

Designing an Interface for Multiple Sclerosis (MS) Patients: Movement Precision and Comparison

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Introduction

- ❖ In this project, we design an interface that will make it easier for Multiple Sclerosis (MS) patients to perform exercises comfortably. We aim to ensure their accuracy by simultaneously comparing these movements under professional motion tracking system. The goal is to provide a more convenient way to continue treatment for patients and experts. Through this interface, healthcare professionals can gain insight and feedback about the accuracy of each exercise by comparing motion data on patients' movement with the associated activity template.
- ❖ Two main methods were used to collect visual data: OptiTrack and MediaPipe. These methods involve capturing data separately from webcam and Optitrack cameras. The collected data is then compared in an interface created using Python. This poster outlines the process of collecting data using these two approaches and highlights the integration of the resulting data into the interface for analysis.

Solution Methodology for OptiTrack

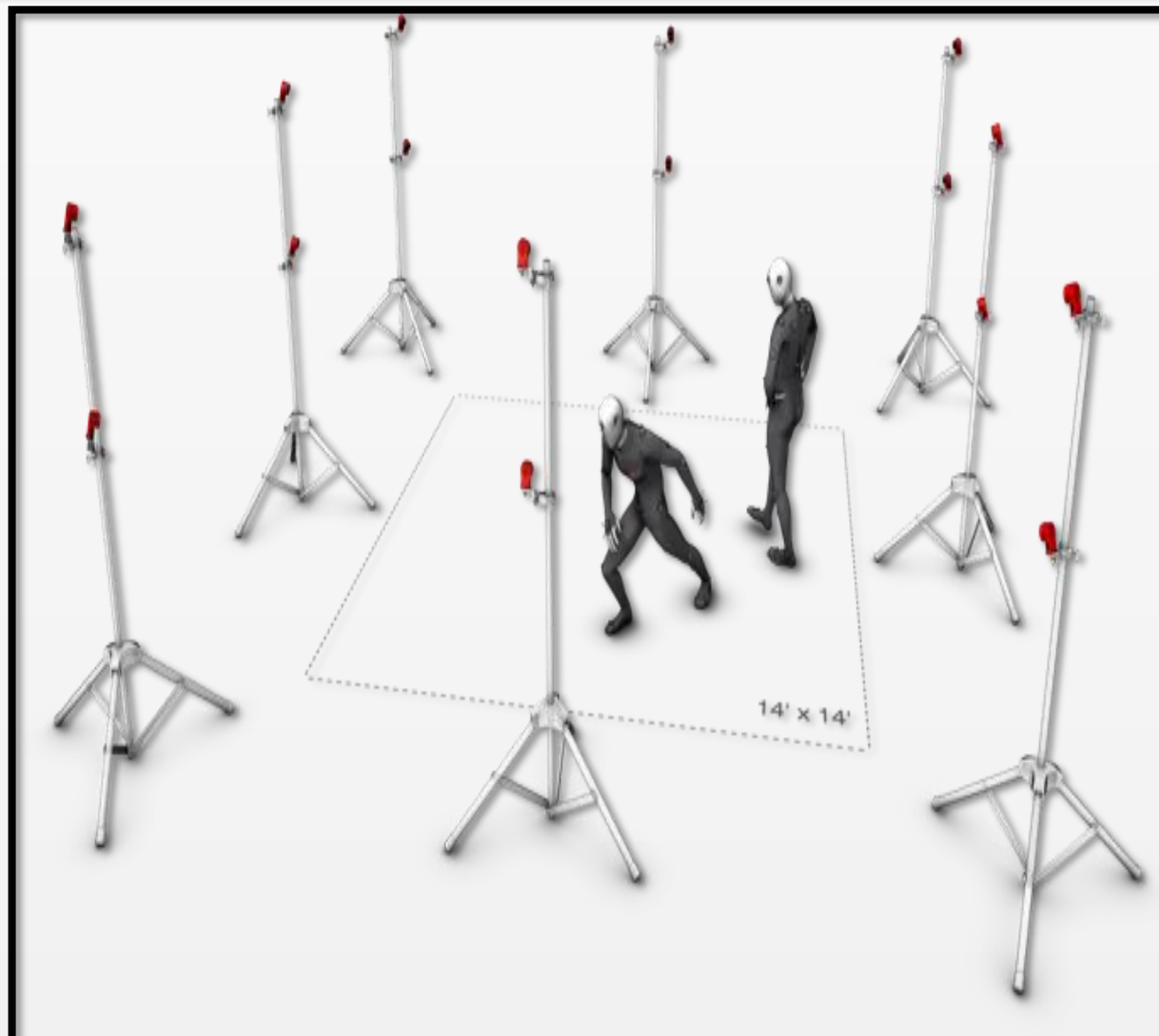


Figure 1 OptiTrack Camera System

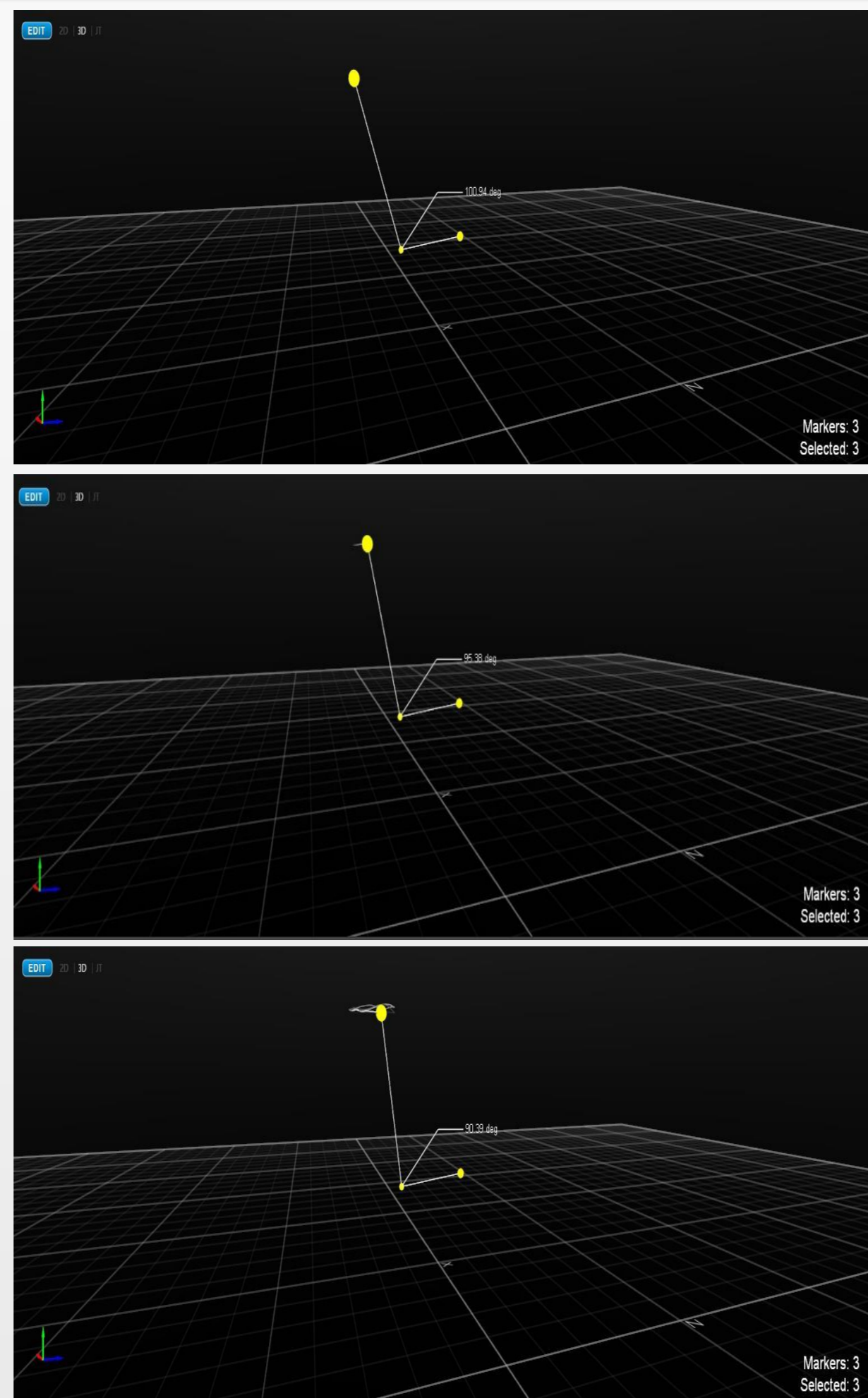
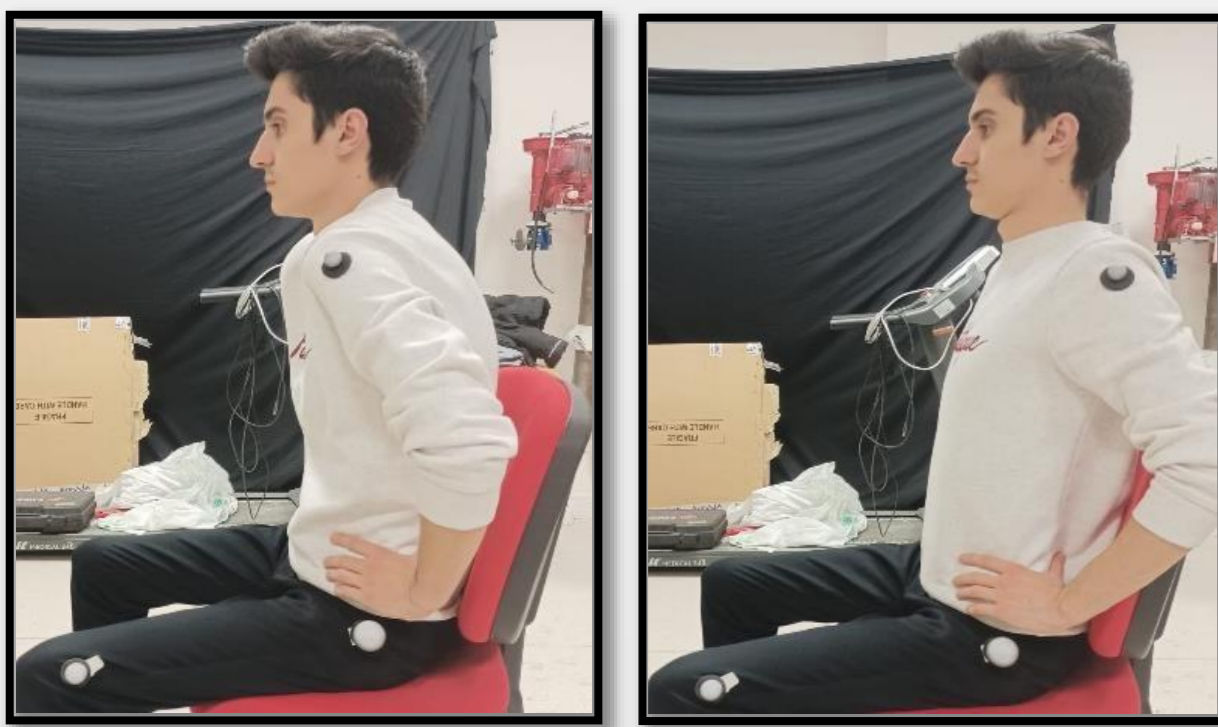


