Astros Technical Assessment

Pitcher: 554430

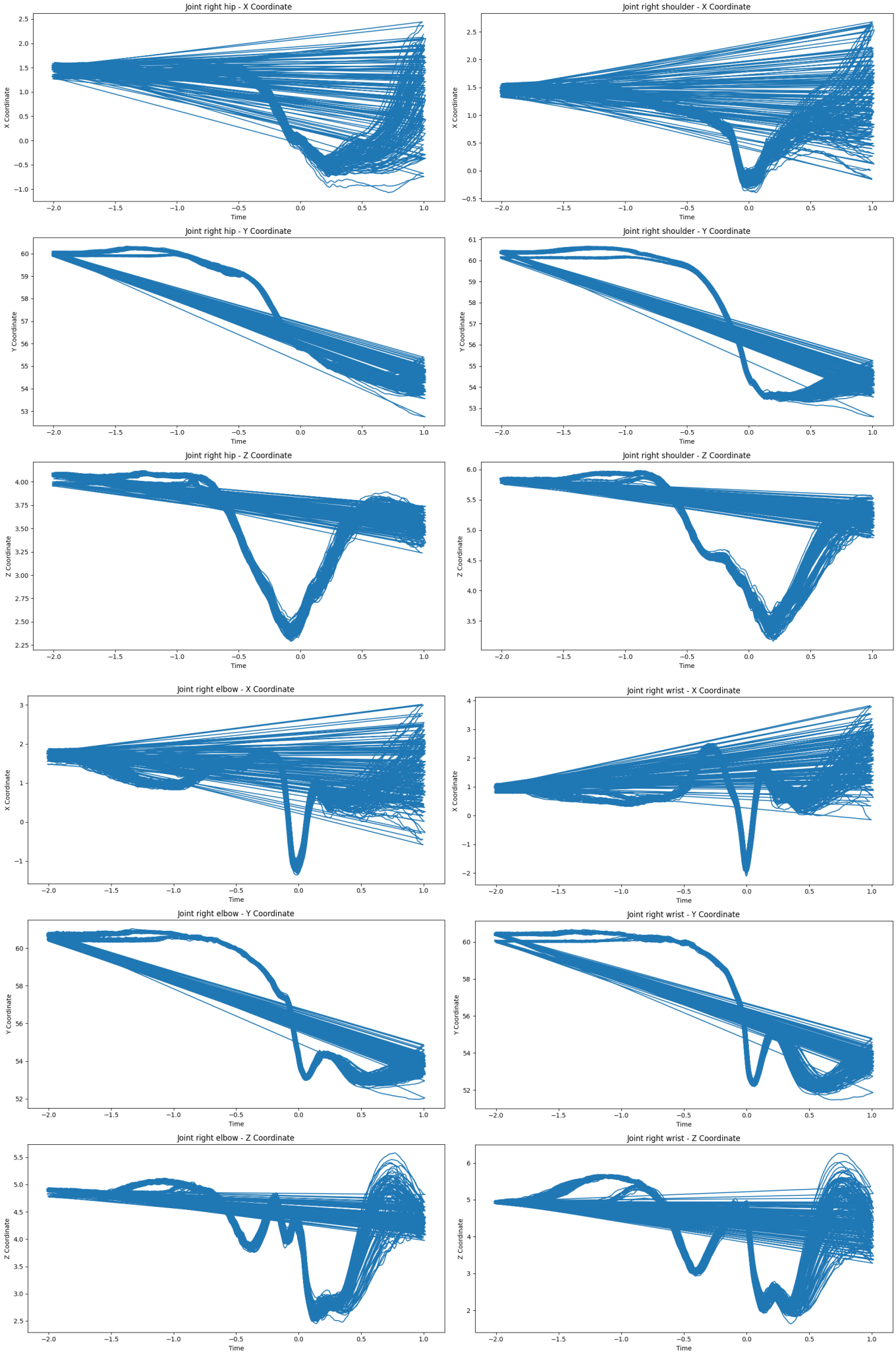
Game: 429722

Visualization of Raw Unprocessed Data

3D movement through time given four (4) joints, all corresponding to the pitcher's throwing arm side - hip (L/R), shoulder (L/R), elbow (L/R), wrist (L/R).

3D Movements of Joints Overtime - Pre-Signal Processing

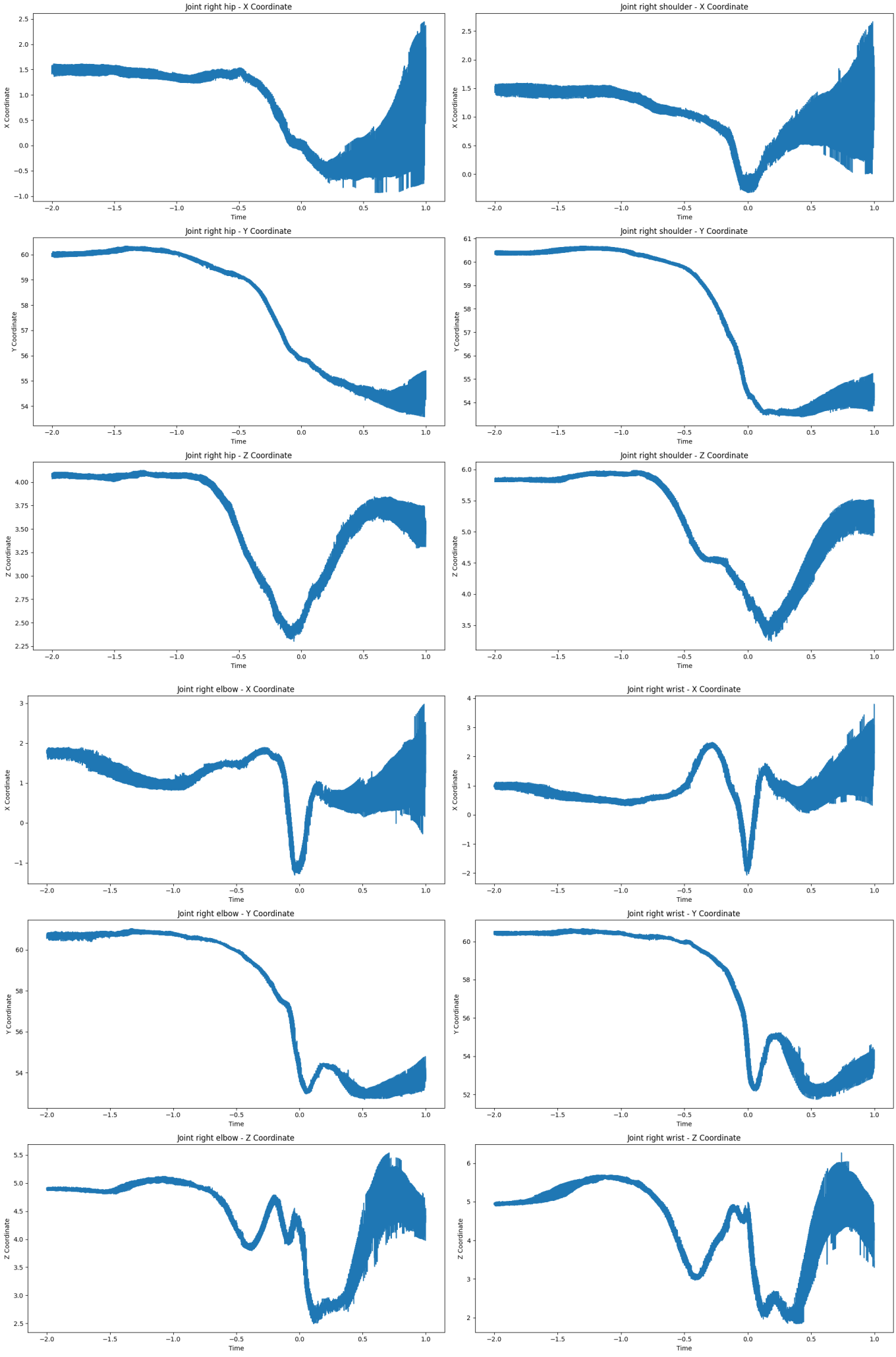
2D movement through time - data remains uncleaned (pre-signal processing):


