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Ethical Issues in Artificial Intelligence-Based Sports Decision-Making Systems in Cricket and Football

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Abstract: Sports like Cricket and Football have employed digital technologies like Virtual Assistant referees (VAR), Hotspots, Ball-tracking, and Goal Line Technology to aid the decision making of Human Judges. Even with the help of these, Umpires and Referees in sports are prone to errors due to inescapable limits in humans' cognitive and perceptive capacities as well as other potential sources of prejudice that influence them. These technologies are only employed when it is deemed necessary by the Referees, so it introduces another level of human bias in the process. These erroneous decisions can create significant impacts becoming the difference between win and loss. To Tackle these problems, several new solutions employing the use of AI have been developed. With AI, there might be new biases created such as a model could be fed augmented images to create confusion, protected features might create a bias in the model leading to unfair decisions. This paper provides a broad overview of the potential ethical issues in these solutions due to AI and suggests the corrective and preventive measures they can follow to create a fair and responsible AI solution. Thus, this article defines chances to use modern technologies such as AI that can aid in making referee decision-making more precise, which maps the cut-off points in the judge's decision-making.

***IndexTerms* – Artificial Intelligence, Bias, Decision-making, Explainbility, Fairness, Offside, Stakeholders, Transparency**

I. INTRODUCTION

Due to the rising ineffectiveness of human referees, even with the assistance of Human Technology, artificial intelligence is becoming increasingly significant in football. AI technology has the potential to improve match results and fairness by allowing officials to make more accurate decisions. To improve the accuracy of the Current Solutions using Big-Data and Camera-based evaluations, AI solutions can be built on top of these for creating accurate decisions. Cricket, the world's second most popular sport, has witnessed considerable technical developments, such as the Third Umpire, Hawk-eye, SnickoMeter, and Hotspot. T20 cricket has accelerated the game, with the team winning the most crucial moments. However, human error in judging No-Balls and Wide-Balls has increased, as witnessed in an Indian Premier League Season 12 league match in which an incorrect decision resulted in a loss for the RCB squad.

Umpire's/Referee's expectations or personal preferences can be influenced by desire, resemblance, and mere-exposure bias. For example, their experience with an athlete and his or her previous success/failure may predisposition him or her to predict a certain level of performance. Personal expectations of judges may affect their objectivity, causing them to see the routine as better or worse than it truly was. Likewise, certain countries' preeminence may steer judges to give decisions in favor of those athletes. Memory biases can exist in these fast-paced sports as sometimes referees and umpires can miss out on some detail in build up to their decision and might create the missed parts based on experience, creating unfair decisions. Biases like memory bias, or errors due to the high pressure and tiring conditions are present in these systems giving rise to unfair decisions. These errors and biases can be resolved by using supportive technologies present, but they also create an overhead and delay in the game causing break of rhythm and momentum. The major disadvantage here is that the technology is not always refereed by the referee/umpires creating another level of bias. Thus, the main challenge is developing an accurate, fair and semi-automated solution with the AI to eliminate various types of human bias.

With the use of Artificial Intelligence in these systems, there might arise several issues and introduce new biases and errors in the systems as these sports are very complex and require a number of rule checks and the context of the events happening in real-time and multiple sources of data from the camera-based systems. These complexities might interfere with the decision-making process of the AI Model and may produce biased and unfair decisions. For example, while deciding whether the player is offside during play it might not understand the context of the player's intention and context of play as understood by the human referees, as the

corresponding rules state and define the rules based on the players intentions and context and need additional information and analysis that current AI Solutions are not capable of. This might create unfair decisions and might create negative effects on the game's events.

II. LITERATURE REVIEW.

AI in sports is a new field of study and research. Integration of AI in sports decision making systems gives rise to several ethical issues. The following section investigates various solutions and approaches that have been used in the sport of cricket and football for automated or semi-automated decision making over the past few years and gives a brief overview of the ethical issues that might arise due to these solutions.

