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CRICKET SHOT CLASSIFICATION AND SCORE PREDICTION

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Abstract : Cricket is one of the most popular sports that is played in many countries and have audience who like it in huge numbers. And in the technology field, Artificial Intelligence has gained lots of interest from people. So, implementing Artificial Intelligence in the field of sports, especially cricket, has brought many advancements which has helped in decision making, ball tracking and many visualizations. In this project we have implemented a model which classifies the cricket shots using the pose of the player and also based on the shot obtained we predict the runs that can be scored. As per the survey many algorithms and techniques have been proposed which include Artificial neural network, Computer vision, Deep convolutional neural network, Pose detection, Long short term memory, Recurrent Neural Network and Deep neural network. The Project has been implemented using Convolution neural network based algorithms which can be used for self-paced training and to predict score from a shot. In other words, the model identifies the shot of the player which can be related to the pose structure, by which the players can improve their shot pose, helping in training themselves. The dataset has been obtained from Kaggle where each shot has around 1000 images, with a total of around 4000 images. The results are obtained from the CNN models that are VGG-16 and ResNet-50, where the better results are obtained using ResNet-50. The dataset has been divided into 80% and 20% for training and testing purposes respectively. The score prediction for shot classification is done using the Linear regression model. This can help batsmen to improve their shot, bowlers to ball so that they can take wickets or reduce the runs and also would be helpful in training the players.

Keywords : Cricket shot, Convolution neural network, Resnet-50, VGG-16, Linear regression.

1. INTRODUCTION

Cricket is considered one of the top 10 most popular sports played across 106 countries of the world, regardless of age and gender. Recent analysis shows that around 460 million people play this sport, including players from low and middle income countries such as Sri Lanka, India, Bangladesh and some more. The new generation is gaining more interest in Cricket and are willing to get trained in this sport. Many are very passionate towards Cricket but they find it challenging due to the unavailability of quality training and coaching. This makes the way for creating new solutions for self paced learning and training, along with the advancement in pose detection technologies.

The training in Cricket involves skills in bowling, batting and fielding, based on which performance of the player is estimated. The main focus in Cricket would be getting the batsmen out. So, it is important to understand the shot of the batsmen so that their wicket can be obtained or runs can be reduced. Based on the shot the batsmen is going to hit, proper strategies can be made in bowling and fielding. There are many shots in cricket such as drives, pulls, cuts, glances, hooks or sweeps and these include subcategories in them. In this project four shots namely drive, leg glance-flick, pull shot and sweep are used which are depicted in fig 1. The recent technologies have gained a lot of interest, especially in the field of neural networks which have enhancements in human or object detection in images and videos. These human detection libraries can be used in cricket to detect the pose of the batsmen. The project provides a web-based interface for classifying the shot the batsmen has hit. There are several research works based on cricket shot classification using models such as Random Forest algorithm, LSTM (Long Short Term Memory) network, Convolutional Neural Network, Deep Learning. In these works, some are video based which were created and used for the project by themselves and some are images based which had a limited number of datasets.

In the project we have used the Convolutional Neural Network models such as VGG-16 and ResNet-50 algorithms. The project classifies the shot of the batsmen from the given input image and based on the random environment of the bowler

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and field zone score prediction will be done which is predicted using Linear Regression model. The output of the project is the shot that will be classified and the score prediction based on the shot classification.

The advancements in Artificial Intelligence and Neural Networks have brought enhancements and new solutions in many fields. Specifically, the pose detection in the field of sports (in specific Cricket) has gained more interest. The classification of the cricket shot is important to give training to the players and improve the performance of the player. These technologies help in selection of the players and in coaching camps. And also, for individuals it can help the players to have self-testing of their performance. The datasets used for the research works were created by authors themselves which can reduce the accuracy. In this project the datasets used are from Kaggle which have clear images. By recognizing the pose of the player, the cricket shot can be classified. The project mainly focuses on these features. Classify the cricket shot of the player based on the pose of the player in the image. Based on the cricket shot classification the prediction of the score for the particular shot will be done. It can be helpful in the selection of the players based on their pose, which gives their performance review of the particular shot. The individuals can gain help by self-testing their cricket shot pose and improve their performance. By score prediction, appropriate strategies can be made to take the wicket of the player or reduce the runs by placing fielders. And also, in peak run chase it can help batsmen to score runs by giving some idea in such a way that, which shot they hit can give them more runs. These can be helpful in improvement of the cricket players and their decision making for fielding and bowling

