Ping-pong Referee: Use of Computer Vision to Officiate Ping-Pong Games

6

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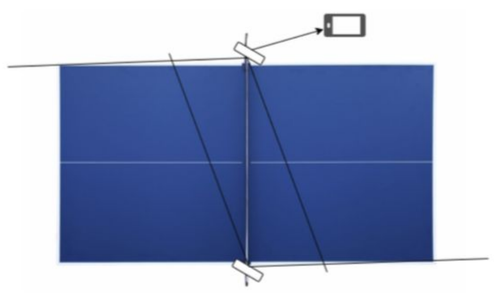
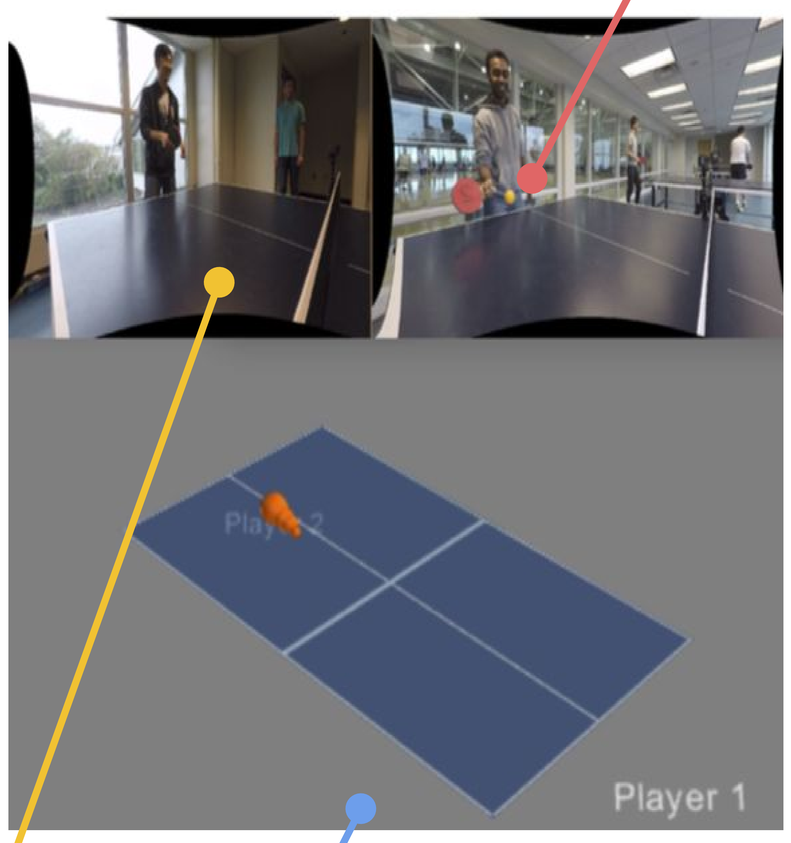
ECE 6258: Digital Image Processing

PROBLEM STATEMENT

- People often lose track of the score when playing ping-pong
- We propose a program that tracks the 3D location of a ping-pong ball based on minimal and low-cost camera setup. It has the potential of leading to a phone application that automatically updates the score of the game based on videos taken from phone cameras.





CAMERA CALIBRATION

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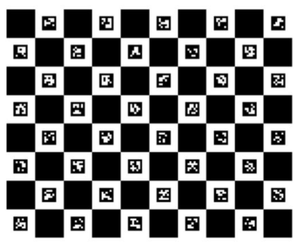
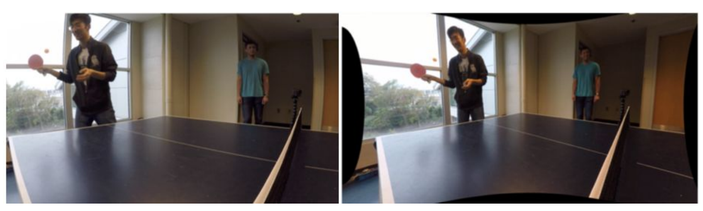
- Intrinsics:
  - Pinhole model
  - Focal length, principal point and distortion parameters of the camera
  - Uses calibration pattern board



- Extrinsics:
  - Pose of the camera with respect to the table
  - Uses table markers



3D POSITION ESTIMATION & VISUALIZATION

3

- Uses inputs from 2D ball position from two frames
- Estimate 3D ball position from each camera's input individually and then combine them
- Use the radius of the ball to estimate its depth from the camera
- Kalman filter based estimation to reduce noise, make the path smoother and more stable

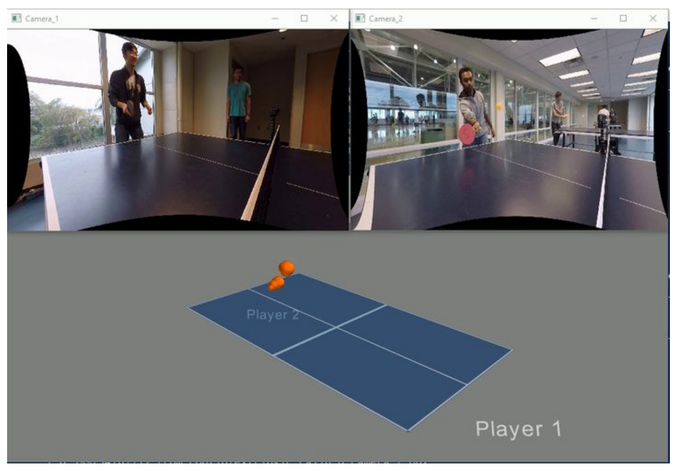
2D BALL DETECTION

2

- Color thresholding
- Background subtraction
- Hough circle transform
- Radius estimation using fitted ellipse to deal with motion blur
- Histogram based detection confidence metric
- Mean-shift tracking

RESULTS

- Accurate estimate of 3D location with very few number of outliers
- More accurate estimate when ball is around the center of either frame
- Very small number of outliers
- Path zigzags



Contributions

Aravind Battaje worked on data collection, camera calibration and the estimation and visualization of 3D ball positions. Sihan Zeng worked on data collection, estimation of 2D ball position and size, and smoothing in 3D. Christian De Le Pena worked on data collection, testing with optical flow, and the marketing video.