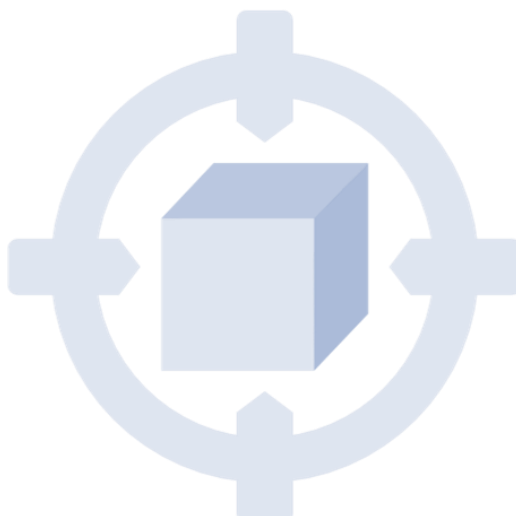
Collision Detection

University of Minho

Master in Informatics Engineering



Computer Graphics

Image Processing and Computer Vision

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Introduction

The objective of this work assignment was to detect general movement in a video, with one or more objects. This movement consists in travels from one side to the other of the screen, collision with the camera and approaching/receding objects.

For this task a script was developed in MatLab 2015 which reads a video, detects its background and starts detecting and tracking an object. Finally it studies its route do determine which type of movement described before is the object performing. The results are then printed on the console output, in real time.

Object Tracking

To track the various possible objects in a given video it was implemented a previously created algorithm. This motion-based multiple object tracking algorithm is available online [1]. As the name suggests this algorithm is capable of detecting and tracking multiple objects. It displays a mask in which we can see the objects detected, as well as the respective bounding box for each object. The centroid of each object is also calculated, but not shown in the original algorithm (the centroid is the arithmetic mean position of all the points in the shape). Later a function from our authoring was added and the centroid is also shown.

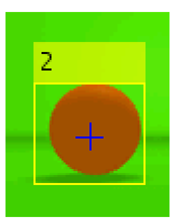

FIGURE 1 - OBJECT WITH BOUNDING BOX AND CENTROID

FIGURE 1 represents a ball moving towards the camera, the bonding box and the calculated centroid in one particular frame of the video. FIGURE 2 represents the same scenario, but with background noise. We can see by these two examples that the algorithm is precise in most tested cases.

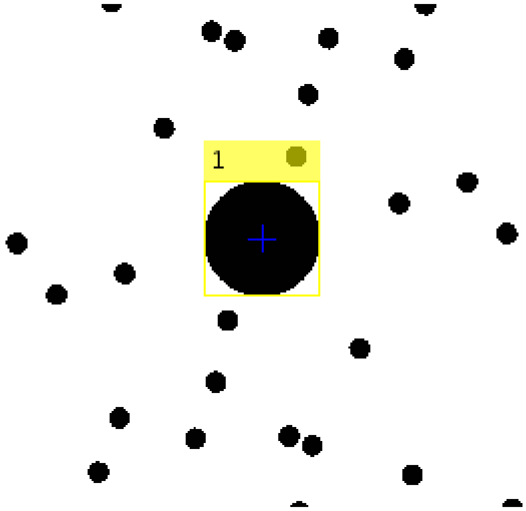

FIGURE 2 – OBJECT DETECTION WITH NOISE

With this stage concluded we were able to use the centroid and bounding box information to detect the direction of the object’s movement, and consequently detect collisions.

Collision Detection

We achieved collision detection be studying the centroid and bounding box of a certain object. For example, if the centroid is always in the center of the video, and the bounding box is progressively increasing, that means that the object is approaching, and if said bounding box occupies most of the screen we can conclude that there was a collision.

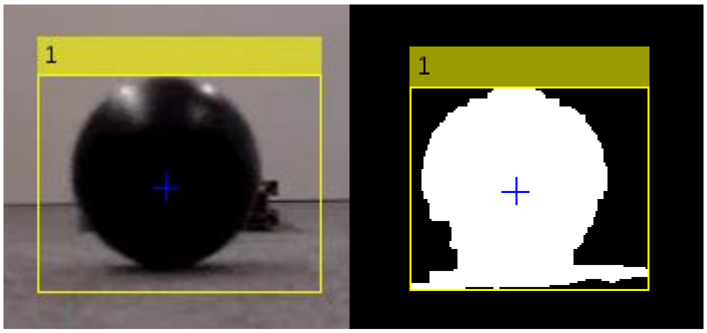

FIGURE 3 - DETECTED OBJECT AND ITS MASK

To tune the script in order to satisfy the most part of the test videos and avoid false positives, the script does not perform the calculations explained before every frame. Instead it calculates the average centroid and bounding box throughout four frames, and only then classifies its movement.

