BOUHELIER

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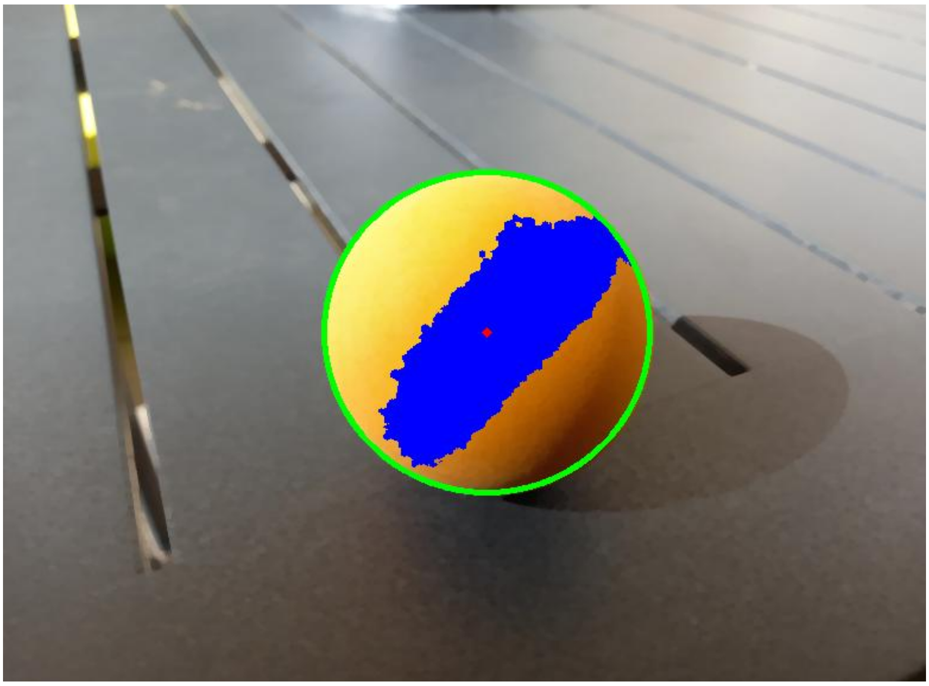
Perception Report

1/Introduction

The objective of this project is to detect an object, specifically a ball, first in an image and then in a video. To achieve this, we will use the Python language coupled with the OpenCV library. We will experiment with several methods, such as detection by color (RGB), HSV hue, and using the Hough transform.

2/RGB Method

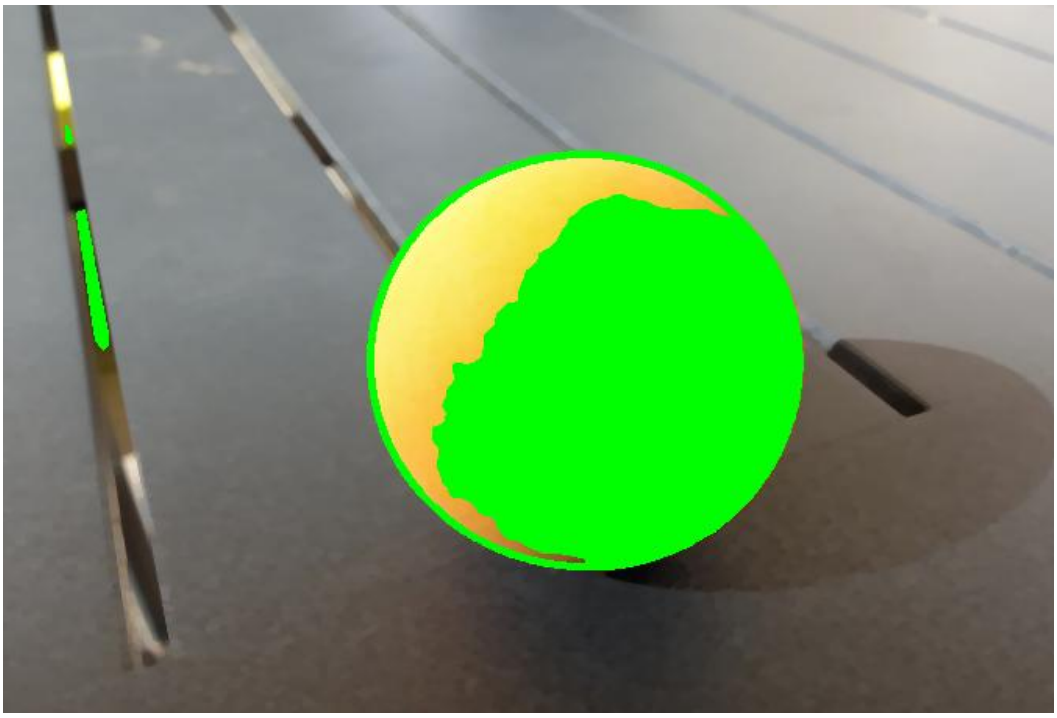
Initially, we will try to detect the ball in the image using the RGB value of each pixel. The goal is to be able to click on the ball in the image and fully color it to identify it. Specifically, the implemented code takes the RGB value of the pixel on which we just clicked, calculates the Euclidean distance between this pixel and all other pixels in the image, and then colors, using a mask, all pixels whose value is close to that of the clicked pixel. The closeness of the value is chosen arbitrarily.



