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HAWK EYE TECHNOLOGY: APPLICATION OF AUGMENTED REALITY IN GAMES

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Abstract: Cricket is constantly getting better. One of the main causes of this progress is the development of sports technologies. One such technological advancement that has been applied to cricket is Hawk Eye. This technology has greatly contributed to the quality of the game by offering a great deal of support, and as a result, it has gained a lot of public popularity. However, fewer studies have been done on this subject, therefore the general public's perception of the technology is still very much governed by law. So, the purpose of this essay is to explore the Hawk Eye's basic idea, its several cricket-related applications, the system's accuracy and dependability, and to make suggestions for its potential future development.

Index Terms **- Hawk eye, Technology, Sports**

I. INTRODUCTION

The industry of broadcasting television has grown to be quite lucrative all around the world. There is a sizable audience available in the sport broadcasting industry. As a result, broadcasting channels are in fierce competition with one another to establish themselves. With the aid of the most up-to-date technologies, networks hope to do this by providing their viewers with an improved experience. One such technology, called Hawk-eye, was employed by broadcasting networks to create a variety of images, like vibrant waggon wheels. Dr. Paul Hawkings created the technology behind Hawk-eye. The Roke Monor Research limited engineers developed it .Although the broadcasting networks employed this technology at first, it has improved to the point that it is now used as a decision-making tool for many sports, including football, tennis, cricket, and snooker. This is utilised to support the LBW (Leg Before Wicket) determination in the game of cricket because it is the first and only ball tracking system accessible. The trajectory of the cricket ball is tracked during the entire play using data from various cameras.

In a paper titled "Hawk-Eye: Augmented reality in sports broadcasting and officiating," which was published in IEEE Visual Information Engineering in September 2008 by Paul Mcllroy, the basic idea associated with this theme is discussed, along withsome implementations of this theme.This subject also fits within the Techathlon category, which refers to technology in athletics.

2018's International Journal of Computer Science and Network Security article, "Hawk-Eye technology: A comprehensive evaluation," by F. M. Hassan and S. Tariq. The writers give a general overview of the Hawk-Eye technology, including its history of evolution and the many sports in which it has been used.

The 2020 Journal of Intelligent & Fuzzy Systems article "Hawk-Eye vision system for sports: A review" was written by H. Wang, Y. Gao, and J. Zhang. The Hawk-Eye system's technical details are

reviewed by the writers, along with its camera configuration, image processing algorithms, and data analysis techniques. They also go over the system's limits and potential advancements.

2011 saw the publication of "The Hawk-Eye system for sport: A review" by J. C. Thomas and J. A. Elliott in the Journal of Sports Sciences. The writers give an in-depth description of the Hawk-Eye technology and its application in numerous sports, as well as a critique of its accuracy and dependability.

T. A. M. Kamarudin and N. A. Azman's article, "The Use of the Hawk-Eye Technology in Sports: A Systematic Review," will appear in the Conference Series of the Journal of Physics in 2020. The writers examine how the Hawk-Eye technology is used in a variety of sports, such as football, tennis, and cricket, and they talk about its advantages and disadvantages as well as how it affects the game.

C. Russell and D. R. Selkow's 2013 Journal of Sports Science and Medicine article, "A review of video tracking systems for sport analysis," was published. The writers give an in-depth analysis of the numerous video tracking systems used in sports, such as Hawk-Eye, and talk about their advantages and disadvantages as well as prospective uses in training and research.

III. METHODOLOGY

The inputs for Hawk-Eye are two. 6 unique cameras are used in 6 unique locations to produce the video. the speed of the ball. A high-speed video processor receives video streams and routes them swiftly. There are also fundamental components that make up this component of the device. Pixels are found in 6 particular places.

Ball velocity, B. A high-speed video processor receives video streams and routes them swiftly. Basic components that make up this device component are also definable

i. To identify the cricket ball-representing pixels in every image taken by every video camera using an algorithm. In the captured image, look for pixels that resemble balls. The method employed to record the ball's size and form is effective. The x and y coordinates of the ball in each frame are output after this point.

ii. Geometric algorithm: Information and coordinates from each camera are obtained using the geometric method that is attached. The HAWKEYE machine is in operation. We can correctly locate the ball since we know where the cameras are located precisely and that their coordinates are greater than any of the pictures they have taken. The technique known as Kalman filtering is used to generate 3D ball trajectories using photographic statistics. The velocity, position, and deviation of the ball's flight may all be calculated from this 3D orbital.