Crick-net: A CNN Approach for Detecting Waist High No Balls in Cricket by Harun-Ur Rashid, Khatun, Zahid Hasan [1] (2018). This paper proposes an approach for detection high-waist no-balls using images when the batsman plays the ball using a convolutional neural network using over 500 images of waist height no-ball and legal deliveries for its training.

Umpire assistance for cricket and tracking mechanism for balls using a single smartphone camera by Arora U, Verma S, Sahni S, Sharma T [2] (2017). This solution employs the use of computer vision along with various machine learning algorithms to optimize its results. It focuses on object detection and ball tracking to assist various third umpire decisions.

In [3], the approach tracks ball and players and gives the decision if the player is offside in the sport of football. They use image processing to check if the player has crossed the offside line or not. Recently in the 2022 FIFA World Cup, FIFA employed a similar technology tracking it players and ball using the state-of-the-art cameras, image processing and AI algorithms and creating the points resulting in better data driven decisions across the tournament. This approach addresses a lot of the ethical issues present such as transparency, Explainbility and fairness by creating a semi-automated approach for decision-making [4] (2022).

In [5], the author uses image processing along with artificial intelligence to in a fully automated approach for giving run-out decisions. This approach increases the decision-making speed significantly reducing the disruption of play and the reducing the loss of momentum due to it. Although, this presents new challenges of its own, it is a very effective approach when it comes to AI based decision making in sports.

The Solutions above may present several ethical issues due to integration of AI technology. Understanding the context of these complex games is still a challenge and might result in these systems and approaches producing biased and unfair decisions when presented as a fully automated approach. For example, in Crick-net where we use CNN for waist no-ball detection, the system should be able to produce fair and equal results for batsman of varying heights and circumstances such as when they step out of the crease. In Football, Offside decision also depends on the context of the player's and team's overall play on the field and might require additional metadata to produce unbiased results.

III. RESEARCH METHODOLOGY

This research aims to present and understand the ethical challenges that might arise due to integration of AI based solutions in football and cricket and study the implications of it. It also presents potential solutions that can be incorporated in the development cycle of future AI based Sports decision making systems making them fair and responsible.

Context and complexity of rules is a major challenge in these AI Solutions. We study the forementioned solutions, some of which are already in use in a semi-automated approach in the real world. There is always a complex decision that might need to be taken care of on the sport, we study these complex decision-making scenarios and how these AI based Systems can face problems while addressing this while employed in a fully automated approach in future or may give erroneous results if used today.

We identify these ethical challenges after understanding the context and rules of the sport and standard ethical challenges faced while building an AI based solution. We also understand the paradoxical tensions that have come up in automated decision-making systems in other sports such as gymnastics and football where these new ethical dilemmas are identified due to a presence of AI in the system [6]. We try to identify similar challenges in the AI based decision making systems in football and cricket. We identify common ethical concerns involving AI based systems and study them in detail in the context of these decision-making systems in sports.

Finally, we proposed potential solutions that can be incorporated in future development cycles for various challenging scenarios faced by current AI decision-making systems and how can integration of proposed AI based ethical practices to these could create a better Virtual Decision-Making system in future that work in a fully automated or a semi-automated fashion. The fast and accurate decisions would have a great impact in reducing interruption time which can affect momentum of players and team, also increasing the accuracy of decisions eliminating and tackling all sorts of Human bias that exists in the current system.

IV. DECISION-MAKING SYSTEMS IN CRICKET AND FOOTBALL

4.1 Rules of the Games

No-Balls: There are two main types of no-balls in cricket. First, when the bowler's foot is ahead of the popping crease at the bowler's end when bowling the delivery. The second type of no-ball occurs when a bowler releases the ball directly towards the batsman above the waist height at a standard distance from the batting crease without hitting the pitch with the ball. No-balls are very significant as they add an additional run and an extra delivery. Please refer to Figure 1.1 & 1.2 for further understanding.

Runouts: Batsman in cricket are required to run between the wickets to score runs. As the batsman reach the opposing end completely inside the crease, a single run is scored. If the batsman fails to reach inside the crease and the fielding team hits the stumps with ball, the batsman is deemed out. Another additional thing to keep in mind is that, if batsman is inside the crease and bails are taken off, the stumps need to be uprooted to hit the bails again potentially for a second run out opportunity.

