AUTOMATED CRICKET INSTRUCTOR

Abstract

Cricket is a very popular sport and growing in size, especially after the Indian Premier League (IPL). A prime challenge is to provide the players with a shot detection and judgmental model. Classifying cricket shots is usually a complex task. This paper presents a perspective of 3 shots of cricket into cut, drive and sweep from videos of shots played. The aims of this work is to classify shots by using images as input to the model as well as provide feedback about the quality of the shot played. The methodology used in this model is Open Pose Estimation which uses 18 key points on each image and the convolution neural network for the classification of shots. The test model accomplished an f1 score of 0.8, which is good considering that the dataset consists of 120 images.

Keyword: OpenPose; convolutional neural network; Cricket Shot ;

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I. INTRODUCTION

In today's world, technology dramatically impacts sports, especially cricket. Compared to the 1990's era, cricket has come way forward concerning technology. We have Ultra-Edge, susceptible cameras, hotspots, ball tracking, etc. However, few attempts at shot detection and comparative analysis of shots played have been made. Researchers use machine learning algorithms in various fields [1-5].

Not many methods in today's world predict shots and provide feedback on the shot played by the batters. Also, technology is developing in the current era of cricket, and many new technologies, such as Ultra edge, Hotspot, etc., are now widespread. However, we intend to develop a shot detection, and prediction system that is not yet active in professional cricket and is only used for training or testing and is not very common.

The attempts in this field, like [6] [7], use videos in combination with neural networks and available datasets to predict the shot played by batters. This work, however, tries to use images to acquire data from batters, like in [8], where a batsman plays a particular shot and tries to detect the shot played by batters and compare it with an ideal shot to produce the results bypassing the data collected into a model.

Our work includes the following contributions:

- To apply the dataset of images to the model in the input phase.
- To train the model based on the classification of the shots
- To compare the shot played with the ideal shot.
- To produce the results with the shot played and the shot's accuracy in the output phase.

II. RELATED WORK

Automated Cricket Instructor aims to detect various cricket shots such as Straight shot, Cover shot, and pull shot and to improve the quality of shots played by batsmen. To improve our analysis and to get a deeper understanding of the same, this work reviewed a few related papers as discussed below:

Semwal et al. [6] have presented a system for recognizing accurate cricket shots. This work presents a contemporary scheme to identify and categorize various types of shots played in the game. This system was developed using clipping from videos of live telecasts and highlights. This system uses Convolutional Neural Networks (CNN) and Support Vector Machines (SVM) to classify different shots. The model classifies the various shots with a precision of 83.098% for shots played by a right-handed batsman and 65.186% for shots played by a left-handed batsman, thus proving to be quantitatively reliable.

Zualkernan, et al. [7] described the outline and burgeoning of a sample electronic training system for cricket. The system is made up of a watch with an accelerometer that transmits real-time acceleration data. on all three axes from the watch using an exclusive wireless protocol and the performance of the player is recorded which utilizes a Learning Management System (LMS). The System is executed using Dynamic Time Warping (DTW).

The accuracy of this system is estimated at 93%. The paper also mentions the use of the Minimum Absolute Distance Classifier (MADC) to classify different strokes. This technique uses statistical properties such as mean, standard deviation, skewness, and entropy. Both methods gave similar classification rates, but DTW proved to be more advantageous.

The work of Tevin Moodley et al. [8] "Cricket Automation and Stroke Recognition Model using OpenPose" uses LSTM architecture and gives an accuracy of 81%. Other works also include making use of sensors and sensor fusion algorithms as well as CNN models for the classification and detection of shots.

Sharma et al. [9] present to design a skeleton CommBox that utilizes sensors to automate cricket commentary.

This approach utilizing sensors outperforms previous video-based systems for some shots.

The framework uses wearable sensor MetaWear CPRO to collect data and sensor fusion algorithms are deployed. 5 shots namely cut, pull, straight drive, cover drive, and on the drive were tested in the experiment. Taking into account 3 shots, a comparative filter, and a gyroscope, the framework gives a promising accuracy of 90.69%.

Kumar et al. [10] have proposed a system to improve the performance of batsmen by computing the degree of the bat while rotating, shot timing, footwork, and so on. The system makes use of sensors that are fitted on the bat, arms, and knees. All values are measured by the sensors and are sent to the microcontroller. This data is sent to a laptop via BLE and can be viewed as graphs so that the performance of the shot played can be interpreted easily.

