The Use of Computer Vision in Stat-Tracking High School Sports

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ABSTRACT

Blueprint Stats, a computer vision startup in that athletic domain, needed to train a computer system and use computer vision to automatically track player statistics. Through the use of image classification and object detection, my team and I were able to correctly identify sporting events and track individuals based on specific attributes. The initial models trained on Google Cloud Platform were used to identify different sporting events. The system was a huge success among local Indiana schools, particularly for basketball, where a multitude of players' statistics are recorded, now with 97% accuracy. After initial application, the next step is to apply this software to other high school sports.

1. INTRODUCTION

Countless young student-athletes have aspirations to compete at a professional level. Unfortunately only a fraction will actually achieve their dreams of reaching the major leagues due to impediments such as background, unlucky recruiting, or even poor coaching. Blueprint Stats sought to alleviate one of the reasons a student-athlete might not get a chance to compete at the next level: improper statistical records for multiple seasons and subsequent failure of college recruiters to evaluate and recognize talent.

There are many reasons an individual player's statistical record could fail to reflect their actual ability, but the most common culprit is simply neglect by team staff to pay attention to all players on the court or field. Granted it could be easy to miss a few plays when each player's statistics are being recorded by a single person, which is the case with high school team managers. However, at a high-level this could be the difference between getting a D3 offer as opposed to a D1 scholarship. College basketball recruiters often make their first cuts based on certain thresholds for each statistic: points, assists, rebounds, steals, blocks, field goal percentages, free throw percentages, personal fouls and even minutes played. As a result, it is important that each player who wishes to move on to the next level receives the proper recognition for each game and is consistently given their correct stat-line. The automation of stat-tracking through computer vision is the goal at Blueprint Stats.

2. RELATED WORKS

According to some Naike et al (2022), the automated analysis of sports footage is extremely complicated and has many components that contribute to a full analysis of any given sport's footage. For example, player positions, extraction of the ball's trajectory, content extraction, generation of virtual view, visualization and enhancing content, gameplay analysis and evaluations, identifying player's actions, referee decisions and other fundamental elements are required for the analysis of a game. Furthermore, the task of player detection and tracking is extremely difficult as there are many factors that affect

analysis such as similar appearance of individual players, background settings, unusual actions or movements, bad camera work, and rapid passing of the ball from player to player. As a result, tracking software is difficult to perfect, and it has taken many years of professional development to get the highest-level of what currently exists.

Zhu et al (2022) took the discussion a step further and even suggested some potential solutions to the issues posed by Naik, et al. They suggest that any poor camera work or unwanted portions of images can be rectified through virtual panoramic imaging. The application of virtual reality in the sports action corrections can be broken down into three main parts: image processing, picture manipulation, and correction of image geometric distortions. This leads to the sports correction algorithm which includes the translation of 3-D parameters to 2-D image coordinates for easy storage and analysis. This process can be repeated and fine-tuned in order to further develop the accuracy of the software. This literature, alongside technical reports of computer vision design, were crucial to understanding how to implement an algorithm that was able to sufficiently track moving objects.

3. PROCESS DESIGN

The starting point of the system used to track individuals was a unique Google Cloud Platform (GCP) model that had to be trained and developed by the software team. I developed an offline script for the purpose of scraping through an image dataset and identifying the type of sporting event depicted, or whether or not it was a sporting event at all. This first step of detection was through the use of written Java programs as well as the aid of the GCP Application Programming Interface (API) it became possible to comb through large image datasets and train a model to recognize the various types of sporting events in the dataset. Thus, most of the algorithm and program was hosted on GCP with some supplemental Java scripts which were utilized as needed.

Once the initial system was accurate enough to identify various sporting events, we transitioned to identifying individuals in random frames from clientele footage. This required the use of unique identifiers such as jersey number, which meant we had to isolate the areas of the frame which contained jersey numbers, and proceed to clean up and enhance those areas of the picture. Once we had our region of interest (ROI) we proceeded to train our algorithm to identify those digits through the use of OpenCV datasets that recognized various fonts of digits as well as being able to identify a digit from partial images (such as distinguish between a 3 and 8, or 5 and 6). This algorithm then was applied to every frame of footage in order to successfully track the movements of each player on the court. This was accomplished by taking each frame that had a difference in player position, and using the detection algorithm to ensure that each player on the court was being tracked consistently. This made it easier to ensure that statistics for each player were tracked whenever a significant play was made.