LBW: While playing a delivery, if any part of the batsman obstructs the ball from hitting the stumps provided the ball did not hit the bat before it hit the body part, the batsman is deemed out via LBW or leg before wicket.

Wide: A delivery is considered wide if it is not within the batter's reach enough for him or her to hit it with the bat using a standard cricket stroke while standing, and if it would not have been within the batter's reach enough if the batter had been in a normal guard position. Consequently, if the ball strikes the bat or batsman or if the batsman moves and puts the ball out of reach, the delivery is not considered wide. An additional run is awarded as the bowler needs to bowl the delivery again.

Offside: In Football, if a player for one team is ahead of the last defender of the opposing team as the ball is played to him/her that player is deemed offside which is considered a foul and the opposing team is awarded a free kick. This rule exists to prevent attackers from taking undue advantage and never be ahead of the last defender. The Player "Run" towards the ball has to be affecting the play in some way – involved directly or obstructing the view for goalkeeper. If the player does not make a run towards the ball from an outside position, he can continue the play further without intervention of the play. Therefore, the intention of the player is very important here. Please refer to Figure 2 for further understanding.

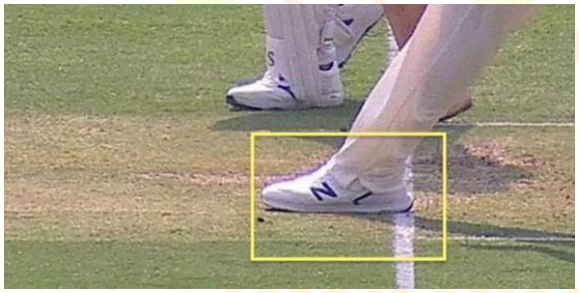

Fig 1.1. Crease No-ball
Source: [7]

Fig 1.2. Waist No-ball
Source: [8]

Fig 2. Offside in Football
Source: [9]

4.2 Need for AI-based decision-making systems

In Cricket and Football, Digital technology has been playing a key role in providing accurate and fair decisions. There exists bias and error in decision making still because technology is not complete and might not always capture the best angles for making decisions. The second factor is the presence of humans in this process which introduces various types of bias that comes due to human decision-making. Umpire's/Referee's expectations or personal preferences can be influenced by desire, resemblance, and mere-exposure bias. For instance, their familiarity of an athlete's past achievements and setbacks may have prejudiced them to expect a particular caliber of performance. Judges' subjective expectations could skew their judgment and make them perceive the routine as better or worse than it was. Similarly, the sway of some nations may influence judges to rule in favor of athletes. Memory biases can exist in these fast-paced sports as sometimes referees and umpires can miss out on some detail in build up to their decision and might create the missed parts based on experience, creating unfair decisions. Biases like memory bias, or errors due to the high pressure and tiring conditions are present in these systems giving rise to unfair decisions. This calls for fully automated approach that can create fair, transparent and responsible decisions as these systems are exact after they have learnt all the patterns. They can also adapt like humans for scenarios given they have a clear understanding of the game. These quick decisions reduce interruption in play and may eliminate a significant amount of human bias from the system. The main drawback in this case is that bias is introduced since the technology is not always refereed by the umpires or referees. The primary task, then, is to use AI to produce a precise, equitable, and semi-automated solution that gets rid of different kinds of human bias.

V. ARTIFICIAL-INTELLIGENCE-BASED DECISION-MAKING SYSTEMS

5.1 Cricket

Crick-net: A CNN Approach for Detecting Waist High No Balls in Cricket by Harun-Ur Rashid, Khatun, Zahid Hasan [1] (2018). This system uses convolutions neural network or CNN to predict Waist Height No balls in Cricket using sample images when the ball is being played by the batsman. The CNN along with transfer learning is used in this method to predict no-balls of waist height. The images are also resized for better results for uniform patterns. This produced a maximum testing accuracy of 92 % with pretty good precision, recall and f1-score on an average dealing with all sorts of waist height no balls.