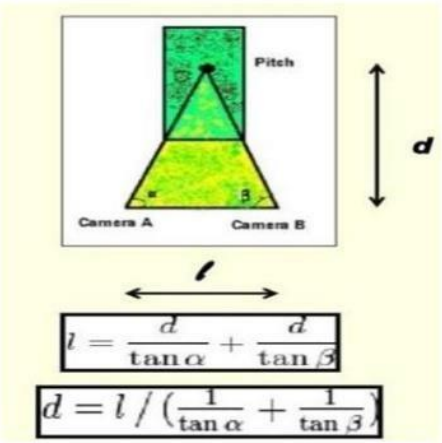

fig 1: block diagram

1.HAWK EYE TECHNOLOGY

- Two inputs are required by Hawk-Eye.
  -Six distinct cameras located in outstanding settings give video.
  -The ball's rate of movement.
- A video processor that is too fast is being used by the system to process video feeds quickly.
- Hawkeye includes both radar time and photo analysis.
- The digital camera's frame rate is 120MHz.
- Shows the ball's complete trajectory from a distance sufficient to keep it from the bowler's hand to the point at where it becomes a batter.

2. PRINCIPLE OF HAWK EYE TECHNOLOGY

Triangulation is the underlying idea behind the Hawkeye system. By measuring the angle between an element and a point found at any end of a predetermined baseline rather than by taking a direct measurement of the distance to the element, triangulation is a system that determines the area of a point. In a triangle with a known edge and angle, this point can be identified as the third point.

3. USE OF HAWK EYE TECHNOLOGY IN SPORTS

In order to attempt and stop play as little as possible, referees can now make decisions quickly and accurately thanks to technology. As a result of more precise judgements, the game is also fairer to the players and officials. The main benefit of this kind of technology is that it allows broadcasters to improve the viewing experience for viewers at home**.**

The technology is utilised in a wide range of sports, including ice hockey, football, tennis, rugby union, and cricket. Technology is also present in sports like NASCAR and horse racing! It's wonderful to see how many sports are utilising technology to provide players immediate feedback on crucial choices.

3.1 Football:

In order to provide the best vision, the location of the cameras is typically in the roof of the stadiums. This process involves installing 7 cameras per goal, for a total of 14 cameras for a game. Each camera processes an image to determine whether the ball is within the goal and to identify places where it most definitely isn't. Any ball pattern can be captured by the camera (even if the ball is covered in muck!). This technology helps in making quick decisions .The system can locate the ball if it is found in 2 of the 7 cameras in the goal, which raises some doubts about its accuracy. As a result of the system's millimetre accuracy, broadcasters are no longer required to replay potentially dubious choices. The mechanism immediately alerts the official/watch referee's when a ball has passed the line, giving them immediate feedback.

figure 2: hawk eye in footbal

3.2TENNIS:

Hawk-eye, formerly known as Electronic Line Calling, has been utilised in tennis since 2002. (ELC). Today, more than 80 competitions across the globe employ the technology each year. Virtual reality statistics, player monitoring, player indents, and post-match analysis are all possible with the ELC. The ball's trajectory and bounce mark can be rendered to real video footage by Hawk-Ultra-Motion eye's camera at a rate of up to 340 frames per second. Around the court, up to ten cameras are positioned to record real-time video and measure bounce marks to determine the ball's contact area during play.

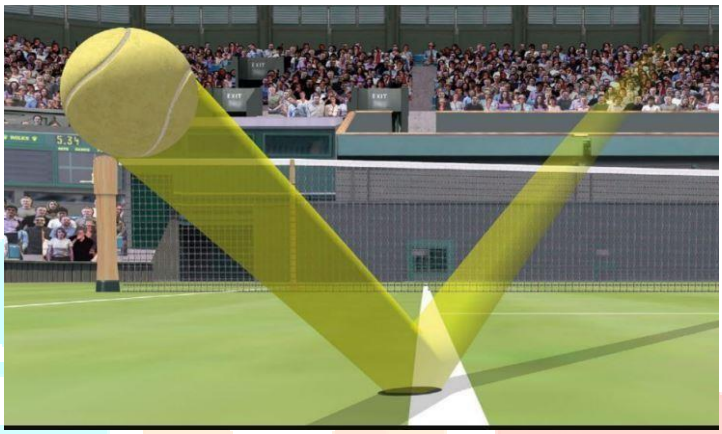

figure 3:hawk eye in tennis

3.3Rugby Union:

Rugby union now makes use of SMART Replay technology developed by Hawk-Eye. In rugby, it allows the referees to make judgement calls that they might have otherwise missed. Also, the authorities can provide films to doctors to aid in the treatment of injuries.