3.1 Requirements

The clientele for Blueprint Stats consisted mostly of high school athletic teams that did not have the resources to accurately track their players' performance throughout the course of the season. They required an easy and efficient method of recording and analyzing their players' statistics and play-style following the game.

Through the use of this Java program, which included the player tracking algorithm, coaches were able to accurately and efficiently record their players' statistics as well as analyze their coaching habits and methods that were working for their team. This platform allowed coaches to analyze not only their players' performance, but also hone their

coaching skills and game-time decision making.

There were some setbacks when designing the initial system architecture, as it was difficult to get started on the computer vision tracking aspect of the program before the GCP model was trained and reached about 95% accuracy. Thus, the first iteration of the program sent out to clients was limited to simple statistical analysis such as recording points, assists, rebounds, etc. However, this would be rectified in the following months.

3.2 Key Components

There were many constraints on the developed system, but the most important ones included: ensuring that the uploaded footage was lossless in terms of quality, allowing multiple administrators to access the footage, including a model that was easy to apply to various types of sports footage, and providing timely and accurate analysis of uploaded footage.

For the duration of my employment with Blueprint Stats, there were time constraints that were not met before the start of the basketball preseason games. This was attributed to the complexity of the algorithm that we were creating. There were many minor bugs that led to major inconsistencies in the system as a whole. For example, during the early stages of development, the GCP model was unable to tell the difference between certain sporting balls that have similar shape. The most difficult part of this issue surrounded basketballs and soccer balls as they are extremely similar in size.

This particular issue was solved by identifying the ball in the field of play primarily by color before shape or size, as all major sports have differently colored standard balls. Furthermore, the issue of providing teams with analysis for the preseason games was handled by interns such as myself, who had to watch the footage and use the preset model manually to ensure that the algorithm did not miss any particular play or key analysis.

4. RESULTS

This computer vision system is currently utilized in high school basketball programs in a number of Midwest states including Kentucky, Indiana, and Tennessee. The model has been further developed to be accurate nearly 100% of the time, and has allowed coaches and players to record their games and analyze performances in only a five hour turnaround time after uploading the footage to Blueprint Stats' system. This is significantly faster than competing sports analysis platforms such as Hudl, QuikCut, and VidSwap, and as a result Blueprint Stats has been gaining traction in school districts across the country. Furthermore, the company has received endorsements from famous venture capitalists such as Mark Cuban. The number of schools utilizing this technology has increased tenfold since I began working on the system, and there have been countless good reviews on the accuracy and efficiency of the system's analysis of various aspects of a particular game.

5. CONCLUSION

In addition to the general reasons why high school athletes may fail to receive offers to compete at the collegiate level, this is an issue that affected me personally in my years as a high school athlete. Although I was a generally good volleyball and tennis player, the lack of exposure and failure of the school district to properly record my exemplary game statistics directly led to the lack of interest I had received from college coaches. The sting of this rejection had fueled my motivation to help other athletes who may be in similar situations. Furthermore, there are countless young athletes who are raised in school districts that may not have the facilities or personnel to provide them with the proper tools to create their resumes and highlight reels in order to

send a legitimate message to college recruiters. This realization dawned upon me after considering my own situation, and I realized that there must be some way to assuage this inequity. There were not many instances where I could actually do anything about it until I received the opportunity to intern at Blueprint Stats. Thus began my journey to help those who were not in a position to help themselves.

6. FUTURE WORK

Although the hard launch of the computer vision algorithm occurred two years ago, there is still room for improvement and expansion. For example, the main reason that this platform is not used widely by schools in the nation is because it is not yet applicable for many sports other than basketball. School districts are likely to employ platforms that can perform this service for a wide range of sports, such as Hudl. As a result, the development team should focus on maintaining the system currently in place for basketball, and further applying the mechanics to other sports with a lot of participants such as football, lacrosse, and soccer. Once they are able to complete a comprehensive computer vision system, they will be able to market packages to larger high schools with lots of young talent that go unrecognized.

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