Umpire assistance for cricket and tracking mechanism for balls using a single smartphone camera by Arora U, Verma S, Sahni S, Sharma T [2] (2017). This employs the use of computer vision along with various machine learning algorithms to optimize its results. It focuses on object detection and ball tracking to assist various third umpire decisions. The main advantage here is that it can analyze the video feed and produce accurate results for various decisions such as detecting wide, no-balls, bouncers, ball tracking for LBW. The approach is complete and provides Explainbility as it visualizes the Batsman, the pitch, the speed of the ball too. Although not a complete solution, this is a very good approach for assisting third umpires as it is implemented using single smartphone camera feed too.

In [5], the author uses image processing along with artificial intelligence to in a fully automated approach for giving run-out decisions. This approach increases the decision-making speed significantly reducing the disruption of play and the reducing the loss of momentum due to it. Although, this presents new challenges of its own, it is a very effective approach when it comes to AI based decision making in sports. This is a fully automated approach using various image processing algorithms and run-out video footage as input. It detects the bat, stumps and the crease and the time when stumps are hit.

5.2 Football

In [3], the approach tracks ball and players and gives the decision if the player is offside in the sport of football. They use image processing to check if the player has crossed the offside line or not. Recently in the 2022 FIFA World Cup, FIFA employed a similar technology tracking the players and ball using the state-of-the-art cameras, image processing and AI algorithms and creating the points resulting in better data driven decisions across the tournament. The new technology tracks each player's precise position on the field 50 times per second, tracking the ball and up to 29 data points about them. It has twelve sophisticated tracking cameras located beneath the stadium top. Among the 29 data points that were collected, every leg and component that is crucial for determining offside calls is represented. When an attacker receives the ball and is in an offside position when a teammate plays the ball, the new technology automatically notifies the video match officials inside the video control room. It does this by combining the limb- and ball-tracking data and applying artificial intelligence. The automatically generated offside line and kick point are manually verified by the video match referees—which is based on the estimated positions of the players' limbs—before notifying the on-field referee of the intended decision. This kind of approach, which takes a few seconds to complete, allows for quicker and more accurate decisions to be made regarding sides. This approach addresses a lot of the ethical issues present such as transparency, Explainbility and fairness by creating a semi-automated approach for decision-making [4] (2022).

VI. ETHICAL CHALLENGES IN AI-BASED DECISION-MAKING SYSTEMS

AI in sports is evolving at tremendous pace. It helps from strategic planning of team's ecosystems to predicting what player can give the best performance on the field based on their history and statistics. Integrating AI in decision-making systems in cricket and football would eliminate significant amount of human bias but also introduce new ethical challenges to develop a complete, fair, and responsible AI based Solution. We look at various ethical challenges faced throughout development cycle of AI solutions and understand them in detail. Thereafter, we identify the main challenges that our AI based sports decision-making systems might face after their full-fledged implementation as an initiative to replace human judges completely. We also understand how these solutions have also incorporated several of these ethical practice into them for creating robust solutions.

Bias and Fairness: AI Models and Algorithms work by finding relevant and generalized patterns which may be different from how a human works on a similar task. An AI Model is as good as the data it is fed during its training so it is very important to handle and input balanced data for unbiased decisions because if the Model is trained on imbalanced dataset, it might make biased decisions about the class with higher representation samples and further may not understand the patterns clearly resulting in an unfair model. There are mainly two sources where bias might get introduced, algorithmic and from the input data. Algorithmic bias is difficult to detect as it requires a clear understanding of the underlying algorithms, parameters. The second source of bias is data and can be handled at the input level and measures can be taken in advance to mitigate it.

