Research Topic: Enhancing The Decision Review System Using Artificial Intelligence

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Research Introduction

Sports have been playing a pivotal role in shaping societies that we are a part of. Socially or economically, sports have a great impact on people and society itself. The sports industry is a now significant global business sector worth billions of dollars in gate, media rights, merchandising and sponsorship revenues (PWC, 2011) which show how impactful it is in the economy across the world. One of the much-loved sports across the globe is Cricket. It has imprinted its presence on almost every generation of people in the world. Like in every other sport, there have been several advancements in different aspects of cricket as well. One of such advancements came as the Decision Review System known in short as DRS. Under the DRS, a player may request a review of any decision taken by the on-field umpires concerning whether or not the batsman is dismissed, with the exception of "timed out". In other words, DRS can also be known as Umpire Decision Review System (UDRS) where a computer-based system is used in cricket to assist the match officials in their decision-making. There are two types of reviews, on-field umpires may choose to consult with the third umpire which is called Umpire Review and a player may request that the third umpire consider a decision of the on-field umpires which in this case is called a Player Review.

There are different aspects of DRS and applications of different bodies as well in DRS. The main elements that have been used are television replays and machine learning technologies that tracks the path of the ball and predicts what it would have done, microphones to detect small sounds made by the ball as it hits bat or pad, and an infra-red imaging to construct a heat map of the movement of ball to determine the impact of the ball on bat or pad. With almost all the players and the cricket enthusiasts enjoying what the DRS has to offer, there still exist some ethical issues on whether or not the DRS should really be implemented. Along with such issues, another major crisis is the accuracy of the DRS system which sometimes fails to live up to the trust that it has been offered by all the cricket lovers.

There are mainly three entities in the decision review system in cricket: hot spot, hawk-eye and snickometer. And all these systems at some times have produced some controversial results. This has not only let down the enthusiasm of millions of people following cricket but also has raised questions against the purpose of its existence. Although all these three systems in DRS are equally important, this research is designed to focus mainly on the Hawk-Eye system. So, this paper intends to discuss the ethical issues that the DRS has been facing and suggest better ways to enhance the accuracy and efficiency of the Hawk-Eye system in DRS in cricket using the Artificial Intelligence (AI) tools and techniques.

Research Background

The game that started a several hundred years ago now has rooted its reach to over 2.5 billion fans across 180 countries (Trustpilot, 2022). Generating millions of pounds in revenue every year, it provides significant employment around the players, match officials and many others required to maintain an international sporting calendar overall managed by an organization called

International Cricket Council (famously known as ICC). ICC is responsible for organizing and governing the major international tournaments in cricket. Two of the most important and valued international tournaments are the Cricket World Cup and T20 World Cup. From being merely a sport for entertainment to a multi-billion pounds organization, the game of cricket has come a long way. But the journey was not that simple and short. It has undergone multiple organizations and bodies and rules and regulations to come to state where it stands right now. And among such several changes, DRS became one famous and official system in the game of cricket. DRS was preceded by a system which allowed on-field umpires to refer decisions to the third umpire who decided to use Television replays in place since 1992. However, the DRS system that allowed players to ask for the review of the decision was formally introduced in a match between India and Sri Lanka in 2008(ESPN, 2008; NDTVSports.com, 2016). This system was then officially launched by ICC on November 24, 2009, during the first test match between New Zealand and Pakistan at the University Oval in Dunedin (Cricketnext.in, 2009; ESPN, 2010). The ICC first made it mandatory to use DRS in all the matches but then made its use optional and could be used only if both teams agree to use it. The ICC has agreed to incorporate the use of DRS in all the events organized by ICC (The Times of India, 2014).

As now the DRS has become a very important part in the game of cricket, how reliable is it in reality? There have been multiple incidents when the decision made by the DRS was controversial. One of such decisions made by DRS occurred when Australia were playing England in 2013 (Essentially Sports, 2015). Usman Khawaja was given out when his bat showed no impact on the ball. The entire cricket world didn't agree with the decision. Even the current Australian prime minister Kevin Rudd tweeted expressing his dissatisfaction to the event. These events show that even the DRS is not completely reliable. And hence, the people have started demanding that ICC must invent more interesting and reliable ways to keep the game fair and square and has to bring necessary change to the current Decision Review System.

With AI taking over almost every sector in the world, can it be used to deliver what people are longing for in cricket? The answer to this question should be answered by an obvious yes. There are different aspects of AI like machine learning, deep learning and computer vision using which the ICC can easily make the DRS system more accurate and automatic. This will not only help satisfy all the players and the fans across the globe who are invested in cricket but also conduct every game fairly for everyone.

