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Testing Low Level Techniques For Real Time Tracking Of Billiard Balls

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Background

Object tracking, a portion of the computer vision field has become a keen research interest over the last decade. This is largely due to improvements in camera technology and even Smartphones. However, object tracking is still a difficult problem to address and you will struggle to find a single solution to all problems. This means individual problems need to be assessed and a range of techniques may have to be used in combination to achieve a viable solution [1].

Setup Diagrams

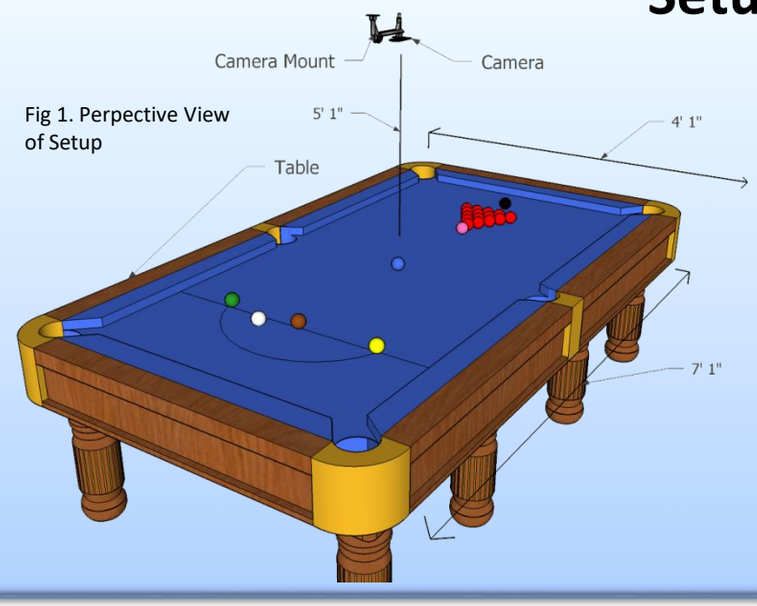
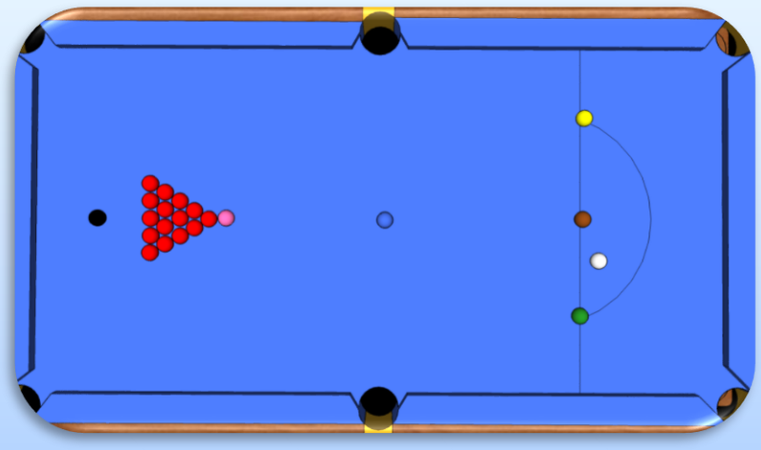


Fig 1. Perpective View of Setup

Fig 2. Initial Camera View



Proposed Setup

The setup proposed consists of a snooker/pool table with a single fixed camera mounted directly above it. This gives us a clean top down view of the table and should be the least likely position where occlusion problems start to be introduced. There are 22 balls in total. 15 reds, 6 colours and 1 white. A diagram of the setup can be seen above. A working solution should be able to detect each individual ball, as well as identify what class (colour) of ball it is. The solution should then extend to be able track where a ball has been and potentially, where its going next. It is a requirement that the camera should be able to communicate externally with another system. Meaning any hardware used must have the potential to send data across some form of connection.

Proposed Techniques

There are a substantial amount of techniques and approaches that can be utilised for this specific problem. These can range from the relatively simple, to complex and computationally expensive algorithms which seem to be slightly unnecessary for this task. Within these initial tests, a range of lower level functions will be placed in combination to try and achieve some usable solutions [2]. Some of these functions include

- Thresholding
- Morphological operations (Erosion & Dilation)
- Linear Filtering (Convolutional Operations)
- Sequential Imaging

The solutions produced will be encapsulated and tested individually using a control sample from the camera.

Testing Strategy

In order to test these techniques, the Strategy design pattern will be used to encapsulate each method and will allow for them to be switched or tweaked at run time [3]. The techniques will be measured in terms of performance and tracking accuracy. This will be accomplished by randomly taking a set of sample frames within a 10 second window. These will then be analysed for accuracy (false positives and negatives) as well as performance (FPS). The results should be easily quantifiable.

To keep research costing to a minimum, these initial tracking tests will be performed using camera hardware present on an old Android Smartphone.

Potential Issues

Some key issues will need to be addressed in order to get a viable tracking solution to work. The most obvious is the fact that lighting conditions can potentially break any hard coded methods which are based on colour. This is because different spectrums of light can alter the colour of the object being perceived. Another issue is the fact that these objects can move at incredibly high speeds, meaning camera hardware will more than likely be the weakness in the system. However, if a method can work well using Smartphone camera hardware, it can surely perform better using more expensive high speed equipment.

1. **Shaikh, Soharab H, Saeed, Khalid and Chaki, Nabendu.** *Moving Object Detection using Background Subtraction.* Springer, 2014.
2. **Kapur, Samuel and Thakkar, Nisarg.** *Mastering OpenCV Android Application Programming.* Packt Publishing, 2015, Birmingham.
3. **Joshi, Rohit.** *Java Design Patterns : Reusable Solutions to Common Problems.* Java Code Geeks, 2015.