

# CMPE 264 Project Proposal

## Impact Alert System

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### Description:

The goal of our project is to design a system that uses a static camera to detect and track the movement of a ball in real-time, and produce an audible alert before the ball hits the camera. The system should predict the trajectory and time-to-contact (TTC) of the ball. If the ball is expected to hit the camera, then the alert must be sounded before the predicted TTC<sup>1</sup> reaches zero.

One possible algorithm for detecting the ball is by computing the optical flow<sup>2, 3, 4</sup>, since the ball will be the only moving object in the scene. The ball's velocity is not directly observable, however by calibrating our system we can estimate the ball's distance from the focal plane. The calibration will involve measuring the foreshortening of the ball's perceived diameter at different distances from the focal plane.

To track and predict the trajectory of the ball we will build dynamical model based equations of motion and the standard characteristics of the ball. This will help us to decide the predicted TTC, and adjust our thresholds for impact detection.

The decision to trigger the alert can be made by detecting whether the ball has entered a bounding box. Focus of expansion<sup>5, 6, 7</sup> can be used to help determine whether impact is imminent.

### Platform:

We are exploring various platforms for the system. Currently, both MATLAB and OpenCV on PC and Mac are a possibility, depending on the performance of our MATLAB simulations. Our project will also need a webcam, and a distinct-looking ball.

### Challenges:

One of the biggest challenges that we expect to face is in achieving a real-time response. Another big challenge that we anticipate is calibrating our system to accurately estimate the distance of the ball from the camera.

### Demonstration:

We would like to give a live demonstration in front of the class on March 12<sup>th</sup>. We also plan to show videos of the system in tested scenarios.

### Contingency:

If real-time response cannot be achieved in MATLAB, then we plan to use OpenCV. If we cannot make the system run in real-time, then we will show the results of an offline computation on a video of the ball being thrown at the camera.

## References:

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4. Horn, B. K. P.; Schunck, B. G. Determining Optical Flow. *ARTIFICIAL INTELLIGENCE* **1981**, *17*, 185-203.
5. Negahdaripour, S.; Horn, B. K. P. A direct method for locating the focus of expansion. *Computer Vision, Graphics, and Image Processing* **1989**, *46* (3), 303-326.
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7. Wahab, M. N. A.; Sivadev, N.; Sundaraj, K. Target distance estimation using monocular vision system for mobile robot. *Open Systems (ICOS), 2011 IEEE Conference on*, 2011; pp 11-15.