Khan et al. [11] have suggested a method based on Deep Convolutional Neural networks that deal with recognizing and grouping different batting strokes from cricket videos. 2D Neural Convolution is used on images to extract the features maps. LSTM neural network is used as it is proficient in capturing persistent dependencies in sequential data. 3D Neural convolution is used on the frames in spatial and temporal dimensions of the video to extract representations. The 3D model has an accuracy of 90% while the 2d model showed an 80% accuracy.

Tariq et al. [12] have suggested a paper in which they want to use MATLAB to develop a straight drive model. Biomechanics video analysis software was used to derive and examine the key aspects at each level of the model's development. MATLAB SimMechanics is used to represent the four main elements of a straight drive. The pole-zero plot of the model is established to check system stability.

LQR Controller with feedforward compensator and LQR Controller with Integral Action (LQI) is used to control system design. The model with LQI was reliable and exhibited the same characteristics as the actual straight drive.

Karmaker et al. [13] have proposed a motion estimation perspective to classify strokes using a 3D MACH filter for recognizing actions. The project is based on motion vectors, which may be used to calculate the angle of any precise cricket hit. The MACH 3D was developed to detect specific action, in this case, a cricket shot. For this project, the MACH 3D of the video was made for specific shots.

To classify the shots, Laplacian of Gaussian (LoG) for each frame was computed using this formula. Using this approach 8 shots can be detected. The accuracy of different shots ie: Hook, Square Cut, Flick, Off Drive was 53.32%, 61.22%, 62.74, and 63.57% respectively.

Foysal et al. [14] have proposed a new way to categorize different types of cricket shots using CNN and Deep Learning. A CNN-based model is proposed where images are input in three convolution layers, three max-pooling layers, two dense layers, and four dropout layers. This model allows for the classification of cricket shots using classifier algorithms. The dataset created consisted of 3600 images and 6 classes of cricket shots and the CNN model consisted of 13 layers.

The classification report shows a Precision average of 0.80, a Recall average of 0.79, and an average F1 score of 0.79. The model achieved a decent accuracy of 80%.

Nicholson et al. [15] have proposed an Activity recognition technology using Hierarchical Representation to assess the quality of cricket shots. Automated recognition of cricket shots is done using low-cost hardware and a simple setup that allows players to analyze the statistics of a shot played.

This work attempt to design a system that find out best shots and use of these shots to train the player in near future.

III. PROPOSED SYSTEM

1. **Dataset:** The dataset used for this model consists of images for each of these shots [16]. The dataset used 120 images of which 40 images were for the cut shot, 32 for the drive, and 42 for the sweep. The dataset applied to the model to generate 18 key points on both axes and then classify shots using the points generated by the dataset. The size of the image 432x368.

2. **Methodology:** The proposed methodology of the system is as shown in figure 1. This system accepts an input images of shots played by the player. This input passed to the OpenPose estimation model phase. The open source computer vision library used to read and convert the image into an array for further processing. The use of HeatMats referred to as Class Activation Mapping (CAM).
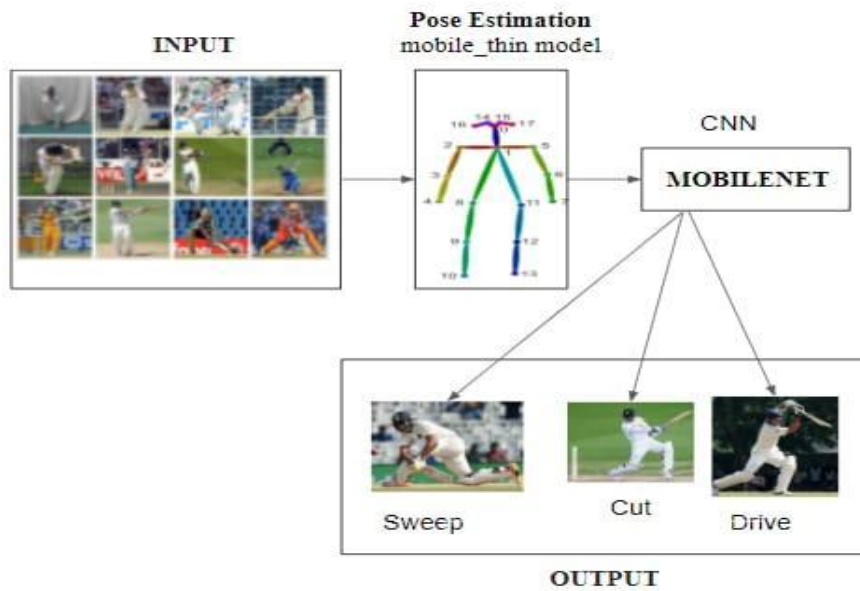
Figure 1: Proposed the Model