Joint right hip - X Coordinate
X Coordinate
Time
Joint right shoulder - X Coordinate
X Coordinate
Time
Joint right hip - Y Coordinate
Y Coordinate
Time
Joint right shoulder - Y Coordinate
Y Coordinate
Time
Joint right hip - Z Coordinate
Z Coordinate
Time
Joint right shoulder - Z Coordinate
Z Coordinate
Time
Joint right elbow - X Coordinate
X Coordinate
Time
Joint right wrist - X Coordinate
X Coordinate
Time
Joint right elbow - Y Coordinate
Y Coordinate
Time
Joint right wrist - Y Coordinate
Y Coordinate
Time
Joint right elbow - Z Coordinate
Z Coordinate
Time
Joint right wrist - Z Coordinate
Z Coordinate
Time

Signal Processing Methodology - Density-Based Spatial Clustering of Applications with Noise (DBSCAN)

Implementation of a machine learning model known as DBSCAN. This is a density-based clustering non-parametric algorithm that groups given a set of points in a given n^{th} dimensional space. It groups together points that are closely packed together, marking outliers in low density regions.

In this study DBSCAN is applied to each coordinate per joint assessed and assessed independently per unit of time. As joint path over x, y, z coordinates is fluid over time, with no interruptions, DBSCAN per unit time allows for the model to identify continuous streams. Parameters epsilon (eps) and minimum number of samples (min_samples) were manually adjusted to produce desired results. Noise can be seen as wider/fatter portions of the plots which primariliy presents itself towards the beginning (set position) and end (ball release position) of pitch