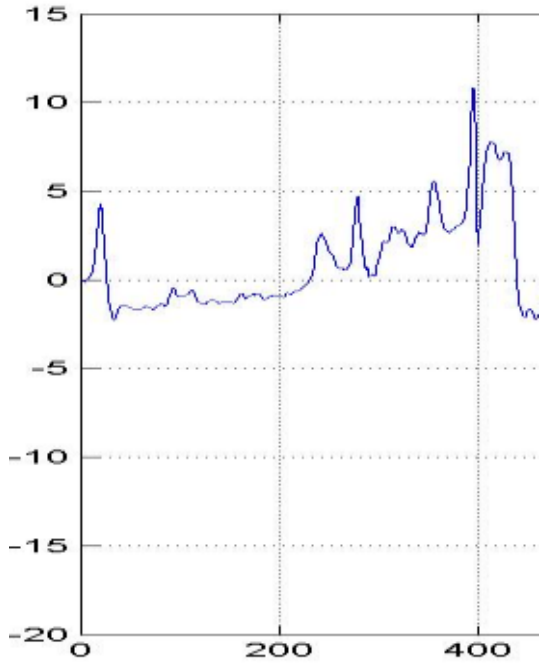


# Plots:


Pitch




Roll




Yaw

# Cost analysis

| Materials | Quantity | Unit Cost(each) | Total Cost |
|---|---|---|---|
| 9 DOF Inertial Measurement Unit | 4 | 34$ | 136$ |
| Arduino | 1 | 32$ | 32$ |
| Zig BEES | 2 | 15 $ | 30$ |
| Xbee adapter | 2 | 14$ | 28$ |
| Ftdi cable | 1 | 5$ | 5$ |
| Jumper wires | 40 pieces | 6$ | 6$ |
| Long Connectors | 70 pieces | 12 $ | 12$ |
| Velcro Bands | 4 | 3$ | 12$ |
| Multiplexer | 1 | 25$ | 25$ |
| Total | | | 286$ |

# Conclusion

- We are able to Multiplex four imu’s .
- We are able to get Roll Pitch Yaw values of human body orientation of specific yoga position.
- We programmed Simulink to receive serial monitor values from Arduino
- We programmed matlab to receive values from simulik.
- We found homogenous matrix with respect to reference plane.
- We plotted real time graph.