Literature Review

Decision Review System in cricket is one of the rules of cricket where a player or an on-field umpire can ask for a review on the decision for a certain play with the third umpire. The third umpire helps to review the decision using audio and video replays and heat mapping of the ball. With International Cricket Council, a parent organization of cricket internationally, officially launching DRS in 2009 (Cricketnext.in, 2009; ESPN, 2010), it has become an essential rule in the game of cricket. There is a significant importance of DRS in cricket as it is only called up on the occurrence of crucial decisions at crucial times. However, many of the decisions given by DRS

have not been agreed on by all the players or the fans around the world. People have been wondering whether introducing DRS in the game has helped grow the game or it has become a mere ethical challenge to cricket. Many concerned people have even started demanding that ICC should try and invent a more reliable and efficient way for the DRS.

As the decision review system as an entity exists with different parts like Snickometer, Hot-Spot and Hawk-Eye, there are some difficulties in integrating the problems regarding them all in a single research. This research thus is focused more on the problem regarding the Hawk-Eye system of the decision review system in cricket. So, this paper intends to review the existing decision review systems and understand their insufficiencies and finally redevelop a Hawk-Eye system on the basis of the current ones.

Usage of Artificial Intelligence in Cricket

Over the past years, the use of Artificial Intelligence (AI) has been increasing tremendously. The market value of AI is expected to reach $267 Billion Dollars by 2027 globally. AI is estimated to provide $15.7 Trillion Dollars to the global economy by 2030. As of today, about 37% of businesses and organizations have started to employ AI (DataProt, 2023). We find the use of AI in our everyday life, for example, they are used in cars like Tesla; smart assistants like Siri or Alexa; navigation help like Google Maps; OTT recommendations like Netflix, according to the watch history of a user, etc. But the most recent development where AI has found its use is in sports. AI is no alien to the field of sports and has largely impacted each of its areas. It has been used in different sports for different purposes like to train professional athletes (Chunguang and Jianbiao, 2021), etc. Like many other sports, cricket has also been influenced by AI to some extent. We can see a significant amount of use of AI tools and techniques for different purposes in cricket over the past years.

The impact of AI on cricket cannot be ignored in the recent past. From Snickometers (Udayagiri, Hussain, and Choubey, 2020) to DRS reviews, cricket has adopted the advancement of technologies in several ways and uses AI and Data Analytics on a regular basis to improve the game. One of the many uses of AI in cricket is known as Batsense (C. Andrews, 2017). Batsense is a sensor chip which is used in a cricket that generates data for every stroke a batsman plays. It has Bluetooth connectivity to transfer the data in real-time and storage to retain the information of the entire session. This sensor measures a variety of aspects such as speed of the bat when playing the ball, power and twist of the ball hit from the bat, quality of the shot, etc. This technology helps the players improve the method of playing a ball and generate better performances from them. Moreover, AI techniques have been used to analyze the matches in cricket as well. This type of analysis helps to understand the condition of the pitch, predict the score of the team in accordance with their run rate, batsman's record against spin balls and pace balls, etc.

AI has completely changed the game of cricket and has made it much more competitive. Apart from the ways listed above, the coaching staff uses the help of AI to measure the team's

performances by analyzing player data and statistics. AI helps in the performance enhancement of players as it helps them understand their strengths and weaknesses. It gives them insights on how to work on their game and improve their performance. Every team relies on AI & Machine Learning (ML) for key data and insights which they use to their best advantage. One can achieve so much through AI and with the advancement of technology, the involvement of AI in cricket will only be increasing.

Artificial Intelligence and Decision Review System

Along with application in above-mentioned aspects and many more, AI has significant impact in cricket. And in a similar manner, the decision review system (DRS) is also powered by AI. One of the most impactful applications of AI for DRS is known as Snickometer (Udayagiri, Hussain, and Choubey, 2020). This DRS is used particularly by the bowling team to get a batsman out. The third umpire reviewing the decision graphically analyzes sound and video to ascertain whether the batsman has edged the ball or not (Ting and Chilukuri, 2009). This system was invented by an English computer scientist Allan Paskett in the mid-1990s (Matt Harris, 2022).
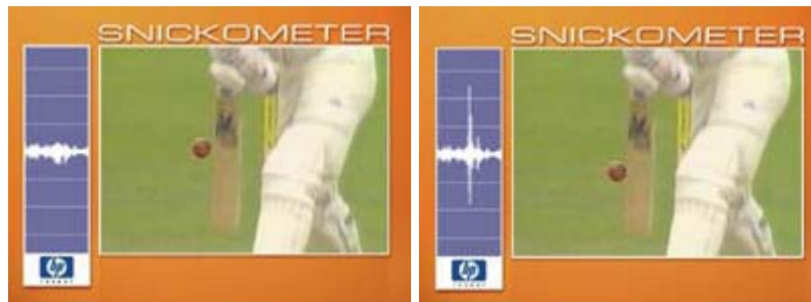