delivery. If not explicitly identified, the default means to calculate distance between isntances in a feature array is via euclidean geometry (note that the metric to measure must be one of the options allowed by sklearn.metrics.pairwise_distances). Further parameters were not adjusted in this study but can be further reviewed to potentially further reduce noise. 2-dimensional plots of the cleaned data can be seen below: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Y Coordinate
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Z Coordinate
Time
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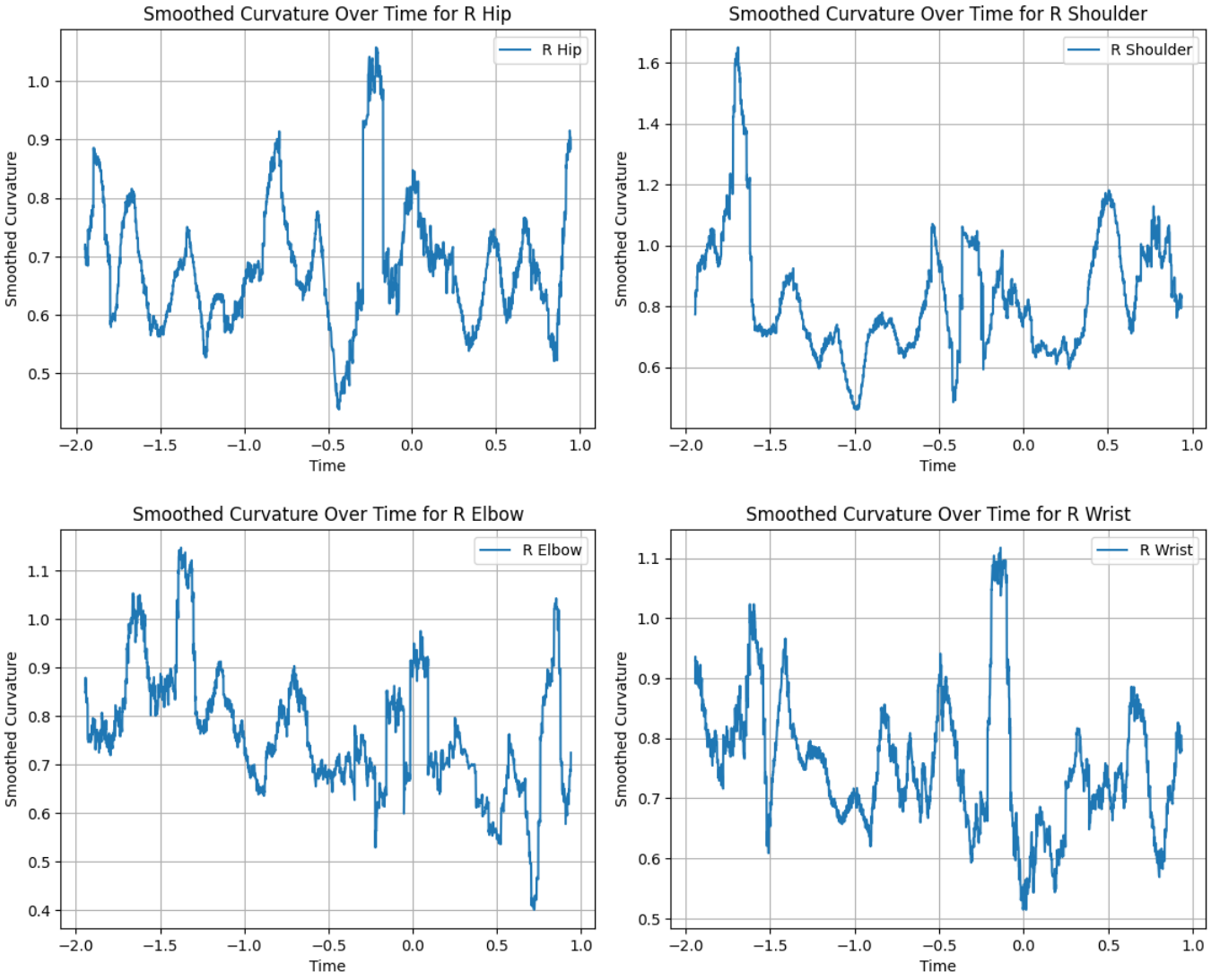
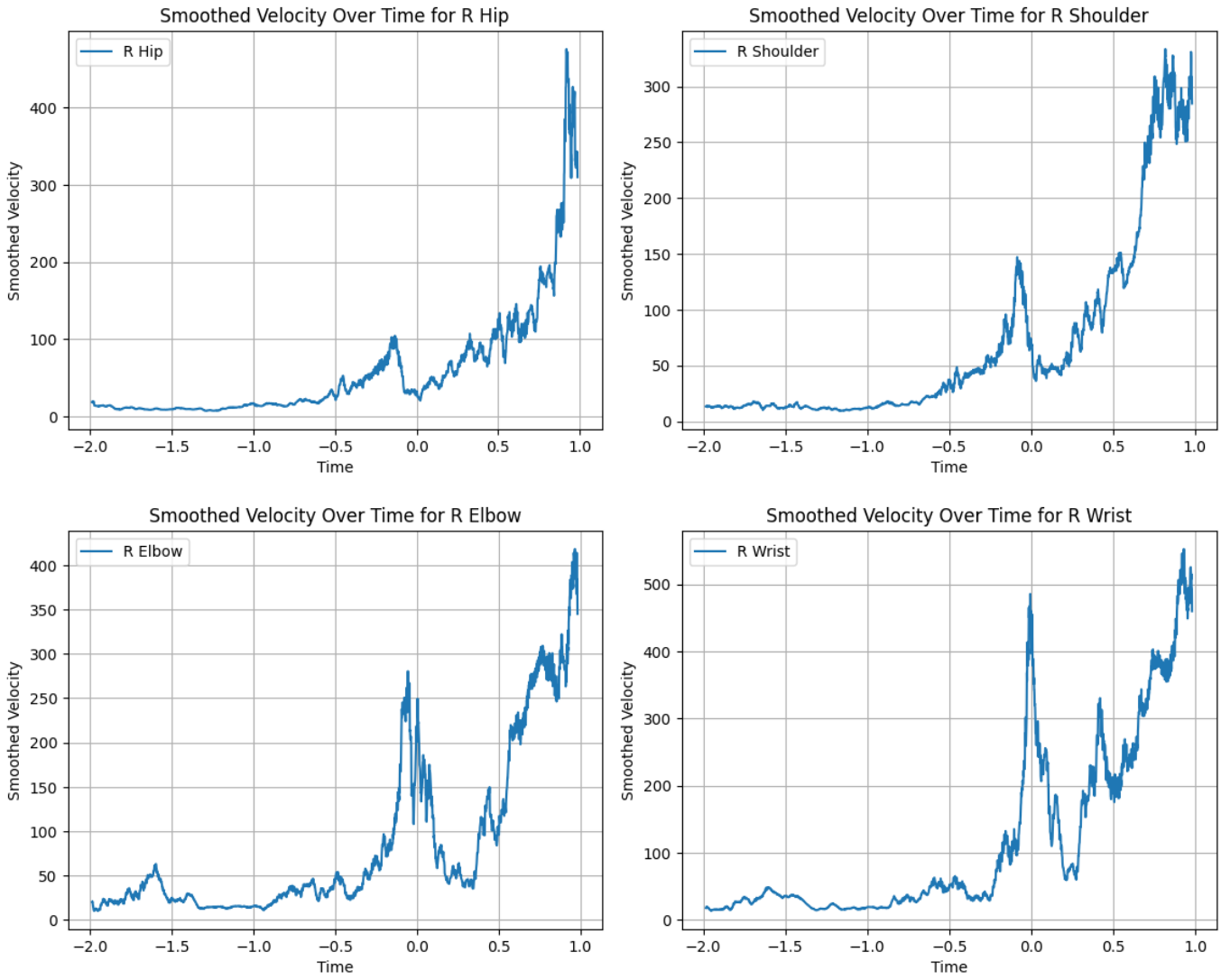
Z Coordinate
Time
Joint right elbow - X Coordinate
X Coordinate
Time
Joint right wrist - X Coordinate
X Coordinate
Time
Joint right elbow - Y Coordinate
Y Coordinate
Time
Joint right wrist - Y Coordinate
Y Coordinate
Time
Joint right elbow - Z Coordinate
Z Coordinate
Time
Joint right wrist - Z Coordinate
Z Coordinate
Time

Measured Metrics to Identify Arm Path

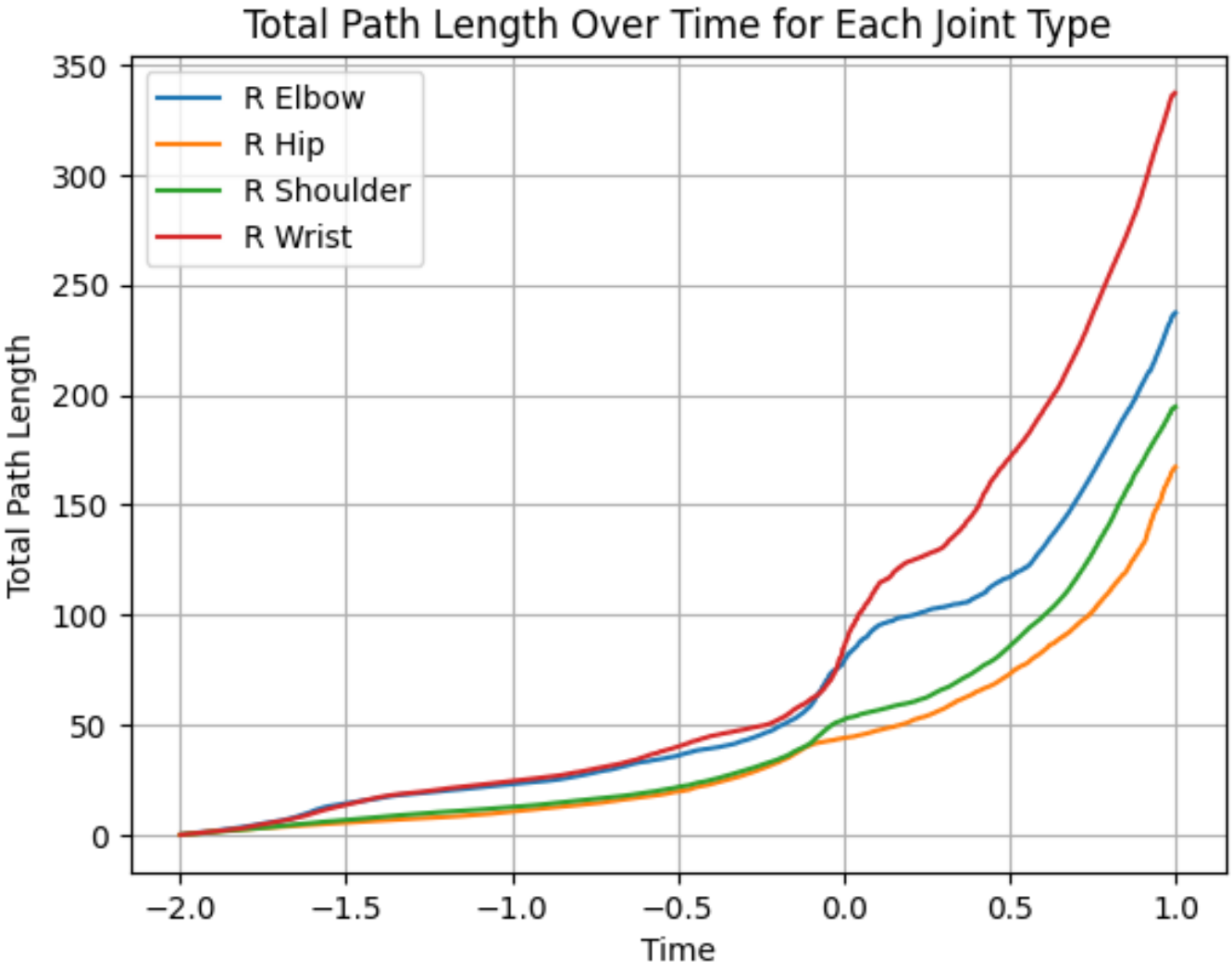
1. Curvature Over Time measures how the bending or tuning of a path changes as an object or point moves. In turms of motion, cuvature can provide insight into the nature of movement.
    - Constant curvature indicates that the object is moving along a circular path with a fixed radius
    - Changing curvature over time indicates that the object's path is bending or turning at varying rates.
    - Zero curvature indicates that the object is moving in a straight line.



