# Data Analysis and Visualization of Player Tracking Using Arduino

Based on the Arduino code (https://github.com/Redback-Operations/redback-orion/blob/main/Accelerometer_KalmanFilter_code.ino) which collects accelerometer data (x, y, z axes), calculates speed, and determines movement direction, here are some specific analyses and visualizations a data analysis team could perform:

## 1. Trend Analysis of Movement Speed and Direction

- **Objective**: Understand how the player's speed and movement direction change over time or during specific game situations.

- **Approach:**
  - Calculate moving averages and variances of speed over the game to identify periods of high activity or fatigue.
  - Correlate direction changes with specific game events, like scoring opportunities or defensive manoeuvres.

- **Visualization:**
  - Line charts showing speed over time with event markers.
  - Vector field maps showing direction and magnitude of movement across the field.

## 2. Boundary Crossings Analysis

- **Objective:** Investigate the frequency and conditions under which players cross defined boundaries, which could indicate strategic positioning or rule infractions.

- **Approach:**
  - Log instances when x or y acceleration goes beyond the preset boundaries.
  - Analyze the context of these boundary crossings in relation to game events or player performance metrics.

- **Visualization:**
  - Heat maps or spatial plots indicating locations of frequent boundary crossings.
  - Timeline views correlating boundary crossings with key game moments.

**3. Detailed Acceleration Data Analysis**

- **Objective:** Deep dive into the raw acceleration data to detect patterns, anomalies, or potential indicators of player health and safety.

- **Approach:**
  - Perform a frequency analysis to identify repetitive movements that might lead to injury.
  - Use anomaly detection algorithms to spot unusual accelerations that could suggest impacts or falls.

- **Visualization:**
  - Scatter plots of acceleration data in three dimensions.
  - Box plots or histograms to explore the distribution of acceleration values.

**4. Performance Benchmarking**

- **Objective:** Compare performance metrics between different players or the same player across different games.

- **Approach:**
  - Aggregate and normalize data for comparisons, such as average speed or total distance covered.
  - Use statistical tests to identify significant performance differences.

- **Visualization:**
  - Bar charts comparing key performance indicators across players.
  - Radar charts to visualize multi-dimensional performance metrics

**5. Real-Time Monitoring and Alerts**

- **Objective:** Provide real-time feedback to coaches and medical staff about player conditions and performance.

- **Approach:**
  - Implement a real-time dashboard that updates with new data as it comes from MongoDB.
  - Set up alerts based on specific thresholds for speed or acceleration that could indicate injury risk or fatigue.

- **Visualization:**
  - Dynamic dashboards displaying current speed, direction, and ace
  - leration with alerts for anomalies.
  - Live maps showing player locations and movements on the field.

**Implementing the Analysis**

- **For integrating and analyzing this data:**
  - **Data Ingestion:** Set up a system where the Arduino sends data directly to a MongoDB collection, possibly through a Node.js server that receives and processes HTTP POST requests.
  - **Data Processing:** Use Python or R to perform complex analyses, especially for statistical modeling and machine learning tasks.
  - **Visualization:** Use tools like Tableau, Power BI, or custom-built JavaScript visualizations for real-time data display.

Each of these analyses will help the data analysis team provide actionable insights to improve player performance, manage fatigue, and enhance overall team strategy, all powered by the real-time data provided by your Arduino-based tracking system.

**For implementing the Kalman filter in Python for data analysis:**

**https://drive.google.com/file/d/1zxRF-GnbyoLz8MQWJS2T85MNg62P6grT/view?usp=sharing**