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Project Proposal

For our project, we seek to create an Android app that aids billiards players in the planning of their shots. A mobile computing platform with integrated sensors like a tablet or smartphone is ideal for this aim. The alternative is to have people walking around the table with laptops trying to find good camera angles, which is a bit ludicrous and cumbersome in practice. The primary vision task here is capturing the state of the billiards table based on a photograph. To help the user accomplish this successfully, the app will provide live feedback that informs whether the current camera perspective provides a complete view of the table. This will involve running a quick and simple segmentation algorithm on each live video frame, reserving the more expensive algorithm for the high resolution image to get precise estimates of the balls' 2D positions.

Once the table state has been determined, the app will display a virtual replica of the table. The player can plan the next shot here using a basic physics model. Some additional graphics will then be shown to provide guidance for executing this shot.

Finally, we will extend our state capture algorithm to work with video for motion tracking of balls. This capability will be geared towards determining the general characteristics and aberrations of a billiards table. If time permits, our physics model will incorporate this information into the shot planning phase.

Our approach is to mock up the core vision algorithms in MATLAB first to make sure that they are functioning, then to implement and optimize them for the mobile platform in C++. We imagine the core tools for segmenting the table will be involve a combination of feature detection and edge filtering with the Hough transform to find the corners of the table. These will determine a perspective transform to warp the table into an orthogonal 2D overhead view. After some scaling using prior knowledge about the size of the table, the coordinate system should be fixed. We can then find the ball locations by correlating for circular objects. For motion tracking, it is likely that processing difference images will be advantageous for performance. Camera motion may be a difficult challenge.

- Goal: A basic tool for planning shots in billiards based on a captured table state and characteristics.
- Vision tasks
    - Determine the 2D position of all balls on table given a single view
    - Motion tracking of balls (may not be live) for determining table characteristics
- Android tasks
    - Live feedback to inform user if current viewpoint is good for state detection
    - Display of virtual table and shot planning, possibly with basic physics