Fig. 1(a) No sound (snick) & 1(b) Sound (Snick) (Ting and Chilukuri, 2009)

Fig. 2(a) No sound (snick) & 2(b) Sound (Snick) (Ting and Chilukuri, 2009)

Another one of such applications is called the Hot Spot. This system is also used for the assistance of the bowling team to determine whether the batsman nicked the ball. It can also be known as an alternative to the snickometer. This system uses an infra-red imaging system to analyze if the ball was really struck by the bat before reaching the fielder.
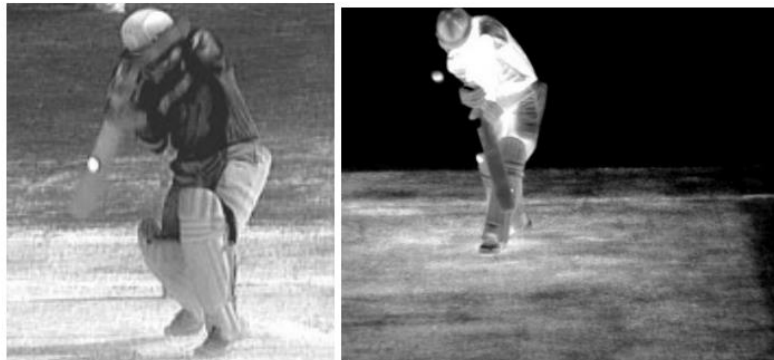

Fig. 3(a) the hot spot where the ball contacts the bat is shown by bright spot (Ting and Chilukuri, 2009).

The third application of AI when it comes to the decision review system is known as the Hawk-Eye. This system is not only used in cricket but in several other sports like tennis, football, badminton, etc. In cricket, this technology is used by umpires in LBW (Leg Before Wicket) appeals. It uses ball tracking and displays a path of the ball to the wicket along with the location of impact with the batsman's leg and determines whether the ball would have hit the stumps or missed them. It can also help to give the length of the bowling deliveries of a pacer and the spin turns of the spinner.

Fig.4 LBW analysis using Hawk-Eye (Jayalath L. M., 2021)

With such a vast yet significant reliability on the techniques offered by AI, the decisions made by the DRS have been controversial from time and again. The whole generation of cricket lovers have been opinionated regarding the DRS and the reviews made. Some people say that with the introduction of DRS, cricket has lost its true essence. Some have their own opinion regarding DRS and question the existence of DRS given that it has not been fairly used in the matches. And along with the ethical dilemma, cricket has yet to overcome the technical errors which give rise to questions about the existence of the DRS itself.

The Hawk-Eye Review System

When we examine the Hawk-Eye and its working system in cricket, we gain a better awareness of the system's complexity and how the error may have occurred. The essence of Hawk-Eye is to feed images collected by various strategically located cameras — the patent specifies six cameras but acknowledges that not all of the cameras will produce usable data — into a computer. Every time a camera clicks (at a frame rate of x per second, for example), it provides a 'data point.' By analyzing the pixels in the images, the computer reconstructs the trajectory of the 66 Journal of Sports Economics 17(1) ball using these data points. Due to the limited frame rate, there will be voids between the data points, which are 'filled' with an algorithm that calculates the most probable trajectory between data points.

Collins & Evans (2008) state that as the frame rate increases, the number of data points increases, the distance between data points decreases, and the technology becomes more reliable. A cricket ball bowled at 80 mph travels approximately 120 feet per second. A pace of 120 frames per second would indicate that the ball travelled one foot between frames, with the computer interpolating the ball's trajectory (of one foot) between frames. This may support Hawk-Eye's claim that it requires 1–2 F of travel after pitching to accurately track its post-bounce trajectory: a frame rate of 120 frames per second would provide three data points in the 2 feet of travel after rebounding, which is sufficient for tracking its trajectory. It has been suggested, however, that Hawk-Eye receives its feed from conventional broadcast cameras with frame rates of approximately 30 frames per second. If this were the case, it would infer that the ball would travel 4 feet between two frames and 8 feet before three data points could be collected. And this leads to blunders that result in unreliable decisions. To reduce or eliminate such errors, precise AI tools with the appropriate training and testing algorithms must be implemented.