Figure 2 Appearance of Movement with Custom Markers



- ❖ The professional cameras used in the Optitrack Motion Capture system are shown in Figure 1. Special markers are used for cameras to detect motion, and these markers are illustrated in Figure 2. Additionally, one of the recommended exercises for MS patients is shown in Figure 2. The Optitrack application detects motion through markers, as seen in Figure 3, and provides position information in an Excel file. By opening the Excel file in Matlab, the angle value is calculated from the position information and plotted after normalization. The formulas for angle calculation and normalization are presented in Figures 6 and 7. The graph obtained using professional cameras with the Optitrack system is shown in Figure 8.

Results and Discussion

- ❖ The image data obtained in Optitrack is better due to the quality of the cameras used. However, the cameras used are quite expensive to purchase and install. For this reason, an interface was designed with the MediaPipe application that will allow MS patients to do exercises comfortably from home via webcam. The data obtained with two different cameras can be seen in Figure 8. When we examine the Graphical Results, even though the data is taken with different programs and cameras, it gives accurate results enough to understand whether the movement was performed correctly or how many times it was performed. At the same time, a simple interface that everyone can easily use and understand was designed, as seen in Figure 4. In this way, MS patients will have the opportunity to exercise comfortably from their homes.

- ❖ If cameras and similar applications are further developed in the future, these technologies can be used not only for MS patients but also in the treatment of other diseases in many areas.

