# Bringing IoT to Sports Analytics

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## The Problem Definition:

Lately, multiple sensor-based innovations are being done in the sports domain (with the advent of wireless and IoT) like football helmets – aimed to detect concussions and head injuries, Shoes with embedded IMU, Camera embedded jerseys, etc. Not only this but the stadiums these days have high-quality cameras to monitor the performance of the player, check for any discrepancy in the decision, analyze the posture of the player while handling the ball (if the game is ball based), etc. However, there is still some gap in the characterization of the 3D motion of the ball, say the ball's orientation, revolution speed, trajectory, etc. This paper brings a new aspect of using IoT in sports analytics (especially cricket) and further claims that the application can be extended to multiple other games as well (like badminton, tennis, etc.). The goal of sports analytics is to make it easy for the players or coaches to track the player's performance as well as to predict the winner/winning team.

## Key Idea:

The solution iBall works on the idea of using inexpensive sensors namely an Inertial Measurement Unit (IMU) and Ultrawideband (UWB) radios inside the cricket ball or as anchors on the fields to detect the motion patterns of the ball to analyze the data for coaching, strategic insights and predictions, together known as analytics. UWB's are being used to compute the time of flight (ToF) and angle of Arrival (AoA) of the signal from the ball. All the information gathered from multiple Inertial sensors and UWB's fused into a non-linear error minimization framework followed by extraction of the parameters of the ball trajectory. The author claims that the same system can be used without any calibration and training to other games as well.

## Important Details:

1. The accelerometer does not measure gravity when the ball is in free fall and the gyroscope saturates at around 6 revolutions per second (rps).
2. To determine the orientation of the object, it needs to rotate around the global rotation axis.
3. Ball Seam is considered one of the rotation axis.
4. The calculations are done taking the advantage of local and global frames of reference.
5. The trajectory of the ball can be determined using the magnetometer when the accelerometer and gyroscope are not efficient.
6. The fitting algorithm is used to find local orientation.
7. Kalman filter is used to lessen the Dilution of Precision.

## My Thoughts and Criticism:

The paper presents a great application for IoT in sports analytics with relevant observations and proofs. It can be observed that the author has tried to be open about the ideas and challenges faced while implementing this solution.

However, a few of the assumptions and scenarios that led me to further questions and thinking are:

1. Ball spin and throw also depend on the through of the baller and we are not considering the baller's position and speed, etc. to perform proper sports analytics.
2. Is wireless charging really a feasible option for the cricket ball? Will It not make the device expensive moreover the probability of a cricket ball losing in the stadium is more than the current battery time (for a good match), will it be affordable to lose the ball with embedded sensors?
3. The testing scope is limited and should be extended to outdoor testing instead of indoor because cricket is an outdoor game and weather, and airflow can have a high impact on the ball's spin and rotation.
4. A few factors are not pondered very well and should be considered: Will the hit speed or force (via bat) impact the sensor readings or the ball's life?
5. As anchors will be on constant power supply, will this keep the whole setup inexpensive?
6. The current rotational error is observed to be below 12 degrees at the end of the flight, but this will make a significant error in the performance analysis for a newbie and a professional spinner.
7. Other environmental factors are not considered while testing like the median of transmissions (can be windy, rainy, etc. day). Also, the pitch can impact the ball's bounce.