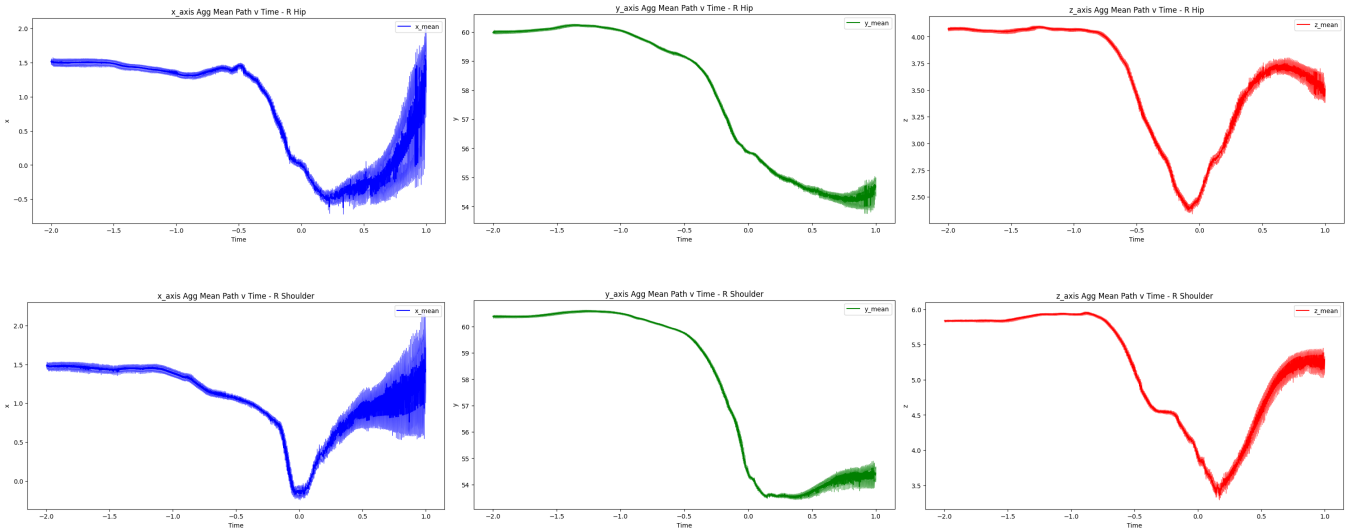
2. Velocity Over Time measure how the speed and direction of an object's movement change as it travels along its path. A more basic metric, but possible to identify differences as pitch count increases.

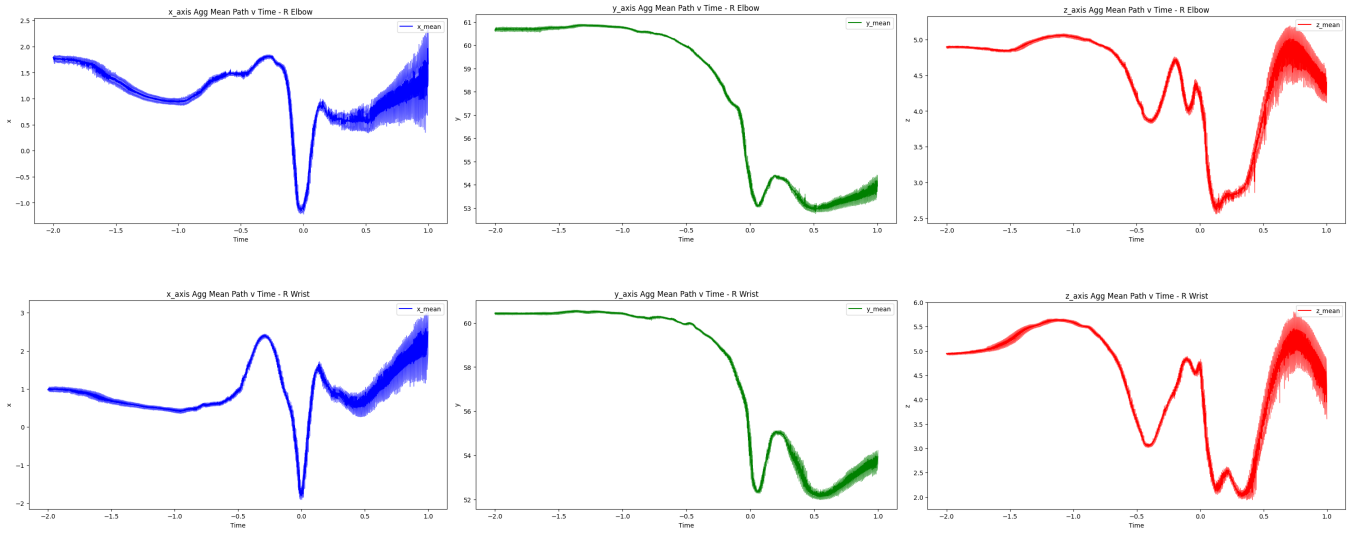


3. Cumulative Distance Traveled provides a quantitative measure of how much the arm/joint ha smoved during the entire pitch delivery. Through this one can gain possibly insights to the efficiency and mechnics of pitching motion. This could also possibly be used to identify any mechcanil differences in a pitchers delivery, potentially identifying injury, strain, or fatigue. (note all joints have been placed in one plot)