Solution Methodology for MediaPipe

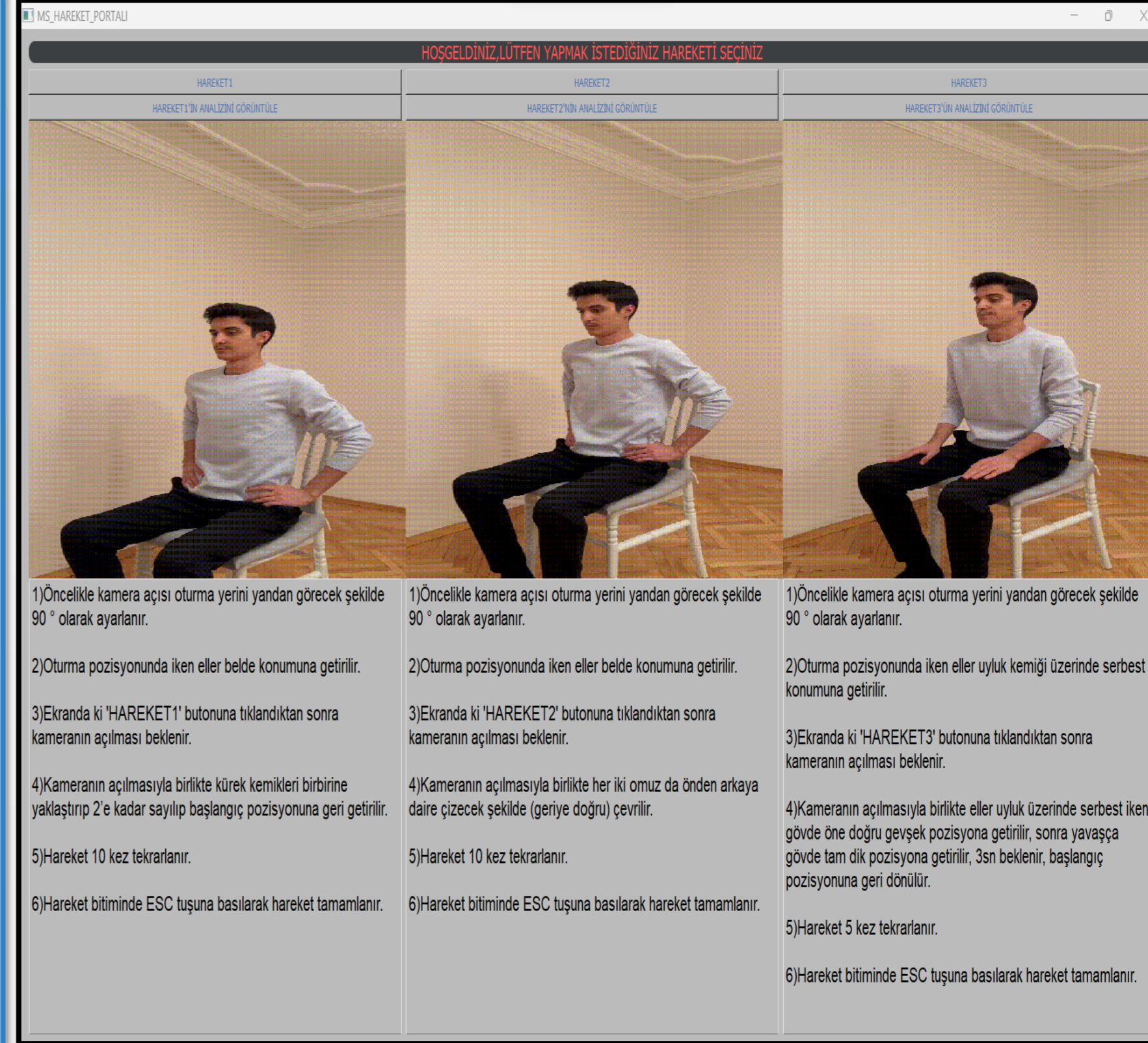


Figure 4 Interface Appearance

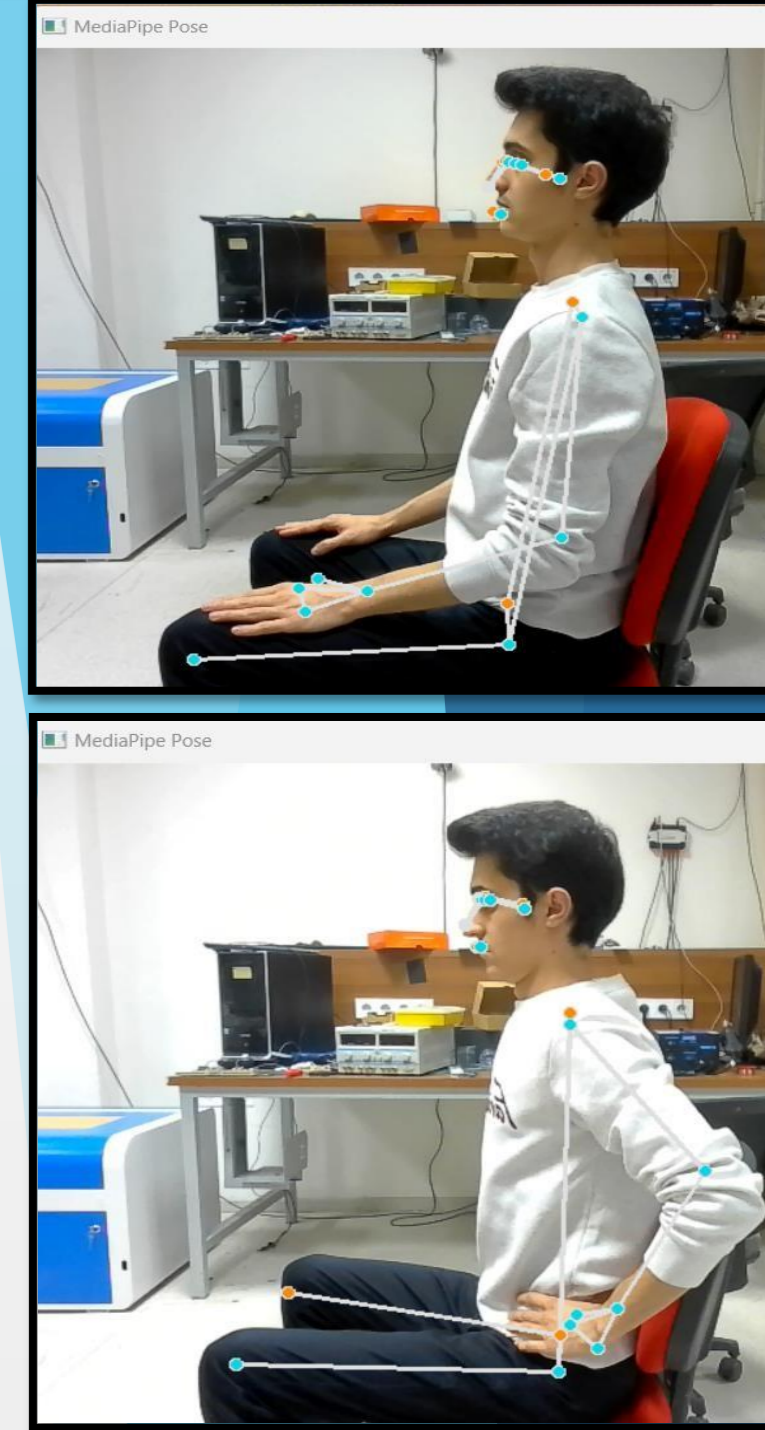


Figure 5 Markers Visible During Motion on the MediaPipe's Camera

- ❖ The interface shown in Figure 4 was designed with the Python programming language. MediaPipe library was used in the interface. Also As seen in Figure 5, location data from Special Markers is obtained using the webcam.

```
a = np.array([x2, y2]) #HIP
b = np.array([x1, y1]) #SHOULDER
c = np.array([x3, y3]) #KNEE

ba = b - a
ac = a - c

cosine_angle = np.dot(ba, ac) / (np.linalg.norm(ba) * np.linalg.norm(ac))
angle = np.arccos(cosine_angle)
print((180 - np.degrees(angle)))
```

Figure 6 Formula Used to Obtain Angle from Image Data

```
y = downsample(y, 15);
x = downsample(x, 15);
x = interp(x, 10000);
y = interp(y, 10000);

max_y = max(y);
min_y = min(y);
range = max_y - min_y;
y_normalized = (y - min_y) / range;
x_normalized = x / max(time);
```

Figure 7 DownSample, Interpolation and Normalization Formula

- ❖ Position data from Custom Markers is converted to angle value with the formula shown in Figure 6. Before plotting the angle values, subsampling and interpolation is performed with the formula shown in Figure 7 to obtain a smoother graph. Then the Graph was normalized. This makes it easier to interpret and better understand the results and ensures that the results are comparable and meaningful.

