IoT for Augmenting Performance of Professional Sports Training

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Abstract- It's no longer a secret that Internet of Things has changed the world a lot. We also know that this decade is the decade of (IoT). We cannot ignore the contribution of data analytics in every sports played in the world whether the sport is football, cricket, volleyball, basketball or kabaddi. It's nothing new that IoT and data analytics has made an impact on the sports world which cannot be ignored. In the recent days IoT usage is quite beneficial for professional sports & athletes. After arrival of IoT things have become quite exciting.

Keywords- IoT, data analytics, network, sports, Training.

I.   INTRODUCTION

IoT or it can be termed as Internet of Things has been the concept consisting so much of excitement over the years, with the benefit or facility of connectivity. Basically IoT is the network of physical 'things' or devices that consist of embedded technology that could process ,act ,communicate & sense within the network & with external space. As we know that there is no further need to explain about tremendous amount of impact of IoT in our daily lives. If we talk about science & technology, medical field, architectural field, economics, sports & many more field then we can see that IoT has played a huge role in evolvement of these fields. Sports industry is very much effected by IoT in recent years. Following are some of the IoT trends that will or may continue to evolve the sports industry.

1.   DATA CAPTURING ON SPORTS

We are well aware of the concept called data capturing & also we cannot say data capturing as new. However, the quality of data available at present and the speed of data gathered has been increased drastically. The way that sports engaged with various technologies is changing the way the fans view the sports, coaching and even the way various sports franchisees are run. At present, there are various apps & websites are available which not only facilitates sports fans to watch their favorite games in a live telecast but also to analyze every situation of game themselves. Anyone can become an expert in their favorite game if he/she has an internet connection.

2.   DATA REVEALS EVERY DETAILS OF THE ATHLETE

Data analysis & IoT has become an integral part for evaluation of every detail of athlete. Few years back, the facility of Data Preprocessing techniques helps in removing the immaterial and redundant features [1]   thereby selecting the optimal features which can improve the overall accuracy of the model.

The features selected using Feature Selection can help in predicting the student's academic performance [2], fit-bit, tracking device, smart phones etc. those devices help them in measuring their performance day in & day out. The IoT possesses a power of offering sorts like distance, movements, acceleration. In cycling in which Le Tour de France is the most popular one, GPS sensors implanted in the riders bicycles in order to measure their accurate position in the race, on the road, and how they will compete with competitors. In cricket, spider camera has been introduce to measure the distance of ball & also there exist some technologies to measure speed of the bat whenever a batsman hits the ball for boundaries. The IoT smart device as described and discussed in the paper plays a vital role [3]. IoT isn't just fix with cricket and volleyball. swimming suits can be equipped with accelerometers and gyroscopes to measure the time, speed, velocity of swimmers.

3.   ADVANCED   WAY   OF   PROFESSIONAL TRAINING

In order to perfect themselves the professional athletes are taking many advantages of IoT by clubbing IoT devices in their training routines. Those devices can be smart wearable devices or any other latest equipment. In cricket, while practicing in the training sessions the players use various technologies to measure their bat speed, bowling speed, or their reaction time while fielding. These analysis will help those players to improve their skills & reaction time. Let's have another example, in football a small device is embedded in the ball to measure the impack of kick by the player this also helps those players in improving their kicking skills.

All of the analysed data can be gathered on a smartphone or computer or in a laptop, where it can be analysed by the athlete to evaluate the effectiveness of training and plan future training sessions accordingly.

4.   MATCH WINNING DECISIONS

IoT technologies possesses the ability to track distance, speed, and position and to showcase those information in the real time. Since data from a similar event in the past can decide or predict a future outcome, the information gathered gives coaches the opportunity to make better and better decisions on the spot and to adjust the game at the right time when it's needed.

5.   PROTECTION FOR SPORTSPERSONS

The IoT in sports also enables protection for players. Most sports are considered as a source of entertainment. However,

there exist some sports which may be risky for the sportsperson like mixed martial arts, skateboarding, car and bike racing. Due to those risk factors in sports some companies have built devices that can actually track these things. A player who gets hit or fall at a particular moment in the game. A sensor fitted inside the helmet measures the impact and forwards information to the coach and the medical staff. This enables medical staff to determine if it's safe for the players to continue playing. The data collected is also used in training purpose. Few times before, retro analysis of athletes done in fixed way such as on a exercise bike. This biological data generated by the usage of IoT can also prevent injuries. Various football clubs such as Barcelona football club, Real Madrid, Liverpool are world famous football clubs and they have utilized the IoT by collecting biological data and reduced the injury risks. Cricket clubs like Chennai Super Kings, Kolkata Knight Riders, Lancashire, Somerset.