In Crick-net, the model uses CNN to predict waist height no-balls which uses images at the instance of batsman playing the ball. Both legal deliveries and no-ball images are used in training of the model. This approach again might produce biased decisions when implemented in an automated approach. For instance, if the batsman if ahead of the batting crease, the waist height no-ball rules for the batsman changes as the batsman is not in his standard guard. Therefore, it should be characterized as legal or illegal delivery based on how to ball trajectory would have been if the batsman would be in a standard position inside crease. If such an Image is input the model, it might give decision of a no-ball even in the instance where it wasn't a no-ball since. In this case, more such images would be needed of such complex scenarios, where the batsman changes his position on the pitch and how he/she hits the ball at the instant without any awkward body movements. All these scenarios need to be used while training or we can track batsman position on the pitch using image processing or using real-time sensors. In Conclusion, the context of where the player is while playing the ball and how his body is inclined is very important in making the no-ball decision for the model. Exclusion of such images or their underrepresentation can result in wrong and biased decisions of always a no-ball when ball is above waist height and can lead to wrong decisions. For White-ball cricket where players have colored jerseys, we need to represent all the team's batsman equally so that the feature is not extracted while decision making by CNN. These class distribution needs to be studied and analyzed before training and re-training and can be monitored using automated manner for underrepresented classes.

In [5], the author uses image processing along with artificial intelligence to in a fully automated approach for giving run-out decisions. This is a fully automated approach using various image processing algorithms and run-out video footage as input. It detects the bat, stumps and the crease and the time when stumps are hit. It detects the stumps have been hit due to change in color of the stumps as stumps are hit, but the issue here is if the bails are lodged off or not as the stumps light up at slightest touch and therefore it is important to incorporate this rule inside the algorithm to produce fair results. Some Video footages this might not get detected as it is covered by the player's body and therefore, we should feed the video from multiple angles or track the bails if they are lodged off or not. It also matters if the player had the ball in his/her hands before dislodging the stumps or it was dislodged before by body part. The ball position needs to be tracked too. These miscellaneous cases call for more video feeds containing such examples and track additional data using various sensors or in images. For the cases, where stumps are hit and batsman safe and is running for an overthrow, the stumps need to be uprooted for another chance at runout completely and mere dislodging does not work. Additional Data about the ball and bails needs to be tracked and input to algorithm for handling of all these miscellaneous cases. The algorithm detects stumps and the moment they are hit and therefore contains algorithmic bias for our miscellaneous case where the fielder needs to uproot stumps in case of overthrow.

In [4] when FIFA implemented the semi-automated approach for detecting offside that work brilliantly in the Qatar world cup in 2022 but was also depending upon human referees and virtual assistant referees during the same period. Context of the player run is very important while deciding upon offside and therefore becomes a very challenging task for the AI system and limits its capabilities. We present one such famous example from Lionel Messi's career where he broke the offside trap as per rules giving rise to number of debated around the world. Let's look at whether our solution could have made the right decision in a fully automated approach without human intervention. Messi can be seen in an offside position in an initial frame where ball lies in his trajectory, however he leaves the ball for his teammate and joins play after scoring a goal. Now as per his position and ball position, he should be deemed offside. There is no way of knowing if he intents to touch the ball or interfere with the ball except by judging the body language which is done by the human referees. This context of play is handled by humans. In [3], the model would have deemed the decision as offside without taking in question the context of play. This would be an unfair decision. Hence, for handling such scenarios human oversight is needed in these AI Models to avoid unfair decisions. Such Images and examples need to in the training dataset where the context and intention of player is another feature, if we need to fully automate the process and eliminate another level of human bias.

Fig 3. Messi is in offside position in initial frame, his play not interfering with the play allows the ball to be rolled to his teammate behind, later he joins the play and scores the goal
Source: [10]

