# IoT and Computer Vision for Analysing the players on the IISERB Badminton court

Group Name : PAI

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## I. Introduction

Object detection for Computer Vision is one of the fastest evolving branches of Artificial Intelligence in the past 20 years [1]. It deals with the detection of object instances in a visual frame with objects belonging to various classes(such as animals, trees, fashion, etc.). With its applications ranging from detection and mapping of tree seedlings [2], to assistance of visually impaired [3], to star/galaxy classification[4], and everything in between.

Similarly, it is being used in sports analysis[5]–[7] by coaches and analyst experts to understand and improve player performance. Considering the popularity of badminton, it has become the most prevalent sport around the world. We aim to combine the techniques of Object detection and classification with, Internet of Things (IoT) to make the data accessible and feasible for implementation by the institute.

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## II. Motivation

Computer Vision for sports analysis is not new, and coaches have been using it for quite some time. This research aims to develop a lightweight model that will process the live video footage of a badminton match and give us relevant data. We believe that the institute can accept this model, who can use a raspberry pi to directly process the live footage from the CCTV cameras at the court.

## III. Research

Tracking players based on the Tracking- Learning-Detection (TLD) model is a viable option, and it is very accurate in tracking objects for a long time. However, the TLD model is highly affected by the gradients of the pixel values. This is a problem since most of the cameras at badminton court are usually monocular cameras fixed at a high distance far from the players. This makes it so that one of the players is partially occluded by the net. And since the net and the background have a high contrast from one another, making the TLD miss-track the player. However, this problem can be minimized by applying Image Compensation techniques such as Image Inpainting [8]. However, this method is not perfect and requires manual input to work at all times

Transfer learning is one of the most popular methods for customizing the model to fit our needs. In the paper by Rahmad *et al.* [9] they used Alexnet and trained it with their data to classify HIT/NONHIT of the shuttlecock. They added a local CNN before the feature extraction by deep learning (DL). The local CNN splits the image into two equal parts, checks the parts if relevant information is present in that half, and then propagates that part to the DL model. They observed a considerable increase in accuracy and showed that global extraction for features is not efficient.

For the project, we are using YOLO at our core and applying some of the techniques proposed by other researchers for the accurate detection and tracking of players. With YOLO, we aim to provide player detection and tracking in real-time with improvements. Furthermore, the Game classification model will be based on Convolutional Neural Network (CNN). This will be an important asset in our future project to generalize the setup to work automatically for various games/sports.

## IV. Problem Definition

The central aspect of the project is to develop a lightweight player detection and tracking model, which can detect and track the player's position. We aim to

process the live video footage from the badminton court and classify the players into teams with this model. Count registered hits, misses, get other relevant things and possibly track the player's movement to translate it to a 3d model for a better understanding. Complimentary to it, we will develop a game classification model to detect the game they are playing. We hope to implement this setup combining both the models on a raspberry pi to process the live game-play from the webcam/CCTV footage from the badminton court (In the future, we hope to generalize the setup to work on different sports automatically. So having a game detection model is the first step towards it). The processed data will be hosted on a website from where one can access the data.

If possible, we will also try to develop a model which can detect and predict the fights on the court. With the help of services such as Twilio and Mailgun, we can alert the relevant authorities if a fight occurs before it becomes severe.

### A. Contributions

With our project, we will have a working setup ready for real-time analysis of any badminton match. We will be able to access the data from anywhere using the internet. The models developed will help future researchers implement their own models for real-time analysis, or they can also be used for a proper in-depth review of a match after it is over. The model for game classification will be helpful in many other tasks involving game detection and classification. The model we proposed for predicting and detecting fights on the court will become an essential asset for keeping peace on the playground.

With this project, we hope to contribute to object detection and classification by developing a real-time, lightweight, and accurate model for analyzing the game of badminton. We will try to solve the problems faced by other researchers, like detection from blurred frames, player occlusion by the net. If possible, we will also try to capture the 3d tracking data of the player, and this will help in generating player tracking data for use in other research projects.

## V. Objectives

- Make a lightweight model for detection and tracking of players.
- Make a Image classification model for classification of games.
- Make a website to display the player data such as:
  - Game they are playing
  - Number of players of each team
  - Team of the player based on color of jersey.
  - Player's position on the court *w.r.t* time.
  - Hits, misses etc.
- Real time 3d motion tracking of players and translating to a 3d body, if possible.
- Possibly developing a model for detecting and predicting fights.

## VI. Methodology

- Understanding the importance of player detection and tracking in sports
- Understanding the existing object detection models
- Researching and understanding the models used for player detection and tracking in sports.
- Developing an improved model based on previous research for player detection and tracking.
- Testing our model with live as well as recorded footage of badminton match
- Extracting the useful information from the model result.
- Developing a image classification model for classification of games.
  - Collecting images of different games from the internet.
  - Labelling the data
  - making a CNN model for classification.
- Combining both the models.
- Try to run on a raspberry pi with live footage of a badminton match.
- Host the results on a website for people to access.

## VII. Possible Result

The model we develop will be able to detect players on the court, track them. Then we will extract the relevant information from the data, such as player team. The number of players, Hit/NonHit, player position during the entire match. We will display the data in a visual format on the website for easy understanding. We may implement our model on a raspberry pi which can analyze the footage from the CCTV or a camera and give real-time statistics of the match. The model that we develop for game classification can be used in other research projects and may be improved by using transfer learning..

## VIII. Roles

### A. Research Phase

#### 1) Khadga Jyoth:

- Researching and understanding relevant articles/projects.
- Going through some of the popular pre-trained models for object recognition.
- Finding the limits of each of these models.

*2) Anushka:* I will be collecting and understanding the relevant articles/ journals for the research and going through some of the famous pre-trained models, and understanding them for future use.

*3) Yasmin:* I will be going through the research articles and understanding them, and sorting them based on our use in our project. I will also look into the pre-trained models and also try to implement the proposed research methods.

### *B. Demo and Coding phase*

*1) Khadga Jyoth:* Here, I try to develop a prototype object detection model, and see the working of each of the existing models. In this phase I will have a model which will give some results. In this phase I will be working on two things , a player detection model and a game classification model. For player detection model:

- I will code a rough prototype and see if it works.
- make some improvements inspired by the research articles
- try further add new ways to improve upon the existing models

For Game classification model:

- I will be involved in coding a CNN based image classifier
- improve its performance by using image pre-processing techniques

*2) Anushka:* In this phase, I will work on data collection and optimization techniques for the player detection model. I will be heavily involved in the coding aspect of the image classifier model.

*3) Yasmin:* I will be heavily involved in data collection and data labeling for the Game Classification model. I will also work on the player detection model and try to implement the researched techniques.

### *C. Final Phase*

*1) Khadga Jyoth:* In this phase, I primarily optimize the models to work on a raspberry pi and be real-time. This phase also encompasses the building of an online website for displaying the data.

*2) Anushka:* In this phase, I will be involved in developing a website for data hosting. I will also work on implementing models on raspberry pi.

*3) Yasmin:* The final stage will involve me heavily in the optimization of the game classification model. This will also require pre-processing of data and post-processing of the resultant data to be visualization the website.

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