1) Filter Approach

The filter function which can be univariate or multivariate depends on the data characteristics. The advantage of the filter approach is that they are not dependent on any machine learning algorithms and are computationally simple and fast. However, the main disadvantage of this approach is that it ignores the dependencies among features and does not interact with the classifier at all. Filter methods used in this research are discussed below.

a) **ReliefF:** ReliefF is a Filter based feature selection technique which was first proposed by Kira and Rendell in the year 1992. It is a random selection technique that weights the features based on Near Hit and Near miss ratios. Relief uses Equation1 to update the weights of the attributes:

$$W_x = W_x - \frac{D(x,r,h)}{m} + \frac{D(x,r,m)}{m},$$

(1)

Where symbolizes the weight of an attribute x, **r** is a randomly sampled instance, **m** is the sum of randomly sampled instances, **H** is the nearest hit and **M** is the nearest miss. **D** here represents the function difference which is used to calculate the variance of an attribute for two different instances. The initial version of Relief was limited to only two class labels, but ReliefF algorithm proposed by (Kononenko, 1994) which is an improvement over Relief takes into consideration multiple class labels and also deals with noisy or incomplete data. The advantage of the ReliefF algorithm over other techniques is that they utilize considerably less time but the limitation is that redundant features are not eliminated.

b) **Chi-Squared Filter**: This is a statistical learning technique which is applied to test the dependence of two variables. In feature selection, Chi-Square is used to identify the relationship between a specific feature and the target class and to conclude whether they are dependent or independent of each other. The statistic fork set of variables is:

$$\chi^2 = \sum_i^k$$

(2)

c) **Correlation-Based Feature Selection**: It stands on the principle that, "An excellent feature is one that has a high positive correlation with the output class and no correlation or is uncorrelated with any other feature of that class". To measure the degree of uncertainty of a variable Entropy is used, which is calculated as stated below:

$$H(Y) = - \sum P(y_i) \log_2$$

(3)

The entropy of a variable Y over another variable Z is defined as:

$$H\left(\frac{Y}{Z}\right) =$$
$$-\sum_{z_j \in Z} P(z_j) \sum_{y_i \in Y} P\left(\frac{y_i}{z_j}\right) \log_2\left(P\left(\frac{y_i}{z_j}\right)\right)$$

(4)

In equation 4 above, P (y_i) represents the former probabilities

for all values of Y, and P ( ) is the latter probabilities of Y, given values of Z.

Information gain is calculated as:

$$IG\left(\frac{Y}{Z}\right) = H(Y$$

(5)

From this, we can conclude that if

$$IG\left(\frac{Y}{Z}\right),$$

(6)

then feature **Z** is extremely correlated with feature **Y** rather than feature **Znew**.

2) Wrapper Approach

Wrapper model depends on a specific classifier to assess the quality of selected features [4]. It starts by searching technique in the space of probable feature subsets and several subsets of features are created. Selected features are used to evaluate the performance of a predefined classifier [5]. This process iterates till the time the anticipated quality is not attained. Wrapper approach based techniques used in this research are discussed below.

a) **Hill Climbing:** Hill climbing technique considers some random set of attributes initially. The neighbors of the set are evaluated and the best one is chosen. The advantage

of using this technique is that it entails fewer conditions as compared to others and is very useful in solving pure optimization problems. However, it grieves with the problem of Local Maxima and Plateau. Local Maxima says that "A state is better than all of its neighbors, but not necessarily with those states which are far away". In

Mathematical terms, for a function **f(x),**   (a, f(x)) is a Local Maxima if there is an interval (y, z) with

$$y < x < z \ and \ f(a) \geq f(x) \forall: \tag{7}$$

b) **Random Forest:** Random forest is a very efficient algorithm introduced by Breiman in 2001. It evaluates the feature subsets by checking the performance quality of subset on a modeling algorithm. Random forest uses tree-based strategies where nodes having the least impurity are set as the initial nodes of the tree and nodes with the higher impurities are set at the end of the trees. Impurity is calculated using the Gini impurity or information gain. Let A be the set of all attributes. The information gain for an attribute   is defined as follows:

c)

$$IG(T,a) = H(T) - \sum_{v \in values(a)} \left(\frac{|\{x \in T | x_a = v\}|}{|T|} . H(\{x \in T | x_a = v\}) \right) \tag{8}$$