The output for a uniformly approaching object throughout the length of the video is:

```
Object Approaching
Object Approaching
…
Object Approaching
Collision Detected!
```

Each new line is printed every four frames, as explained before, which gives us the real time movement detection. Another output for a translating and then receding object is:

```
Movement to the right
Movement to the right
Movement to the right
Object Receding
Object Receding
…
```

Unsuccessful Cases

The developed algorithm has two main problems. In some case test videos the algorithm was unable to identify any kind of movement correctly. In other cases with a uniformly approaching object an "Object Receding" message can be found on the output, along with the "Object Approaching" messages.

These problems are the result of a very low differentiation between the object and the video background or the reduced number of frames the videos, which does not allow a clear object detection and tracking.

For example, FIGURE 4 represents the first problem, and FIGURE 5 the second problem (lack of frames did not allow the algorithm to detect a collision).

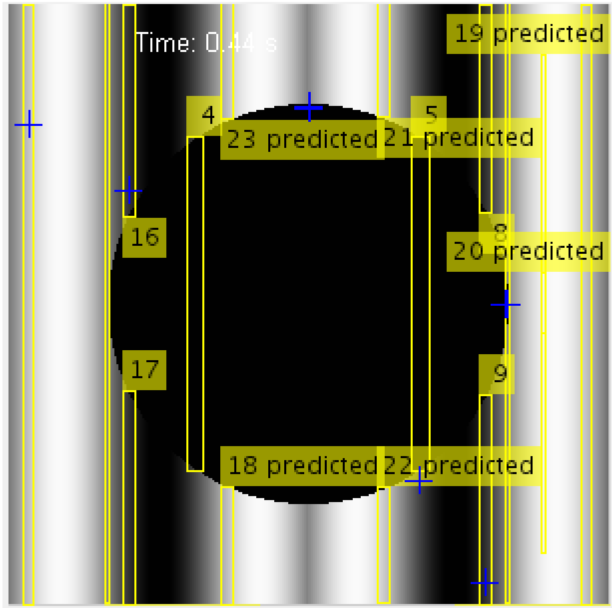

FIGURE 5 - EXAMPLE OF AN UNSUCCESSFUL CASE

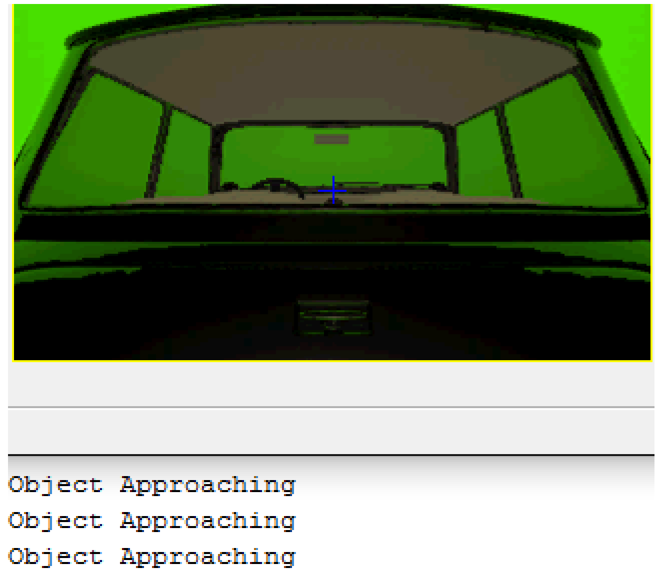

FIGURE 5 - COLLISION NOT DETECTED

Conclusion

We have concluded that the developed algorithm works efficiently and accurately for the most cases tested, giving real time information on objects contained in the video. Although there are some known problems explained in Unsuccessful Cases. Some of this cases are due to the need learning frames, which increased the problem of low frames.

The results obtained could be better if the algorithm were focused in one particular case, or have one common background. This way the algorithm could be tuned appropriately. Another improvement could be to refine the collision detection in order to reduce the number of frames required to achieve an acceptable result with a low resolution video input.

References

[1] MathWorks, "Motion-Based Multiple Object Tracking," [Online]. Available: http://www.mathworks.com/help/vision/examples/motion-based-multiple-object-tracking.html.

[2] MathWorks, "Computer Vision," [Online]. Available: http://www.mathworks.com/products/computer-vision/.