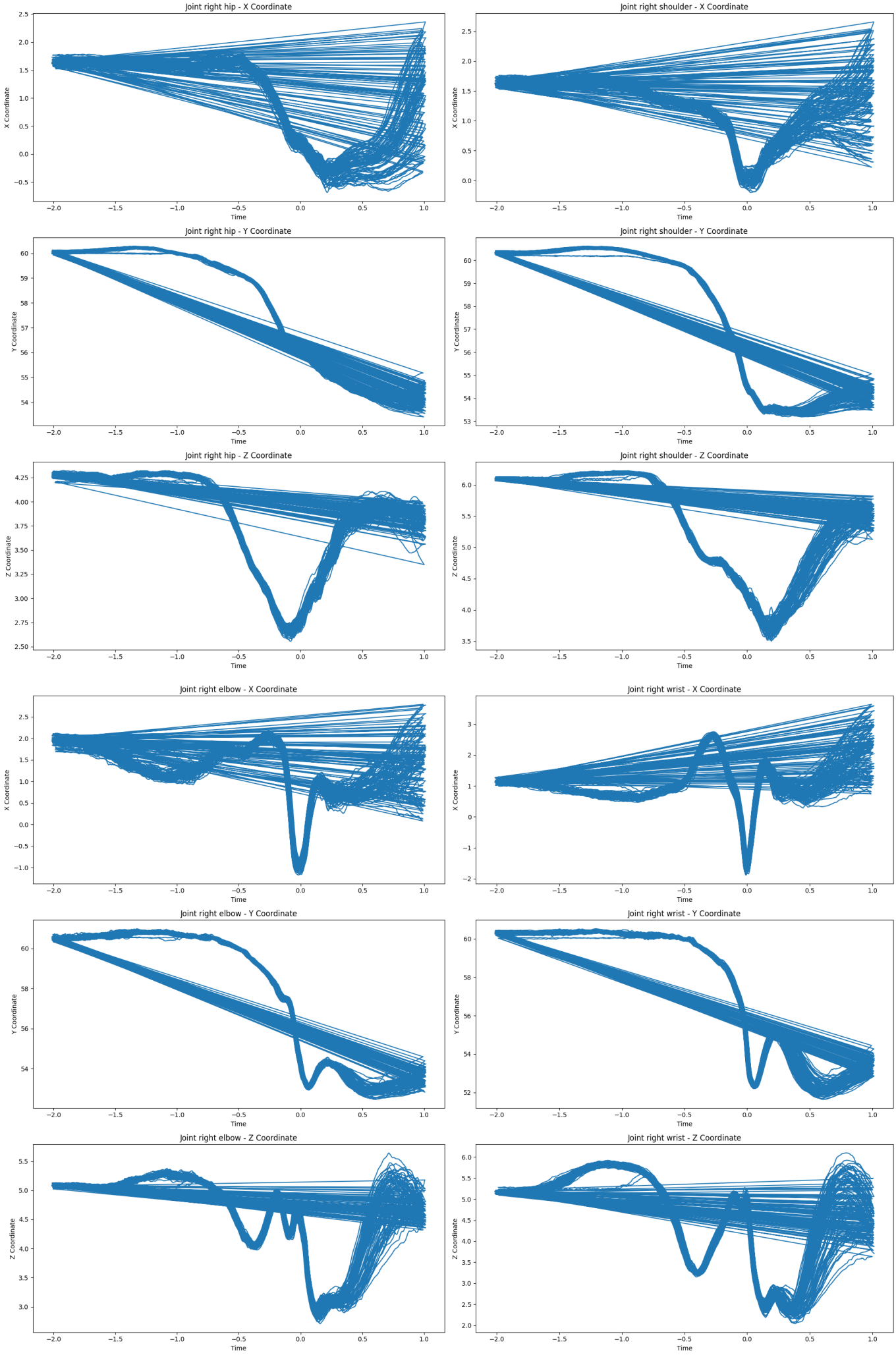
4. Aggregate Mean Path tracks the joint path through time and computes the mean for all samples per time increment. Once the mean path is computed a tolerance can then be set to allow for normal deviations in pitch delivery. If the delivery starts to fall outside of the "pocket" then further investigation may be needed.





Game: 429804

2D movement through time - data remains uncleaned (pre-signal processing):


Joint right hip - X Coordinate
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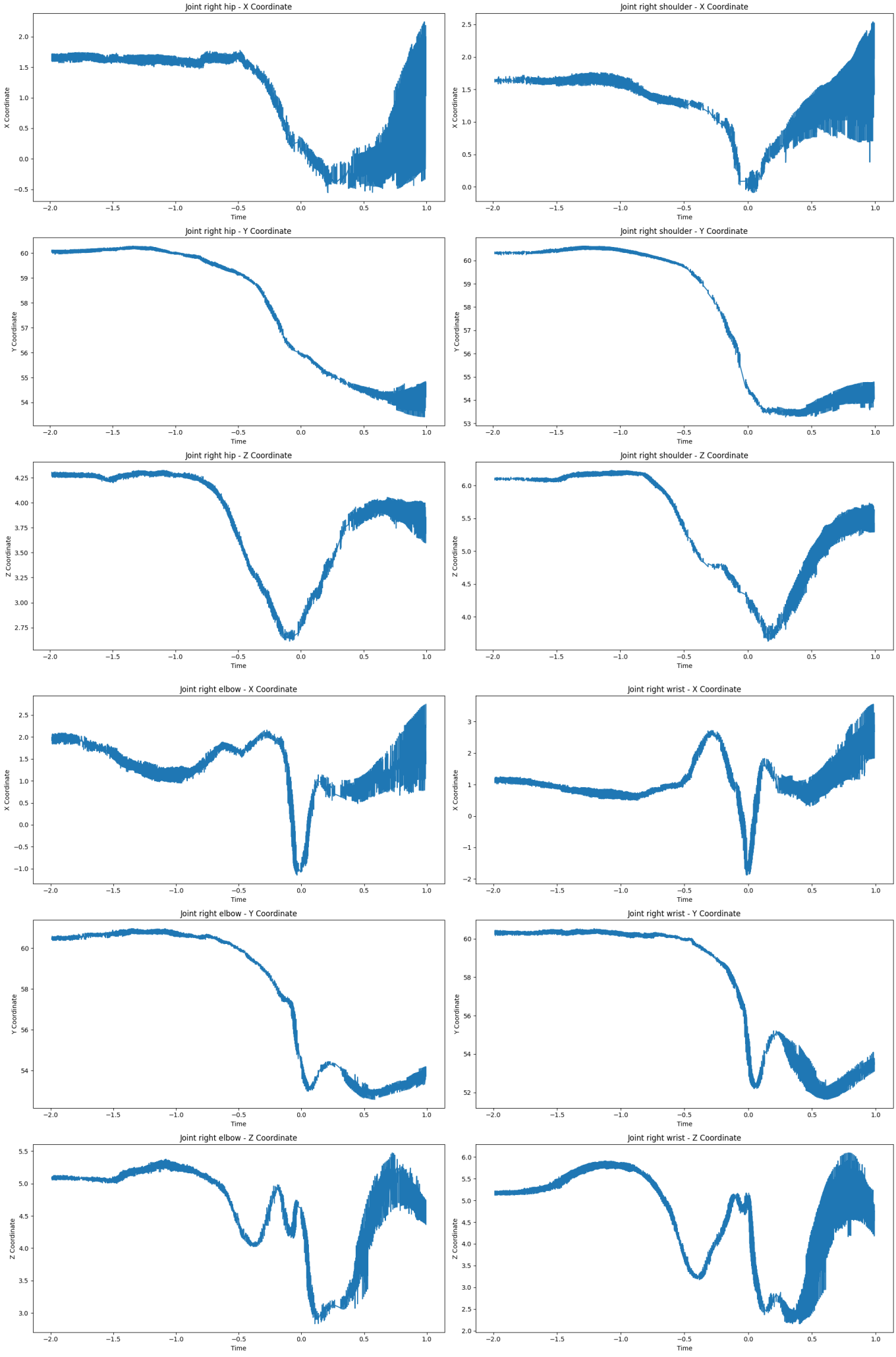
Joint right wrist - Y Coordinate
Joint right elbow - Z Coordinate
Joint right wrist - Z Coordinate
X Coordinate
Y Coordinate
Z Coordinate
Time