CAM is used to collect each output of the convolution layer as an image and combine them in one shot, as shown in figure 2.
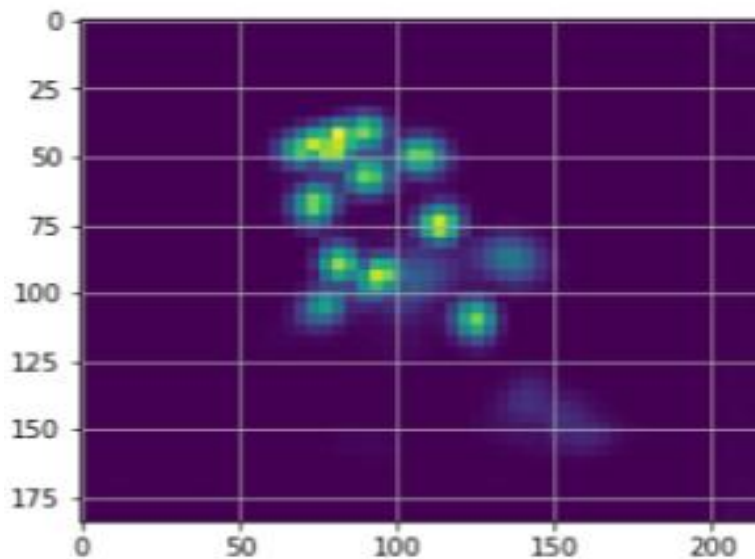

Figure 2: Heatmap of 18 Key Points

Thereafter, the pixel of the image is analyzed, and we get the 18 key point coordinates of the body parts. These points used to plot the image respectively. The model uses OpenPose Estimation, which is a real-time multi-person human position detection library that can recognize important spots on an image for the human body, foot, hand, and face. Our model uses 18 key points on each image. Figure 3 shows an image of OpenPose using the 18 key points. The X-axis and Y-axis are generated from 18 key points respectively.
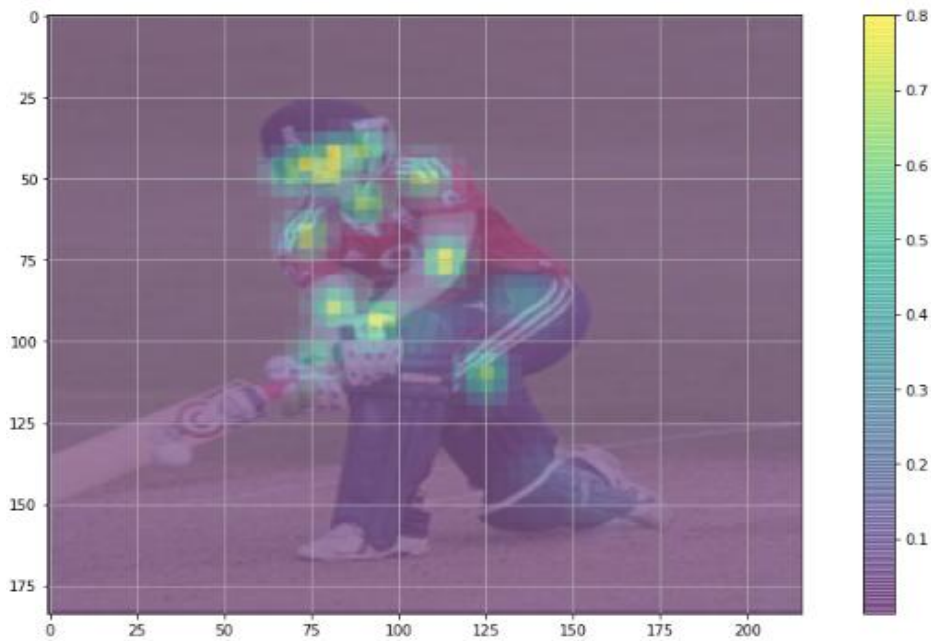
Figure 3: Pixel Image of 18 Key Points While Playing Sweep