2. RELATED WORK

Artificial intelligence in the field of sports is an emerging research field where several articles have/are being published.D Karmaker et.al[1], in 2014 proposed a model which was used to obtain images from a given video and classify the shorts using 3D MACH for action recognition. The final accuracy was done for 8 different cricket shots using 4 ranges of angles of 360 degree. The input is given through videos and obtained 7 frames out of 31 and obtained an accuracy of 53-63% for 4 tested shots. In[2] Zuhammad Zeeshan Khan et.al presented their work which was to identify and classify the cricket shots from videos. They have used over 800 batting clips. They had trained using 2D CNN and 3D CNN and obtained an accuracy of 90%. They had 9 3D convolution layers, 8 Relu layers, 8 batch normalization layers and 4 max pooling layers. That concludes a total of 29 hidden layers. This model has been trained by Torch7 deep learning framework on NVIDIA 1080 Ti GPU having 11 Gb memory.They have obtained better results for 3D compared to 2D. The paper from Avula Rajini Devi ed .al[3] designed DNN predictors, which helps in detecting the pose precisely. They mainly consider joints to describe the posture. They have used Java as a framework. The model out is a coordinate of joints of humans. They also used a general convolution neural network to classify the postures which gave the approach to represent the pose of humans. Md. Ferdouse Ahmed Foyal et .al[4] in 2018 presented their own CNN model to classify cricket shot activities.The proposed model had 13 layers. Probability of each class was obtained using the softmax function. Adam optimizer was used to compile the model.The model was trained using 840 images. Rohit Kumar et .al[5] proposed a deep learning model in 2019 for bat to bat outcome classification. A dataset of 480 video clips were picked and the samplings of frame and temporal augmentation was for outcomes such as run,Dot,boundary, and wicket. LRCN is used to classify the ball to ball activity. Single video frames were passed in VGGNet to get visual features and CNN extracted features and combined them in the same sequence. The extracted feature was passed to LRCN for training with 0.000001 learning rate which used Adam update method for parameter updation in each iteration. Ishara Bandra ed .al[6] in 2020 presented a model to classify front food and back foot strokes using LSTM and Bidirectional LSTM. Stick figures were drawn using the library OPenPose and the interaction between foot and ground information was added using COCO+foot key point estimator and generated around 25 key points coordinates. The dimensionality of key points were reduced to 4 key points by calculating the Euclidean distance between key points. LSTM and Bidirectional LSTM networks were trained and tested which contained 44 strokes and 19 strokes dataset portion respectively. Anudeep Ayinaparthi ed .al[7] in July 2020 built a cricket shot classification model Google's Person Detection API and Long Short Term Memory network. Tracking the movement of key points in the body as they move through space is the main purpose of the API. The steps included creating training data, processing training videos through Person Detection API, data preprocessing, training LSTM model and evaluating LSTM model. Mithelan Devanandan ed .al[8] in December 2021 proposed a cricket shot classification approach using random forest algorithm. It was implemented using MediaPipe, providing solutions for processing multimodal data. MediaPipe in specific BlazePose model which is a lightweight convolutional neural network architecture which is used for human pose estimation composed of two models: a Detector and an Estimator. Blazepose