Signal Processing DBSCAN - Cleaned Data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Joint right elbow - Y Coordinate
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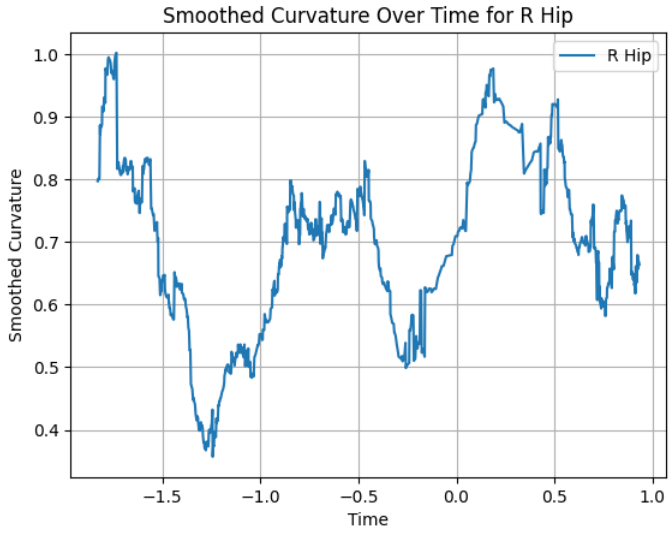
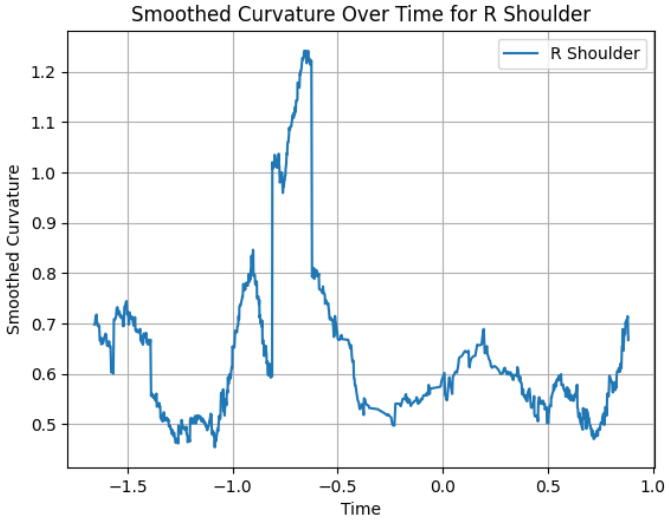
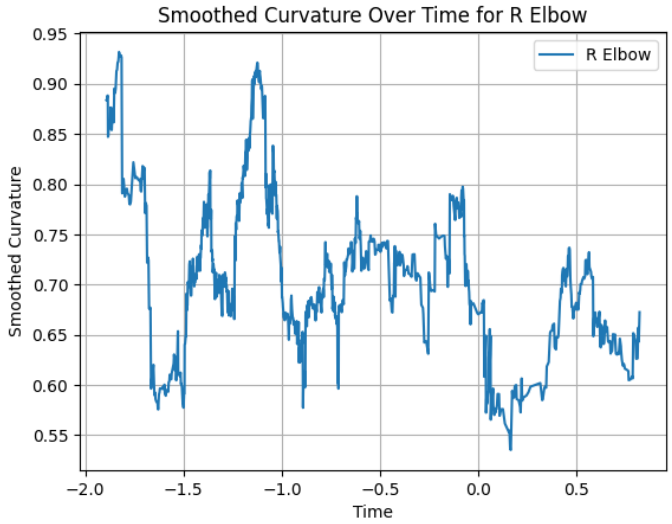
Joint right elbow - Z Coordinate
Joint right wrist - Z Coordinate
X Coordinate
Y Coordinate
Z Coordinate
Time