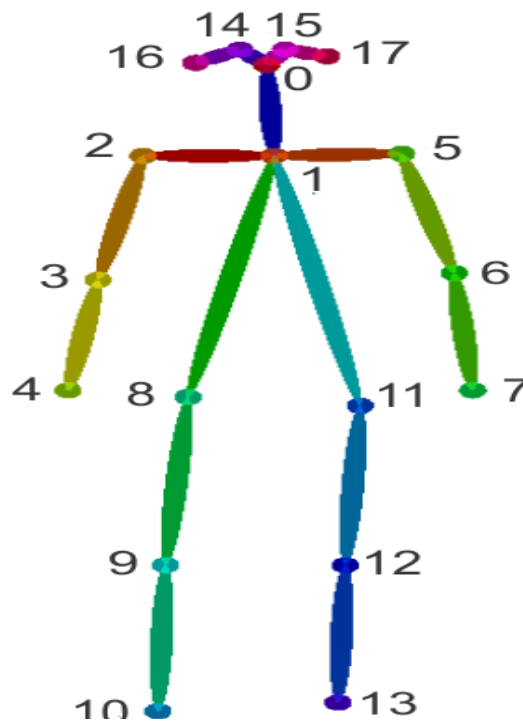The 18 key points that are considered are shown in the image below.

Figure 4: 18 Key Points for Openpose Estimation

The model uses these key points to classify the shot into the cut, sweep, and drive shots. The trained model uses the mobile net thin model, which generates 18 key points. The model classifies the image into the cut, drive or sweep shot using the mobile net and min-max normalization as per the 18 key points generated by the player while playing the shot.

Once Open Pose is loaded in the model, each shot image is also loaded, the shots' features are extracted, and the shots are loaded in a single data frame. We have then normalized all the x and y values from the data frame using the Min-Max Normalization technique [17]. For every feature, the minimum value is converted into a zero, and the maximum value is transformed into one.

The Min-Max Normalization formula is as follows:

$$x' = \frac{x - min(x)}{(x) - min(x)} \quad \text{------------ (1)}$$

where x represents the normalized value, x is the original value, min(x) is the minimum value of x, and max(x) is the maximum value of x respectively.

The output will then be generated and accuracy will be displayed of the shot the player has played. The following dataset was used for training the model. The dataset was extracted from GitHub [16]. The results are then displayed for visual validation.
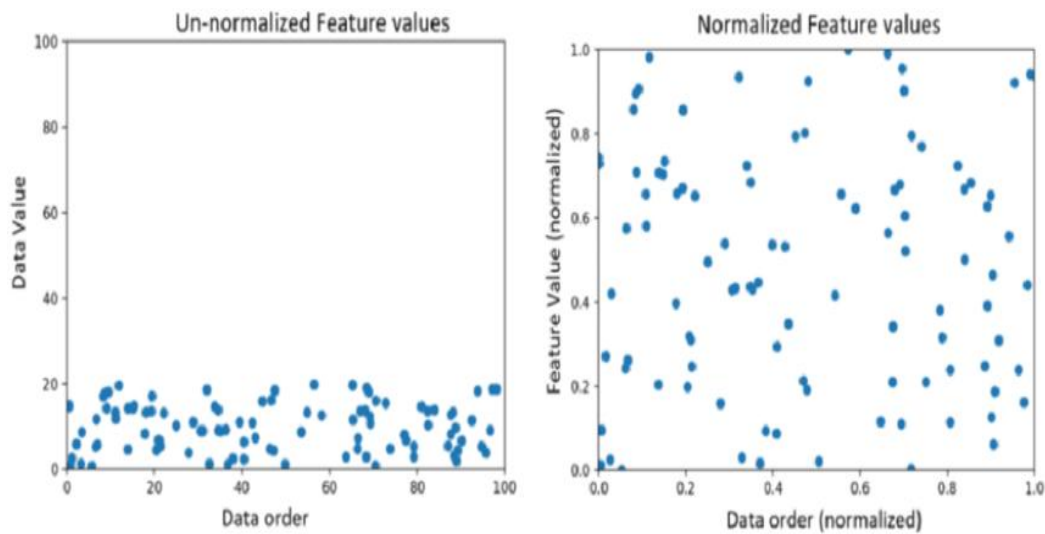

Figure 5: Illustration of Min-Max Normalization

The table 1 discusses the cricket shots that have considered for experimental purpose and description of each type of shot such as cut, sweep and drive.