Here:
T: represents the set of all training sets,
H specifies the entropy.

d) **Best First Search:** To select the feature subset one can choose forward or backward selection techniques. Best First search proposed by P.M. Marendra and K. Funkunaga (1977) is a slight variation which is alike the forward search technique above and beyond the truth that it selects the finest out of the assessed set of features and then evaluates it.

3) Embedded Approach
Another class of feature selection technique named as an embedded technique which selects an optimal subset of features using a classifier i.e. Feature Selection is a part of the training procedure of a classifier used. The advantage of using Embedded methods is that they comprise of interaction with the classification model, and are far less computationally demanding as compared to wrapper methods.

Data gathering is not limited to the athletes and their equipment. Even the training places where they practice are fitted with devices enabling data analysis. During water sports, data from the swimmer's embedded sensors are equipped with video footage taken from cameras both above and below the surface of the pool. After then, Information is analyzed using various software to determine the results achieved by swimmer. coaches can easily find out where they can improve.

6. NEW WAY OF EXPERIENCE FOR FANS
So far we have seen how technology especially IoT has transformed the way coaches coach and players play. But what about the fans who are the soul of any sports? Fortunately, fan experience is enhanced and more interactive than ever. Fans are always just a one click away to gather everything about their favorite sport, athlete or team since much of the data collected by coaches is highly available to fans via apps and websites.
But the real fan experience is the physical presence in any of the sports events. Social analytics technologies allow spectators in the stadium to see the game ordering a pizza while sitting and just with one click and also pizza is delivered to their seats.
While the idea of collecting data during game is not new, the quality of the data now available, the excessive speed at which it is collected, and various ways in which it is used has reached new heights. In sports, wins are obviously not determined by technology, but more by how skilled and agile athletes are. However, in the world of sports where monir margins reflects a huge impact, wearable devices, monitoring systems, and data analysis tools provide that extra edge that so often delivers victory.

7. EVOVLVEMENT OF IoT
Classifying data is one of the common tasks used in Machine Learning. To evaluate the performance of the model built using selected features, we have used Support Vector Machine (SVM) [6] which is the most frequently used classification techniques in Data Mining. This is used to classify Students performance based on their GPA into three classes i.e. "A", "B" or "C". Researchers in their paper has confirmed that SVM Classifier is well-known for highest accuracy [7]. Here, to perform the experimentation and to evaluate the selected features, we have divided the entire dataset into two sets i.e. training and testing data. The model is trained on 70% data and the rest 30% is used to test the model. There are total 385 instances out of which around 270 instances are used to train the model and rest 115 are used to test the validity of the model. If the accuracy of the model is above the minimum threshold level then the features are selected, else the process continues until the desired level is not attained.
In order to determine the major influencing features affecting the Academic Performance of students, the researcher has contemplated the previous efforts of other researchers in the field. This research primarily considers the Psychological factors that influence a student's academic performance.

Michelle Richardson et al. [8] performed a review of 13 years, which focused on the student's performance based on Grade Point Average (GPA). He studied three important traits traditional, psychological and demographical which affects the student's academic performance. In their research they have identified conscientiousness, need for cognition, emotional

intelligence, a locus of control, optimism, academic intrinsic motivation, learning goal orientation, effort regulation, test anxiety, measures of goal commitment, general stress, and academic stress are positively correlated with GPA. Among demographic traits, it was observed that female students higher in age and from higher socioeconomic backgrounds obtained higher grades.

II. CONCLUSION

This research paper mentions about the inspirational aspects towards IoT in sports. In very short time the way of broadcasting, training, analyzing in sports has been changed at speedy rate. Its quite true that IoT in sports has helped a lot whether it's the case of prevention from sports injuries, strategy building during games, analysis of data to judge the performances of sportspersons, or broadcasting of sporting events. IoT in sports plays a major role in the transformation of world of sports.

It should be predicted that IoT in sports will continue to surprise us by bringing some phenomenal changes in the sports field which were possible only in dreams few years ago.

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