For the aforementioned objective, it is necessary to first comprehend the mathematics and logic underlying the Hawk-Eye system. If we assume that Hawk-Eye's errors are generated by a normal distribution, we know that 68% of the errors will fall within one standard deviation of the mean and 95% will fall within two standard deviations of the mean, but we do not know the standard deviation. Using the ''mean squares'' method (Peter, 2001), we can estimate the standard deviation as follows: $\sigma = \sqrt{(\pi/2)} \times \mu = 1.245 \times 5 = 6.27$ In nearly one-third of cases, Hawk-Eye's error would be greater than 11 millimetres, and in 5% of cases (one in twenty), it would be greater

than 17 millimetres. It should be emphasised that these calculations are performed using Hawk-Eye's own estimates of its average error without any reference to ''add-on'' variables such as the current shape, hardness, and texture of the ball, the condition of the pitch, the weather, etc. Therefore, by decreasing the deviation, we are able to improve the system's overall precision.

Future of Artificial Intelligence System in Decision Review and Cricket

AI tools and techniques have been becoming more and more popular in the world of sports. And it is no alien for the game of cricket as well. The use of AI has been massive in cricket. The most influential usage of AI has been the DRS. As the fans and the players have more positive reviews regarding DRS regardless of some errors that it has shown over the recent years, we can predict that there will be continuation and advancement in the DRS in coming days too.

The world of sports is wanting their systems to be artificially intelligent for the aid of the officials and the players. Virtual Assistant Referee (VAR) in football is one of the examples that resembles DRS in cricket. To make the judgment more efficient and fairer, it is obvious that the world of cricket will seek help from AI like every other sector did. The responsibility of AI then will be to deliver a more accurate system for cricket that in future will not produce any controversial decisions.

Conclusion

In this paper, we discussed the decision review system in cricket in brief. We reviewed how the system works and how AI has turned out to be helpful in implementing this system. Even though the DRS falls behind on its AI aspect due to accuracy errors, the use of this system has been successful and demanding. With a more accurate, efficient, and automatic intelligent decision review system, the game of cricket can be impacted in such a way that every stakeholder in this sport will be advocating about the game not being able to be any fairer. And certainly, such an intelligent system will be quite useful in live broadcast of cricket matches for the benefit of audience and adjudicators, especially when it is followed by one billion fans all over the world.

Research Question

What ethical issues does the DRS in cricket carry in regards of the essence of cricket and the people who love and follow the sport? And how can we improve the Hawk-Eye system while reviewing the decisions so that it produces highly accurate decisions?

Research Aim and Objectives

The sole goal of the research has been to find a more accurate and reliable way to conduct the Hawk-Eye system in decision review system used in the game of cricket using the essence of artificial intelligence. And to achieve this aim, the objectives that this research follows are as follows:

1. To conduct empirical research on the performance of the existing systems and the ways we can modify them to generate higher accuracy.
2. To find methods to minimize or eradicate the controversial decisions given by DRS by refurbishing the back-end algorithms.

Research Methods:

This research will be conducted in two steps. First, to achieve the objective no. 1, the research will undertake activities to collect all the possible information and data about the existing decision review system and the algorithms and methodologies behind it. This will help in turn to understand the efficiency, working environment and the reliability of the system.

Secondly, to achieve the objective 2, the research will focus on the development of the system for the decision review in cricket. This will be achieved by refurbishing the existing system so as to get the highest accuracy rate possible. The different techniques of AI like computer vision, machine learning and deep learning will be used to do so.

Timeline, Planning and Risk Management

The research will follow on the timeline in accordance with the table given below:

SN	Week Number	1	2	3	4	5	6	7	8	9	10	11	12
1	Research Proposal	▓	▓										
2	Literature Review		▓	▓	▓	▓	▓	▓	▓				
3	Data Collection			▓	▓	▓							
4	System Development					▓	▓	▓	▓	▓			
5	Write up Research									▓	▓	▓	▓
*Note: The weeks start from the 1st week of June													

Table 1: Gnatt chart for the research.

The initial plan is to complete the entire project in the 12 weeks out of 15 weeks time period as shown in the Fig.5 above. If the timeline (plan) is hindered by any unanticipated circumstances, we will be using the additional 3 weeks left.

Personal Reflection

This research has been one of the most challenging jobs that I have ever done. I suppose this is what research is about. Still, my favorite part is that I got to pick my own topic, integrating two of my major interests: cricket and artificial intelligence. I developed a timeline to guide my research process to put the time management skills into practice. Though an arduous process, I believe this dissertation has provided me with transferable skills that will tremendously benefit my

personal, academic, and professional development, such as critical thinking, collaboration, organizational skills, decision making, abstract reasoning, and flexibility towards change.

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