Initial Plan

A Camera System for Tracking Baseball Pitches

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CM3203 - One Semester Individual Project – 40 Credits

Project Description

Since 2006, Major League Baseball has used a camera system to track the speed, movement, and position of each pitch thrown by the pitcher[1]. While the technology is not used directly to determine whether a pitch is a strike or a ball (non-strike), it is used as a visual indicator for spectators and importantly, a training tool to improve the accuracy of umpires' calls. The technology also has additional uses as a training tool for pitchers, as well as a method through which a player's performance can be analysed over a long period of time to assist the opposing team in developing strategy[2]. Unfortunately, the technology is only available within professional baseball and so amateurs such as myself and other members of the Cardiff University baseball team cannot make use of it. Amateurs rely purely on their judgement to track the accuracy of their pitching. Due to this, not only is there often disagreement between players, but bad habits may develop when a pitcher thinks they are throwing accurately when they are not. The problem stands that players at this level have no objective metric through which to improve.

This project aims to solve this problem by creating a version of this system that can be used by amateurs. The system will be made up of one or multiple cameras connected to a computer running the relevant image processing software. The software should be able to track the position of the ball in the strike zone as it crosses home-plate. After the pitch has been thrown it should feed back to the user the ball's position, the speed at which the ball crossed over home-plate, and a judgement on whether the pitch is a strike or a ball.

As well as being a tool to be used by players to improve their pitching accuracy, it is possible that the system can be extended to collect analytical data about groups of pitches for different players to help them further improve.

A Professional Pitch-Tracking System in Action

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[1] (Slowinski, 2010)
[2] See Sabermetrics (sabr.org)

It should be noted that the strike-zone is traditionally defined relative to the batter and as a result, each batter's strike-zone will be slightly different depending on their size. However, for this project, and indeed for the existing technology, a general-purpose strike-zone is predefined for all batters.

The system must be relatively cheap to construct as using multiple pieces of expensive equipment defeats the purpose of creating a tool for use by amateurs. The system also needs to be easily portable. Baseball is played outside, and in Wales is typically played in public parks, so the system must be easy to quickly set up and tear down (a laptop and a couple of webcams will likely suffice).

Project Aims and Objectives

I have defined several points below that I believe are the fundamental aims of this project. Each aim consists of several objectives that must be met in order to achieve the overall aim.

Background Research

Before any programming can be started, research must be conducted to determine the best approach to solving the problem. The main objectives of this are:

- Identify different computer vision technologies that can be used. Compare them to find the most suitable one. Confirm which technologies will be used in the solution.
- Research and compare existing solutions to the problem.
- Research potential object tracking algorithms. Design a preliminary algorithm.

Ball Detection and Tracking

The next objective is to make the program be able to detect a baseball as it is being thrown. This is a fundamental feature that is needed before the more complex, baseball-related tracking can be implemented. The objectives of this step are:

- The program should be able to recognise a baseball in a video. There is no need for it to recognise multiple objects as in a real scenario only one ball will be used.
- The program should be able to track the ball as it moves through the air.
- The program should be able to provide feedback to the user to prove it has tracked the baseball. This could be drawing a box around the baseball on the video, or some other means of feedback.

Strike Calling

Once the program can detect a baseball, features then need to be added to allow it to record the ball's position in the strike-zone and call the pitch. The objectives of this step are:

- The program should be able to determine when the ball crosses home-plate. Thinking of the space in terms of 3D coordinates, this is when the ball has moved the distance from the pitcher's rubber to home plate in the Z direction.
- At the point at which the ball crosses home-plate, the program should record the position of the ball, verify whether it is within the strike-zone, and tell the user whether it is a strike or a ball accordingly.

-   The program should also be able to record the speed at which the pitch was thrown (in miles per hour) and display this to the user.

Pitch Analysis and Additional User Features

There are countless extensions to this program, the most useful of which is a way for analysis to be done on the pitches. The objectives of this are:

-   Pitches and their accompanying information should be saved for review at a later date.
-   The user should be able to select a pitch or a group of pitches to "export" to the analysis part of the program
-   The program should display an analysis of the pitches that have been selected, such as a scatter plot of the pitch positions, for example.

Work Plan

I have created a work plan detailing what I hope to achieve during each week of the project. While efforts will be made to keep to this schedule, like any project the exact timings of each stage are subject to change. To attempt to alleviate this, the Easter break has been designated as contingency time. This time can be used to catch up on any potential areas of the project that may take longer than originally thought. If the project is progressing faster than expected, this time may be used to develop extensions to the system.

In addition to the work items listed on this schedule, I will also have short, weekly meetings with my project supervisor to discuss progress. Longer meetings can be scheduled where appropriate, such as when significant milestones have been reached. These longer meetings will be used to review the progress made on the project up to that point, and to potentially adjust future work based on this progress. The review meetings are currently listed in the work plan after significant milestones in the project's functionality have been met, although the exact timings of these meetings may be subject to change.

Week	Tasks	Milestones
Week 1 (01/02/21)	- Write initial plan - Meet with supervisor to finalise objectives of the project - Conduct initial background research on computer vision solutions	
Week 2 (08/02/21)	- Continue more in-depth background research. - Experiment with and learn necessary frameworks - Decide on which technologies are to be used - Determine what hardware is needed	**Initial plan submitted** **Background Research Completed**
Week 3 (15/02/21)	- Create basic baseball detection prototype - Begin writing Introduction and Background for final report	**Baseball Detection and Tracking Completed**

Week 4 (22/02/21)	- Work on baseball speed tracking - Continue writing Introduction and Background	
Week 5 (01/03/21)	- Begin work on baseball position tracking and strike calling - Begin writing Approach section of final report - **Supervisor Review Meeting**	**Speed Tracking Achieved**
Week 6 (08/03/21)	- Continue working on strike calling - Test the accuracy of the position tracking	
Week 7 (15/03/21)	- Finish work on strike calling	**Strike Calling Completed**
Week 8 (22/03/21)	- Begin working on analytical tools - Continue report writing as seen fit	
Week 9 (29/03/21) *Easter*	- Contingency time for any development that has fallen behind - Continue work on analytical tools	
Week 10 (05/04/21) *Easter*	- Additional contingency time - Continue work on analytical tools	
Week 11 (12/04/21) *Easter*	- Additional contingency time - Editing of report work done so far	
Week 12 (19/04/21)	- Finish analytical tools - Test and evaluate the solution - Refine the accuracy of the baseball tracking	**Pitch Analysis and Additional User Features Completed**
Week 13 (26/04/21)	- Continue testing the solution, update the solution according to the testing - Focus on report writing - **Supervisor Review Meeting**	
Week 14 (03/05/21)	- Continue report writing and editing - Time available for any outstanding areas that need attention	
Week 15 (10/05/21)	- Finish writing and editing report	**Submit Final Report**

Ethical Considerations

It may be necessary to involve human participation for the purposes of testing. This may either be done through user testing or by using the software myself and recording other people pitching. In the case of user testing, data would need to be collected from the participants. In the case of filming participants pitching, consent to be recorded would need to be obtained instead. In both cases the university's policy on ethics must be followed and approval will need to be obtained from the School Research Ethics Committee[3].

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[3] (Zoumpoulaki, et al., n.d.)

References

Slowinski, S., 2010. *What is PITCHF/x?.* [Online]
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