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generates 33 human body key points which are represented using x and y coordinates.So images of different players can be included and also while eliminating the keypoints if an important body keypoint is ignored then it would result in an incorrect classification. Manisha Patel ed.al[9] in 2021 presented a paper that gave some brief details about human pose estimation which can be a single person or multi-person and various approaches based on deep learning. The objects seen by humans can be modeled and replicated in computers using computer vision. Architectures like CNN architecture, Stacked Hour Glass, Convolutional Pose Machine and Open Pose were described. In 2017[10] Eralda Nishani ed.al[10] presented pose estimation through CNN for improving existing systems using Recurrent Neural Networks (RNNs). With the introduction of Graphics Processing Unit (GPU) for extensive purpose issues, there has been an increasing attention towards exploiting GPU processing power for deep learning algorithms.The objective of this paper was to perform a systematic mapping study, in order to explore existing research about implementations of computer vision approaches based on deep learning algorithms and Convolutional Neural Networks (CNN). Ali Rohan ed .al[11] in 2020 presented their own model to classify the cricket shot images using human body key points extracted with MediaPipe. This toil presents an approach where human pose estimation is combined with a CNN for differentiation between usual and unusual gait of a human with an ability to provide information about the detected abnormalities from an extracted skeletal image in real time. To classify into multiple classes the obtained image is given as input to a CNN trained model. The performance of this classifier is evaluated based on sensitivity and precision.

3. METHODOLOGY :

The implementation of the model involves four steps which is shown in fig 1. The steps are Dataset Preparation, Model Training, Prediction and Model Integration which are discussed below. The dataset is obtained from Kaggle which contains around 1000 images for each of 4 shots. The images were augmented and pre-processed and converted to a NumPy array which was fed to a deep neural network. The dataset is divided into 80% and 20% for training and testing the model. In deep learning model training the process included feature extraction, max pooling, dense softmax activation layer. The model was trained using two algorithms of Convolution neural networks such as VGG-16 and ResNet-50 algorithms. Using the ResNet-50 algorithm the shot prediction is done. For predicting the score for the particular shot linear regression model is used and the dataset is created randomly. With help of this the score will be predicted for the particular shot that has been uploaded by the user.

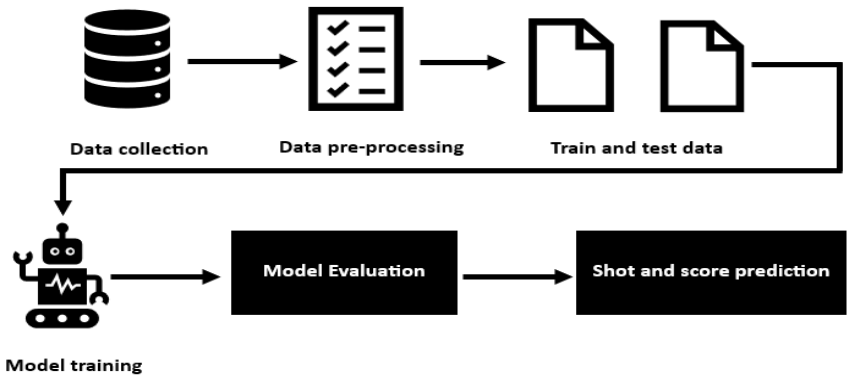

Figure. 1. Steps involved from data collection to predictive modeling

3.1 Description

Step1: Data collection:

At the initial stage the image dataset was collected from Kaggle[12] which contained 4724 images. The shots which were considered for the study were pull shot,leg glance-flick, drive, sweep each containing around 1000 images. A random dataset containing 4,108 was created for score prediction with features such as shot types, shot zones, bowler types and fielder positions.

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Step2: Data preprocessing:

Relevant images data were considered for the project . The person can be right handed or left handed batsmen so the images were augmented and flipped horizontally . The dataset for run prediction was checked for null values and handles.

Step3: Training and testing:

Both the dataset must be trained, hence the data was divided as train and test data for training and testing the model with 8:2 ratio.

Step4: Model training:

Machine learning algorithms were used for the design.ML related supervised learning algorithm was used for run prediction and Convolution neural network algorithms(subset of ML) were used for training shot classifier model.