Table 1: Description of Shots used in the Dataset

Sl. no	Cricket Shot	Description
1.	Cut Shot	A cut shot is similar to a cross-court stroke, but the ball is struck at a much steeper angle. This shot is a batsman's cross-batted shot into the cricket field's offside, commonly the point area or backward of the point. (refer to Figure 7)

| 2. | Sweep Shot | The sweep is a cross-batted stroke delivered behind square on the leg side on or around the leg stump. When the bat makes contact with the ball, the goal is to go as low as possible and roll the wrists when the bat makes contact with the ball(represented in Figure 8). |
| 3. | Drive Shot | A drive is a straight-batted shot made by driving the ball through the line of the ball in a straight arc, i.e. hitting the ball in front of the batting player along the ground. (represented in Figure 9). |

IV. RESULTS AND ANALYSIS

On training the model and predicting the type of cricket shot played for the test split, the following values for precision, recall, f1-score, and support were obtained as shown in fig.9. With a train test split of 70/30, we obtained F1 scores around 0.8 on the test set. This is pretty good considering the data set consists of 120 images.

```
              precision    recall  f1-score   support

           0       1.00      0.33      0.50         3
           1       0.67      1.00      0.80         4

    accuracy                           0.71         7
   macro avg       0.83      0.67      0.65         7
weighted avg       0.81      0.71      0.67         7
```

Figure 6: Performance Results

On testing the model, for prediction of the type of shot played and visual validation, the following results were displayed from the test set. Figure 10 demonstrates the forecast of a Cut shot and figure 11 demonstrates the forecast for a sweep shot.
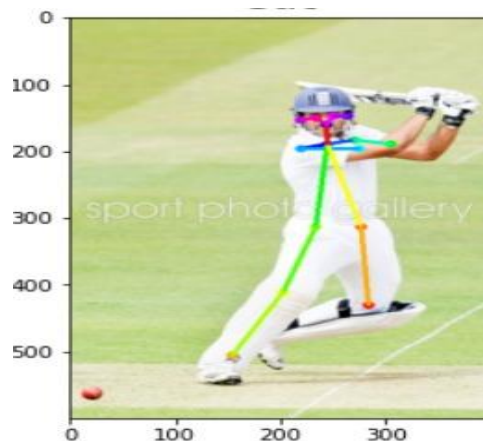

Figure 7: OpenPose Estimation for the Cut Shot.

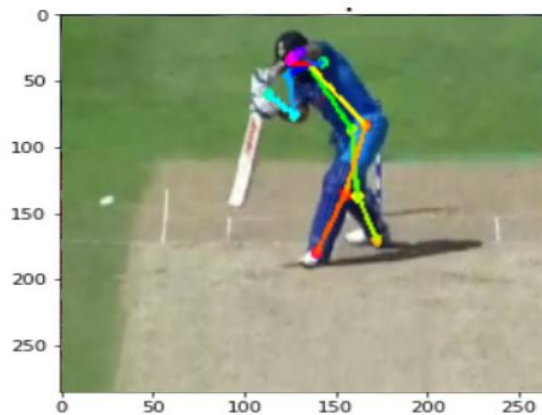**Figure 8: OpenPose Estimation for the Sweep Shot**

Figure 9: Openpose Estimation for the Drive Shot

V. CONCLUSION AND FUTURE WORK

The paper aims to achieve and implement a model to accurately predict the shot played by the batsman and provide feedback based on the quality of the shot played. Currently, the model is used to predict the accuracy of three shots i.e. Cut, Sweep and Drive shot using OpenPose, which is a real-time multi-person human position detection library that can recognize crucial points on an image such as the human body, foot, hand, and face. The model then uses a neural network classifier for the classification of shots and testing.

This work uses images as inputs and predicts the shot played concerning the three shots considered as cut shot, sweep shot and drive.

In the future, we will plan to cover more shots and also develop a server and an online platform that takes in data and produces the required output in real-time. The performance of the model improved by considering 25 points instead of 18 points for pose estimation.

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