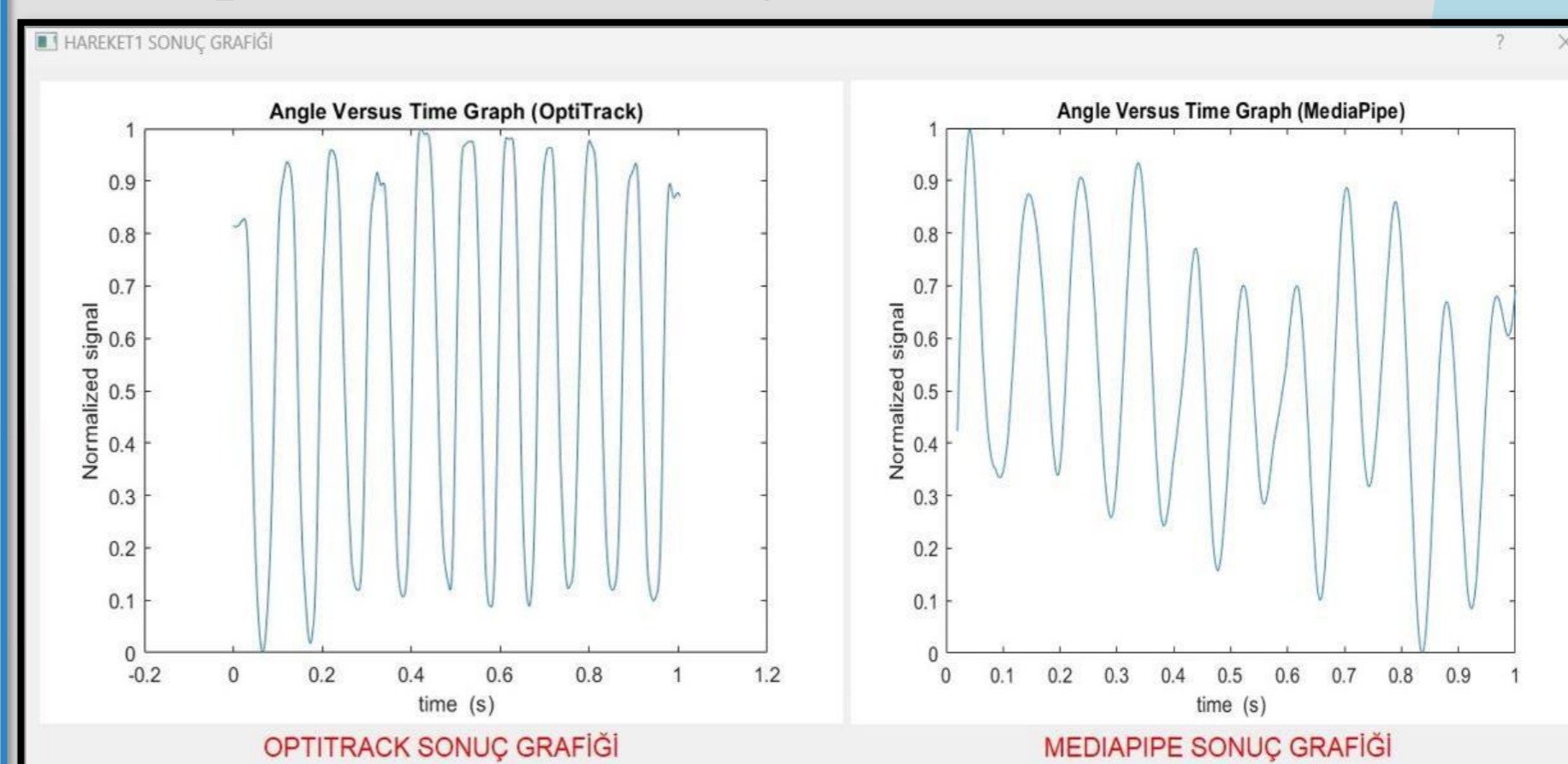


Figure 8 Result Graphics Taken from Optitrack and MediaPipe

In Figure 8, we see the graphs obtained from OptiTrack and MediaPipe image data. With the designed interface, these graphs are printed side by side, facilitating analysis.

References and Acknowledgements

- [1] <https://kadakod.com/python-ile-grafik-arayuz-hazirlama-qt-designer/>
- [2] <https://www.youtube.com/watch?v=mOKX8Gaqo0&list=PLdKrdVGpO5OZSIQDCyYFT-iOo1QmfzI7Z>

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