Hello everyone

My name is Ben and my project explores aspects of designing a pool safety system

I am an electronic engineer.

I work for Texas Instruments as marketing product manager in the wireless connectivity organization and this is my first class in the SCPD program

Pool safety system that is based on camera and computer vision techniques can detect the event of a kid falling into the pool and start an alarm.

This is a main concern for many home owners with pool and kids.

Available systems in the market are prices in the $2000 range and based on underwater cameras. This project explores ways to implement such a system with one or two cameras positioned outside of the pool.

The project implements a pipeline that is constructed from 3 main phases:

* + Phase one: Identify the pool boundaries
  + Phase two: Object detection to detect object in image
  + Phase three: Decision criteria for each detected object (inside or outside the pool)

Phase one:

I investigated several methods trying to reliably detect the boundaries of a pool on data set of images that I downloaded from Google.

* + I tried Canny edge detection and Hough transform as can be seen in the left and middle figures
  + I tried the Segmentation algorithms K-mean and mean shift
  + And I tried to detect the pool by looking for polygons in the blue share range and manipulating the results using approximation and convex hull

The last method gave the best results as can be seen in the figure on the right

The chosen method performance is decent even in the presence of occlusions and non-rectangular shapes. Some example are given here

This slide describes the algorithm in more details

The second phase is object detection. I used pre-trained models for TensorFlow. I tested several models to find the best tradeoff of runtime vs performance that worked for me.

The last phase is the decision criteria. Deciding per detected object whether it is inside or outside the pool. I used the bounding box found by the object detection phase and compared bounding box position to the position of the polygon that represent the pool. You can see the objects that were detected as inside the pool marked in red and the ones outside marked in blue

Further work can be done to refine and improve the pool boundary detection.   
In addition, there is at least one flaw in the decision criteria that need to be fixed. As can be seen in the image, an object that “flies” over the pool (like the pink ball) is detected as inside the pool. I designed this image to emulate the case of a bird flying over the pool. Triangulation and structure from motion techniques can be used to detect the object more accurately. Other method that I consider and believe will work well that uses single camera is to compare several images taken at different times to filter out very short detections like the bird example.

Thanks you