Transparency and Explainbility: For an algorithm to be considered comprehensible, or understandable, it must be possible to communicate the reasoning behind an AI model's decision-making clearly enough for people who will be impacted by it. A clear understanding of the process or rationale behind a certain decision made using inputs is essential. In [4], FIFA made the process of new semi-automated technology clear without revealing the underlying technology and algorithms so that all entities and stakeholders involved can understand how the decision is being made. The new technology tracks each player's precise position on the field 50 times per second, tracking the ball and up to 29 data points about them. It is installed beneath the stadium roof and consists of 12 specialized tracking cameras. Every leg and component that is important for making offside calls is represented among the 29 data points that were obtained. Ball position is also tracked. After this the offensive player's line and the offside line are calculated using AI Models to give the correct output. This transparency helps the virtual assistant referees in making the important decisions. AI is used in finding the accurate offensive and offside lines using data points, the referees need to understand this output to provide a human oversight. The context of player's intention while giving offside decision is very important and thus there should be understanding between the stakeholders, what output AI is responsible for and where the human referees need to intervene for the decision. The final output of AI is modelled in Virtual 3D environment representing the similar situations on the field in the exact same manner. This adds a layer of trust to when this output is being referred by referees, fans, and players. Simulating the decision and plays in 3D environment also helps add Explainbility of how the algorithm is working and how it makes decisions. Tracking the ball also helps when to take the decision and when not to, hence capturing both player and ball positions helps in better decision-making. We find a similar modelling in [2], where system tracks crease, ball, line, and player movements and models them. This modelling helps increase trust in the system.

In Crick-net, there might be issues of bias due to underrepresented samples of various other cases of images. Hence, for being transparent we need to understand and make aware what data is handled and how. The stakeholders affected such as players, fans, coaches and especially umpires need to aware of how the CNN approach is working and AI researchers must explain how features are extracted on a black box level so that real entities can present cases that might cause error in decisions. However, the transparency should be such that, no outsider can take advantage of the system with incorrect inputs when implemented in a fully automated approach.

The current limitations of the model should also be available to all stakeholders especially ones involved directly to provide an oversight and a second opinion in case of errors. In [5], the approach uses image processing to detect stumps, the times of dislodging stumps, the crease, and the bat, however, if a case comes where the bat was inside the crease for some time but later it was in the air when stumps were dislodged. The system would give biased output and mark it as not-out however it would be out. These limitations need to be worked upon as the game are very complex at times. Understanding the limitations would help in making decision-making fair, transparent and unbiased. Other complex AI Models used face the problem of Explainbility and being transparent, as they process everything in patterns and numbers, different from how humans work in similar situation. These models need to be tested with a variety of input cases and their output needs to be analyzed, making the stakeholders aware of any limitations and bias that might be detected.

Governance & Accountability: Structures and procedures for governance are essential components of a robust ecosystem to manage AI. AI governance handled successfully may aid with risk management, uphold ethical standards, and guarantee compliance. To hold AI accountable, organizations must demonstrate strong governance. This includes having a diverse range of

stakeholders, a multidisciplinary workforce with the ability to manage AI systems, well-defined roles, responsibilities, and lines of authority, as well as risk-management procedures.

Various Solutions we saw comprises some level of human oversight within the model whether it be at input level to check what data is input or to validate the output of the AI model. Variety of stakeholders act in the development and production lifecycle of the AI Model. The developers and data scientists need to work alongside the referees and the players to understand the complexity of the games and decision making needed there. The players, fans and referees must need to understand where and how AI is working in improving the decision making and where it can go wrong. The highest entity here is referees who take the decisions on how the output of any AI Model will be considered, he/she needs to be aware of the AI Model used and at what point is the AI not responsible for. For example, input a video footage with unclear view of whether stumps were dislodged in approach [5] only results in an incorrect output. If the umpire understands the limitations and how and why AI is working that way, they will make the correct decision based on their experience and insights. The input that is passed to model also needs to be monitored in all cases whether there exists some class imbalance, some incorrect data is passed that can hamper the model. There should be a AI expert in this monitoring lifecycle who has an understanding of the sport that can monitor the model and take decisions needed for it.

VII. ADDRESSING ETHICAL CHALLENGES IN AI-BASED DECISION-MAKING SYSTEMS

Bias and fairness: Bias and fairness: Cricket and Football are very complex sports with multitude of rules and scenarios for a single situation. To build a robust model, the AI System needs to understand all these beforehand. A major issue in AI is class imbalance, which can result in biased choices that favor overrepresented classes when features that aren't important are extracted.. The Sports Experts and Umpires need to be involved in the development of the AI along with researchers to guide them about all the miscellaneous scenarios that may occur and prepare a strategy for their representation in the dataset or handling them with additional metadata in the algorithm.