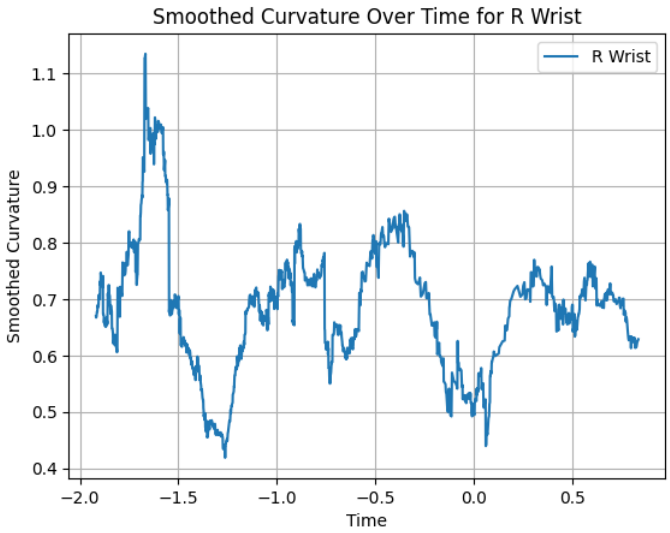
Measured Metrics to Identify Arm Path

1. Curvature Over Time Profile

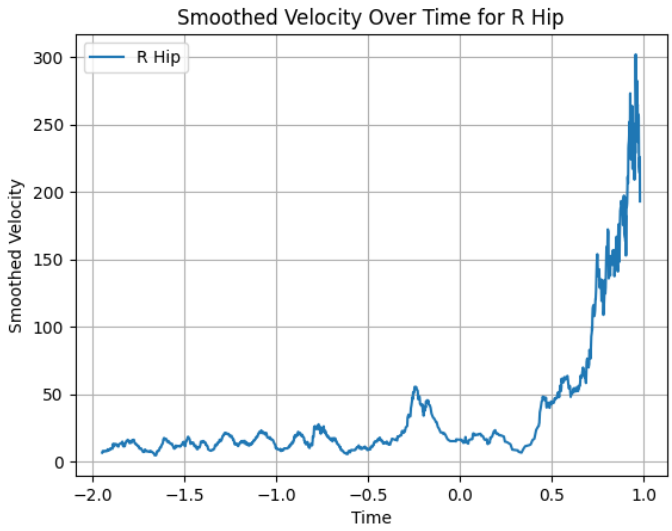


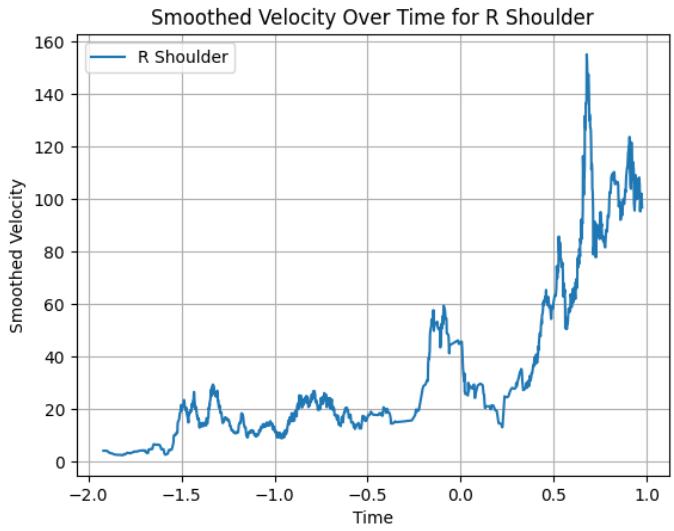


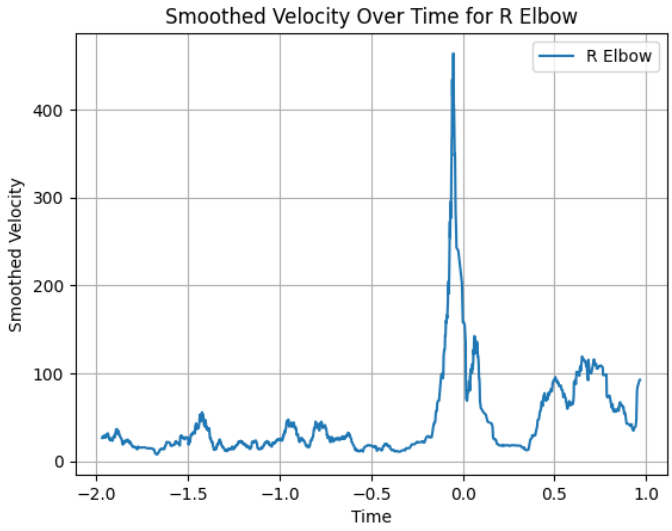


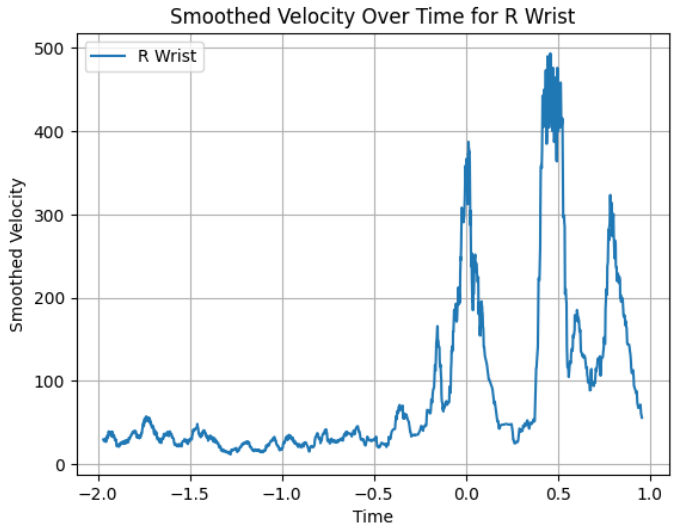


2. Velocity Over Time Profile

