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**College of Business, Technology and Engineering**

Department of Computing

Project (Technical Computing)

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| **Title of Project:** | **Tracking Snooker Balls and Assisting in Their Replacement After a Foul Shot** |

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| **Confidentiality Required?**  **NO** |
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| I give permission to make my project report, video and deliverable accessible to staff and students on the Project (Technical Computing) module at Sheffield Hallam University.  **YES** |
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# Acknowledgements

# Abstract

In my four years of watching and playing the game of snooker, I have witnessed many a dramatic moment on TV and have partaken in some interesting passages of play. One recurring incident that bothers me, though, in both the professional and casual setting, is an unsolved yet seemingly solvable problem: The issue of replacing the balls after a foul.

The aim of this project is to develop a proof-of-concept system to assist in replacing the balls after a foul and a miss is called, by tracking and storing their positions throughout a game and being able to recall this information when necessary.

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# Introduction

## Project background and motivation

When a foul is committed in the game of snooker (given certain circumstances which are not relevant to this report) the player who the foul was committed against can request for the balls to be replaced to their positions before the foul shot and have their opponent play the shot again.

If a referee is present, it is their job to replace the balls, and in televised matches the TV cameras are rewound to inspect their previous positions if necessary. Due to the inaccuracy of this method, players sometimes disagree with how the referee has placed the balls, and there have been instances of players disagreeing with each other on this matter, which introduces what is, in my opinion, unnecessary tension into the match.

In non-televised matches, be it non-TV tables at professional tournaments, amateur tournaments, or casual settings, there is obviously no TV camera to rewind. While some snooker clubs may have cameras recording the tables, these are usually not configured in a way where their footage could be accessed while a game is ongoing. This presents the issue that, for all of the listed scenarios, there is no solution at all for accurately replacing the balls – only the player’s judgement of the positions can be used as a resource, and particularly if more than one balls needs replacing, this is likely to be unreliable and inaccurate.

As someone who naturally thinks about solving problems that I face in everyday life, especially when software is applicable, I often wondered why no better solution existed, at least in the professional setting, for replacing the balls to their previous position after a foul. Thus, I chose to undertake the task for this project.

## Scope

It was clear from an early stage in the planning of the project that I could not address the entire problem, in all settings, due to limitations in both time and knowledge. This is acceptable, and in fact the case for many academic projects, but does mean that a scope must be defined:

…

## Project Aims

1. Detect the positions and colours of all of the snooker balls in an image or frame of video.
2. Display the tracked information in some way that can be used to restore the balls to this state.
3. Support video throughput, storing each new shot as it is played, and allow displaying the last still positions of the balls on-demand.
4. Develop a more advanced display to further ease the process of replacing the balls.

# Research

## Similar Projects

As part of my research into appropriate technologies and planned approaches, I reviewed existing projects that aim to tackle similar problems to the one defined in this project, or are relevant on a technical level.

Unsure how to reference these subsections – in the body or in the subheading?

### Blog post: The Pool Ball Tracker

### Technical blog post: Snooker balls tracking on video

### Project: snooker-ball-tracker

### Project: TrackingSnookerBalls

## Relevant Technologies

Given that prior to taking on this project, I have not undertaken any programming projects utilising computer vision, research was necessary to determine available tools and their suitability for the project. Below is the resulting overview of tools I found, a shortlist, and conclusions drawn.

# Design and Architecture

## Ideas and approaches

## Selected Technologies

Chosen technologies will probably be made obvious in research section, but provide an overview – ‘tell them what you just told them’

## Planned Architecture

# Development

## Basic detection

Some view normalisation must be performed before any kind of detection has taken place – the later section on abstract views will discuss dealing with more ‘extreme’ angles.

### Shapes

Discuss different algorithms tried (HoughCircles, findContours, Canny) and any issues encountered. Explain decision to use Canny in the end.

Colour detection is independent from shape, so this does not need to be discussed at all in this section.

### Colours

Discuss thoughts behind most effective method for colour detection and justify the approach taken.

## Basic output – rendering the balls

The data returned from cv.Canny() is an array formatted as a cv.Mat which means it can be rendered straight to a canvas using cv.imShow(). It includes a black background but this can be somewhat worked around using some opacity value less than 100%. This is the crudest form of output.

Slightly more advanced output is finding the positions of each ball and drawing a custom render over the display (correctly coloured, labelled?).

## Normalising abstract views

## Video support

Mention converting image input to video input

### Detecting when a new shot has been played

Explain continuous frame comparison – should be simple

### Storing multiple positions

Discuss approaches – structs, objects, arrays, etc.

### ‘Rewinding’ to a previous shot on-demand

## More advanced output

If not implemented, discuss ideas and potential implementations

# Testing

As part of evaluating the success of the development process, I will perform thorough testing of the deliverable in its final state.

# Critical Evaluation

Headers do not need to be separate sections – these are just the points to discuss as per marking scheme

## Project Success

* Issues staying within scope
* Struggle establishing a clear direction for the project (notably professional vs. amateur settings)
* However, concept is proven and viability of chosen technologies is demonstrated

## Professional and Ethical Concerns

No issues. What do I even discuss? My project involved very little in the way of ethics in my opinion. What is a “professional concern”?

As neither my research nor project involved any participants – other than background individuals in a sparsely used recording, who I made sure were not visible in any used sections of video – there was little in the way of ethical concerns when undertaking my research and development.

## Risk

No participants involved in the project – is there anything to discuss here?

## Personal Development Planning (PDP)