In Crick-net, only the no-ball and legal deliveries are used for training, to mitigate the bias from CNN Model we can pass all the scenarios such as when batsman steps out of the crease in the training dataset or parameterize the batsman's location in the Model so that these cases might be handled. We also want to make sure only relevant features are extracted and nothing else, such as a batsman's jersey color as a feature. To ensure this, we can ensure training samples from mixed color jerseys or apply a filter to remove it completely in pre-processing. In [5], while using image processing we need to capture the ball's position and bails accurately not just with the video as they play a very important part in the decision. Handling the miscellaneous case, where the fielder needs to uproot the stumps afterwards an already attempted run out. All these cases must be passed in training dataset with equal representation. Cases where the model is indecisive also need to be passed so that model can become responsible and fair whenever the algorithm might produce inconsistent results due to its limitations.

In Football, as we saw with the solution used by FIFA, it remains a semi-automated approach in present but can be automated completely in future. Decisions where context of play and player's intention might come into play can be handled by analyzing subsequent frames and tracking player's movement in the video and the player's surrounding him/her. This is possible with the kind of technology FIFA has. These frames can be analyzed then. Representing these as samples and with appropriate labels by referees can be then passed in next iteration of the model for training will help in increasing the fairness of the decisions.

T**ransparency and Explainbility:** There should be clear and standard frameworks describing the functionality of AI Models, how they handle and process data without revealing proprietary technology. How a change in input data can affect the output and the model's learning capacity must be understood by all stakeholders. A lot of complex scenarios arise in cricket and football where a lot of expertise is needed to make the decision. The steps that the AI is taking should be explainable to the fans and players. Modelling them in a 3D Software for representation such as done in [4] by FIFA and in [3] by the umpiring assisting system. This increases Explainbility and increase trust in the AI System. Providing complete transparency remains a major challenge as the way AI makes decisions is significantly different from humans though some features may overlap.

Governance and Accountability: Having various stakeholders providing oversight to AI Model to various levels such as monitoring the data it is fed, or any output it gives is very important. All parts of the process where AI Operates must be clear and monitored by stakeholders who understand both the sport and the AI Model.

All the points where AI is responsible should be disclosed to all stakeholders and create Explainbility with the use of simulated models, or virtual reality that can help increase trust and allow referees and fans to see where the Model might go wrong and what type of decisions need oversight such as the example of Lionel Messi's offside brilliance we considered. No matter how robust the technology was, AI would only create the lines but would not be able to judge the offside accurately. In [5], the approach uses image processing to detect stumps, the times of dislodging stumps, the crease, and the bat, however, if a case comes where the bat was inside the crease for some time but later it was in the air when stumps were dislodged. The system would give biased output and mark it as not-out however it would be out. Therefore, a clear parameterization of the manual intervention by the referee or Umpire is needed and these roles and responsibilities need to be defined.

VIII. CONCLUSION AND FUTURE SCOPE

AI is increasingly being used in decision-making systems in Football and cricket in a semi-automated approach. It helps various types of human biases in the system and also helps to reduce overall decision-making time which leads to loss of momentum and disruption of play. AI is exact and is as good as the input data it is trained on, so it eliminates all human bias when implemented in a semi-automated or automated way. However, integrating AI also introduces new ethical challenges and bias of its own that have been addressed properly. Various scenarios which deal with complexity of the games were used to review the current AI Solutions

and suggest potential ethical issues they might face. Potential Solutions were also discussed on how the Models can mitigate these ethical issues and adopt helpful practices.

Future works can focus on testing out these ethical issues in real-world implementation and studying their ethical impacts and challenges through variety of models such as Fairlearn in Python. A Standard set of practices and ethical framework should be developed for AI in Sports for testing these AI Models to develop and monitor them to streamline the overall process.

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