Step5: Model evaluation:

Once the model was trained ,it was evaluated by considering epoch, accuracy, train_loss, valid_loss, error_rate, time.

1. **Epoch :** It is the total number of training iterations.
2. **Accuracy:** It is the ratio of right prediction to total number of data points evaluated. Mathematically accuracy can be calculated as :

$$Accuracy = \frac{True\ positive + True\ negative}{True\ positive + False\ negative + False\ Positive + True\ negative}$$

3. **Train_loss:** It shows how well the training data fits the model.
4. **Valid_loss:** It shows how well the model fits new data.
5. **Error_rate:** It represents the frequency of error.
6. **Time :** The time taken by the model for each iteration.

Step6: Shot and run prediction:

The obtained output was checked for correctness using testing dataset for both shot classification and run prediction for the specific given shot.

3.2 ML Algorithms

3.2.1 Linear Regression:

Linear regression is a supervised learning algorithm which gives linear relationship between dependent and independent variables.The algorithm aims in computing the value of the dependent variable by considering the values of remaining independent values.

The Mathematical equation for linear regression is:

$$Y = mX + c$$

Where, m is coefficient of X and C is interception.

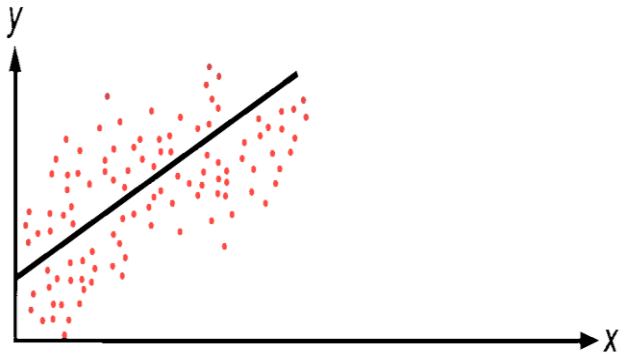

Figure. 2. Graphical representation of Linear Regression

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3.2.2 VGG-16:

VGG16 is an object detection and classification algorithm which is easy to use with transfer learning.The 16 in VGG16 refers to 16 layers that have weights. In VGG16 there are thirteen convolutional layers, five Max Pooling layers, and three Dense layers which sum up to 21 layers but it has only sixteen weight layers i.e., learnable parameters layer.

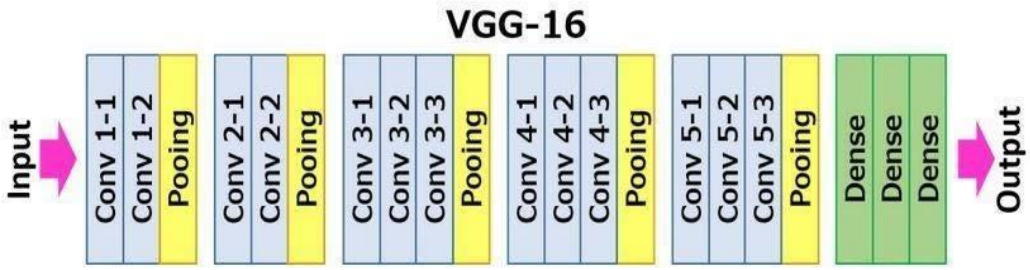

Figure. 3. VGG-16 architecture

3.2.3 ResNet-50:

ResNet-50 is a convolutional neural network which is 50 layers deep. ResNet, stands for Residual Networks, which is mainly used for computer vision tasks. It was developed to overcome the “vanishing gradient problem” of CNN by making using of “skip connection” .