figure 4:hawk eye in rugby

IV. APPLICATIONS AND FUTURE SCOPE OF HAWK EYE TECHNOLOGY

4.1 LBW Decisions:

When LBW decisions are made, Hawk-Eye can predict the ball's likely forward trajectory through the batsman's legs to determine if the wicket would have been hit. The technology is utilised by the third umpire to make LBW judgements that have been referred in addition to informing TV viewers. The Hawk-Eye system's ball-by-ball tracking enables the broadcasters to highlight a variety of different aspects of the match, including contrasting the bowlers' velocities, spin, swing, lines, and lengths.

figure 5:ball tracking

4.2 Wagon Wheels:

The technology keeps track of the paths the ball has gone after the batsman hits it. With this, a graphic of 1s, 2s, 3s, 4s, and 6s in various colours is produced for a batsman. Commentators, viewers, and players can examine the batsman's scoring areas and determine if he has played more strokes in the air or along the ground using these specifics. A fielding captain needs this information so that he can adjust his field positioning in later games to account for a specific batsman's hitting style.

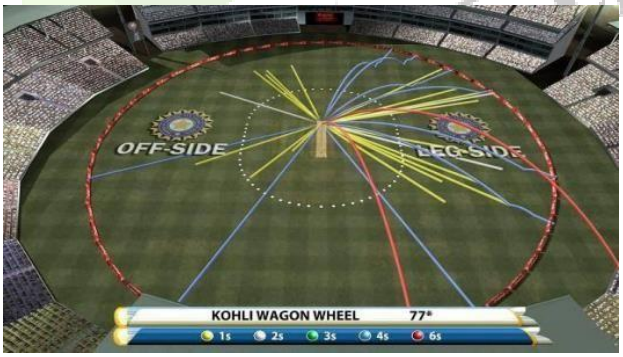

figure 6:wagon wheel generated by hawk eye

4.3 Prediction of path in Snookers:

In order to track the cue ball and forecast its route, which can be accurately followed to produce the desired outcome in the game of snooker or even pool, Hawkeye is crucial. The benefit is that it builds a virtual environment in which the cue path is still visible after the ball has been struck. Hawkeye is used differently in this application than in others because it is only a coaching tool that can assist players without influencing any referee-helping decisions

figure 7:path of cue ball as shown by hawk eye

4.4 Computer Games:

In order to enhance the simulation of television coverage in the computer game Brian Lara International Cricket 2005, as well as in Brian Lara International Cricket 2007, Ashes Cricket 2009, and International Cricket 2010, Codemasters has been granted a licence to use the Hawk-Eye name and simulation. The PSP version of Smash Court Tennis 3 does not have a similar version of the system, despite the fact that it does have a standard ball challenge that does not use the Hawk-Eye technology. Nevertheless, a similar version of the system has since been added to the Xbox 360 version of the game

Figure 8: the trajectory of ball shown by hawk eye in Brian Lara Cricket

4.5 Line calls in Tennis:

Basically, tennis players call lines using this picture. The player can contest a manual line call made by the line umpire, at which point Hawkeye can be utilised to create a model of the tennis court that shows the precise trajectory of the ball as well as the impact. With the aid of this impact image, the referee may determine whether the ball was "in" or "out" and decide whether to stick with the on-field call or reverse it.

1.FUTURE SCOPE OF HAWK EYE TECHNOLOGY

It is obvious that professional games' use of technology will increase and that lower league teams will have easier access to it as a result of the extensive use of technology in sports. Technology, like Hawk-eye and VAR, is increasingly embraced in professional sports. The decision-making process's rapidity has drawn criticism, though. In addition to technology improving sports decision-making, Smart Goals and other sports training aids have grown in popularity (A innovative technology to make training more effective). As a sports manufacturer, we welcome these changes in sport and eagerly anticipate what lies ahead. The future of sport appears to be one of technology and creativity.

2. ADVANTAGES

- **i.** Gamers can use a review system, and hawk-eye technology can provide a forecast that is 99.99 percent correct.
- **ii.** It aids in game analysis and helps players perform better.
- **iii.** It reduces the amount of effort required from humans, eliminates human error.
- **iv.** Makes decision-making simple.

3.DISADVANTAGES

i. This technique is expensive
ii. It forces humans to rely on technology
iii. It sometimes has difficulty forecasting the curving course of a cricket ball after it bounces.
iv. It occasionally impairs the decision-making abilities of umpires

V. CONCLUSION

In order to provide the public with a better understanding of the technology, the study covered its various applications, dependability, and unpredictability while also suggesting potential future improvements. One can see how closely this technology relates to the sport of cricket in many ways. Thus, it is important to build technology in a way that does not alter the nature of this lovely game.

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