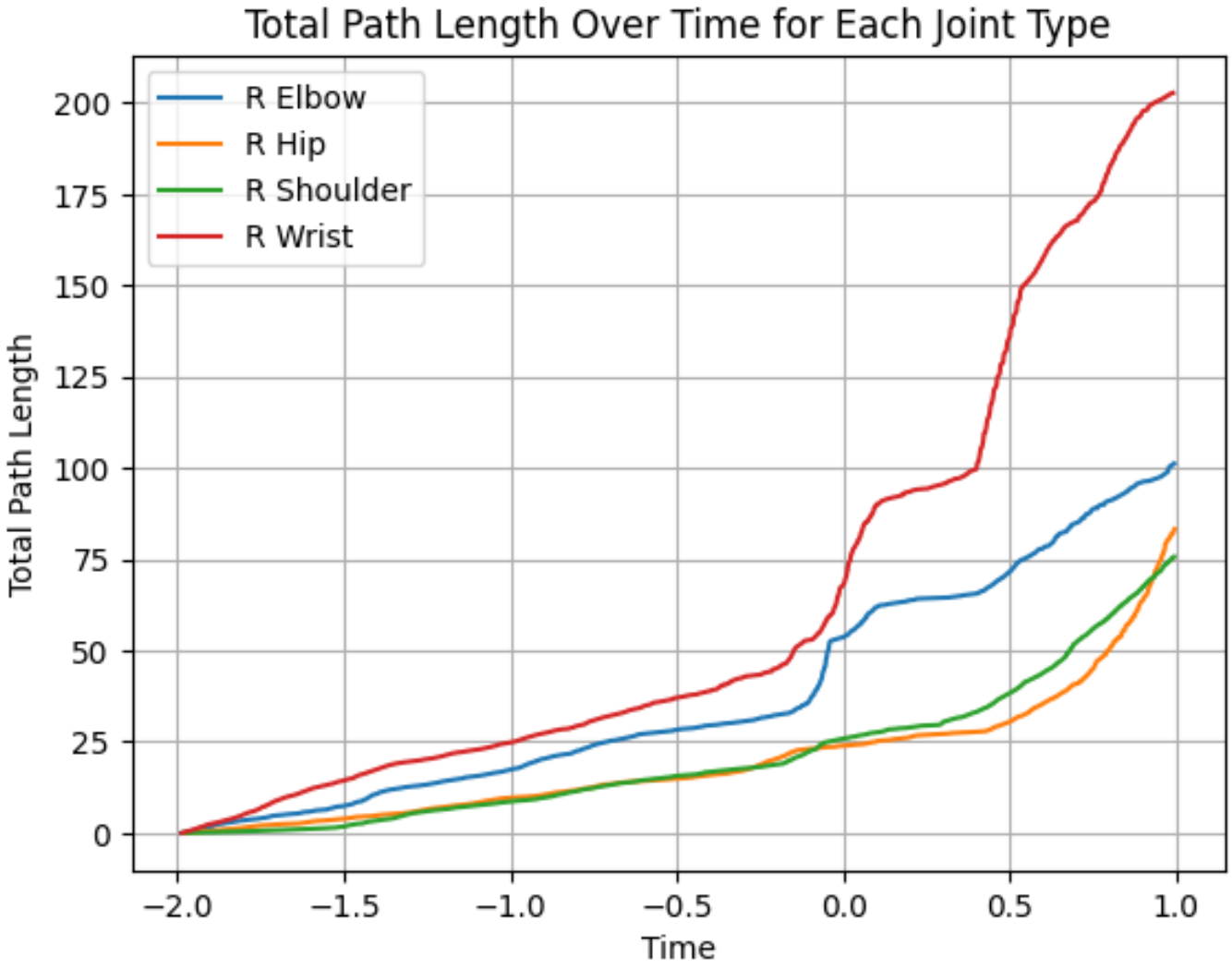




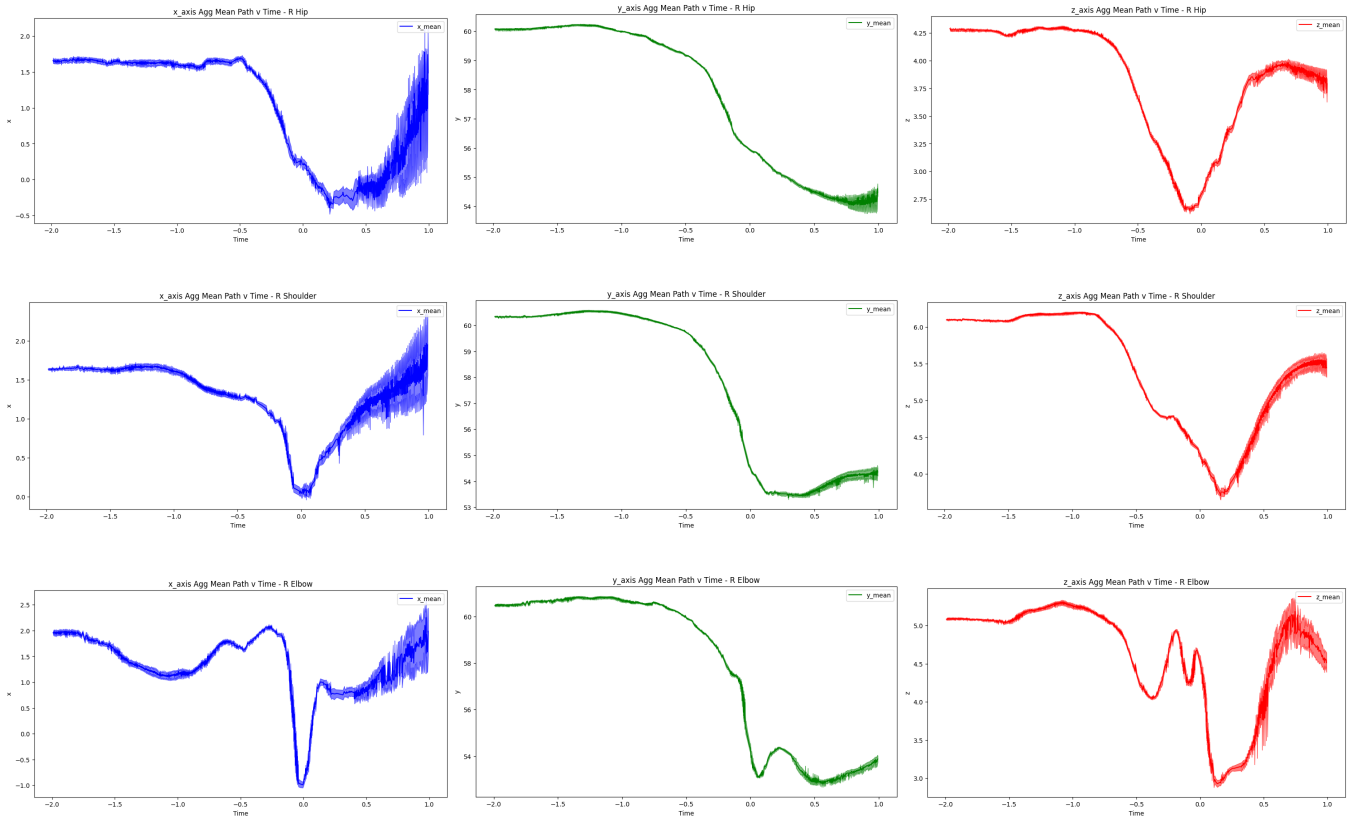


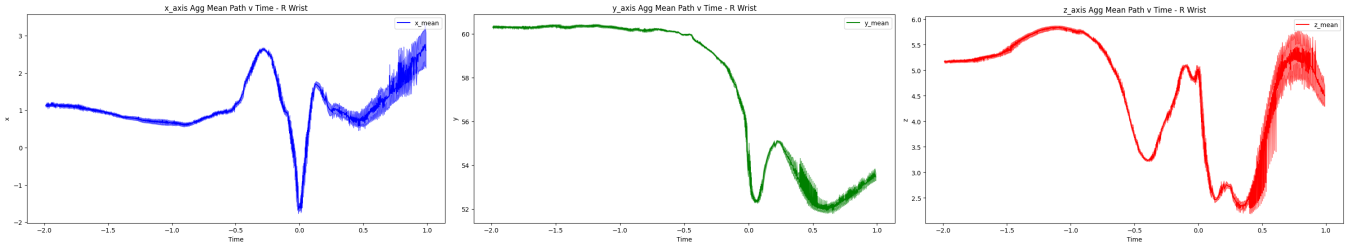


3. Cumulative Distance Travelled



4. Aggregate Mean Path




x_axis Agg Mean Path v Time - R Wrist
x_mean
Time
y_axis Agg Mean Path v Time - R Wrist
y_mean
Time
z_axis Agg Mean Path v Time - R Wrist
z_mean
Time