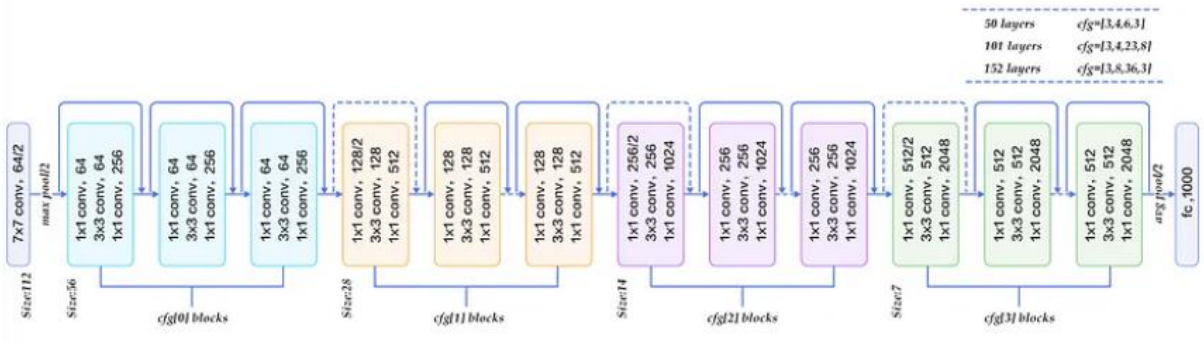

Figure. 4. ResNet-50 architecture

4. MODELING AND ANALYSIS:

The obtained images from the dataset are pre-processed and augmented. The images are flipped horizontally to train for both left and right handed batsmen. Figure. 5(a) is the original image and Figure. 5(b) is the result obtained after applying horizontal flip.

Figure. 5(a).Original picture

Figure. 5(b).Flipped image

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The flipped images are divided into testing and training with 8:2 ratio and passed into VGG-16 and ResNet-50 models. Both the algorithms were used for training the model .The results from both the algorithms were observed. The accuracy obtained for ResNet-50 was better than that of VGG-16, hence the model was continued using ResNet-50.

On the other hand, a random dataset for score or run prediction was developed by considering short_type, shot_zone, bowler_type, fielder_position, match_situation and score.

shot_type	shot_zone	bowler_type	fielder_position	match_situation	score
drive	leg	spin	backward	0.00161716579	72.3871177
pullshot	straight	spin	backward	0.5077015102	76.10577295
sweep	off	fast	forward	0.9676184523	51.67753785
pullshot	leg	spin	forward	0.0378605634	93.55970164
sweep	off	spin	backward	0.5330867619	91.70836488
pullshot	straight	fast	backward	0.5746929792	39.72366118
pullshot	straight	spin	deep	0.748361082	45.90597691
pullshot	leg	medium	backward	0.7911709993	64.5645539
leg glance-flick	off	spin	backward	0.2017471783	42.13074179
pullshot	leg	fast	forward	0.376592763	32.89569878
pillshot	leg	fast	deep	0.3401858696	13.42448232

Table. 1.Sample of score dataset

The dataset was then passed to a linear regression algorithm to predict the score based on the particular short.Python based flask framework is used for model integration. This basically plays a role to integrate back end trained deep learning model with front end user web-based application along with this a dynamic graph which renders in the front end for score prediction.

The final project along with the provided web based user-interface work as follows:

1. The user will upload the input image in the front end. The user will have to upload the image from their local system. Once the user selects the upload option, they will be providing a dialog box which enables them to select the image from their system.

2. The uploaded image will be pre-processed. Once the image is uploaded by the user it will be processed such that it will be converted into a numpy array. The pre-processed image will be provided as input to the model trained.

3. After preprocessing, images will be sent to the back end and will be processed by each layer of the Convolution neural network. Each layer enhances the prediction of the shot in the processed image.

4. The prediction of the shot in the image will be displayed in the front end with score prediction. Based on the accuracy of the image obtained, if it exceeds the threshold then only it will be displayed to the user. The score prediction will be displayed through a graph.

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5. RESULTS:

The model is being trained using two CNN algorithms of CNN that are VGG-16 and ResNet-50. The results obtained from both the algorithms can be seen in Table. 2 and Table. 3.

epoch	train_loss	valid_loss	accuracy	error_rate	time
0	0.905672	0.233310	0.917174	0.082826	07:24
1	0.443251	0.140299	0.948843	0.051157	00:50

Table. 2. VGG-16 model result

epoch	train_loss	valid_loss	accuracy	error_rate	time
0	0.782129	0.363086	0.901340	0.098660	00:46
1	0.346847	0.098172	0.963459	0.036541	00:46
2	0.179356	0.060114	0.975639	0.024361	00:44

Table. 2. ResNet-50 model result

The obtained results from the proposed web based user application can be seen in Figure. 6,7,8,9 and 10.

Figure. 6. Cricket shot prediction homepage

Figure. 7.Cricket shot prediction web page

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Figure. 8. Upload and predict interface

Outputs

Figure. 8. Shot classification

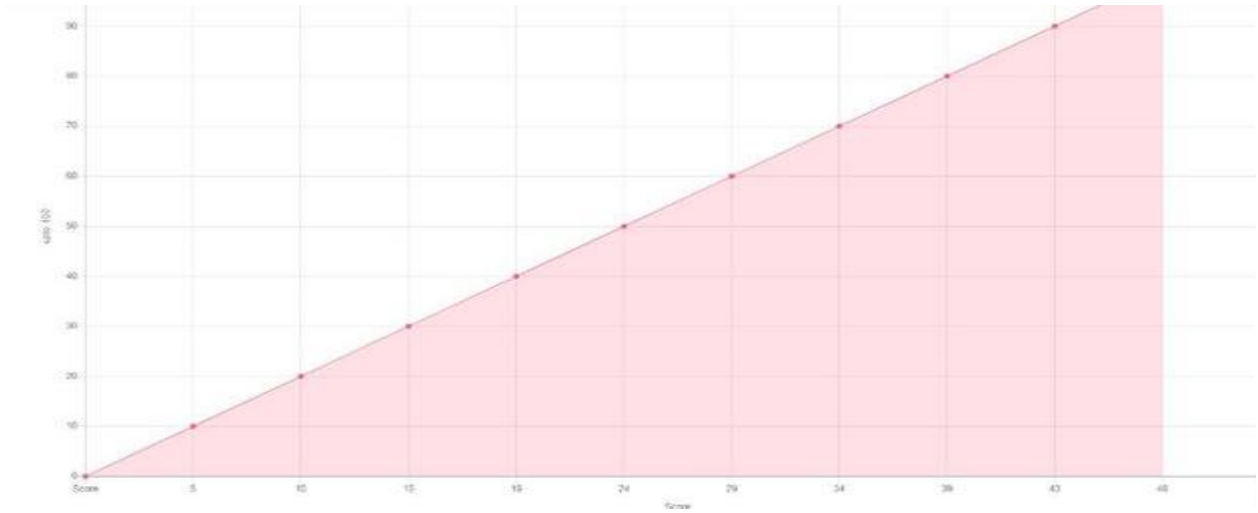

Figure. 9. Linear graphical representation for score prediction

6. CONCLUSION:

Few papers implemented the model using images as the datasets but had a smaller number of images. The model we have trained will predict the shot of the given image. The score of the respective shot will be predicted. The model is able to classify the shots. There is a lack of availability of training for some of the passionate cricket players.This web-based cricket shot classification application can be used by any individuals or by the coaches for knowing the performance of

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the player. Using this model the Batsman will get to know the possible shot he can play in the innings. The Bowlers will get to understand the shot of the batsman and bowl accordingly to reduce the scores. The captain can alter the fielding to reduce the runs. Hence the overall performance and decision-making strategies can be enhanced.

The future extension of this model can be done by adding different shots and train models. This model is being trained on four shots such as drive, pull shot, leg glance flick and sweep. There are some more shots such as cut, hook, straight drive and more, and also, they can be subdivided into some more different shots. We can also extract the images or frames from the live streaming, also, bowler speed and suggestions can be given based on the added features.We had tried for streaming videos, due to unsupported libraries the video processing was not performed which can be enhanced.

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