After several tests on different images, the conclusion is that this method is far from optimal for various reasons. First, there is no “perfect” proximity value: if it is too low, only a small part of the ball is detected; if it is too high, the ball is relatively well detected but other elements in the image are also colored. Furthermore, in an image containing parts with the same color as the ball we want to detect, the method makes no distinction whatsoever. Finally, depending on the ball’s exposure, a pixel in shadow can have a completely different value from overexposed pixels, for example.

3/HSV Method

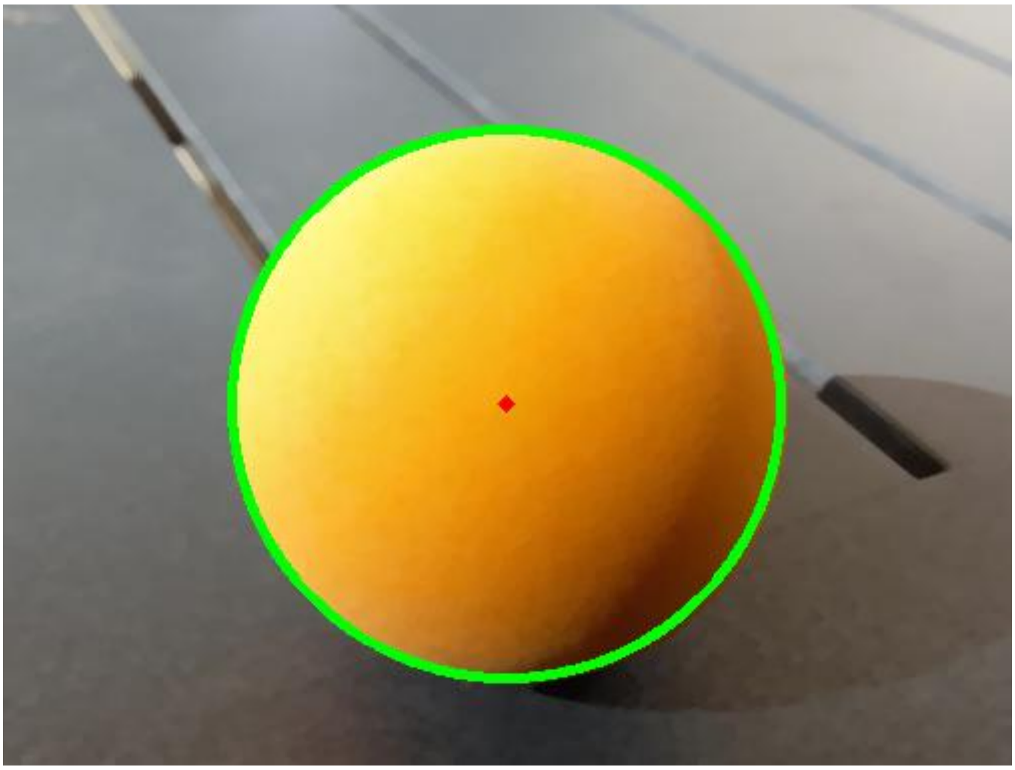
This method works in the same way as the first one (comparing the value of a pixel of the ball to all other pixels in the image); however, we use three other parameters to define a pixel: Hue, Saturation, and Value (HSV). Here, to calculate the proximity between two pixels, we also use the Euclidean distance, but since the H value is an angle, its range must be treated as circular (an angle of 360° and an angle of 1° are actually very close). Once this is accounted for, we perform the same operations as in the RGB method. The result is:



Pour conclure s’agissant de la méthode HSV, nous remarquons que la balles est en plus grande partie colorié par rapport à la méthode RGB mais cela reste imparfait pour les mêmes raisons évoquées précédemment hormis que la teinte (paramètre H) reste stable face à un changement de lumière.

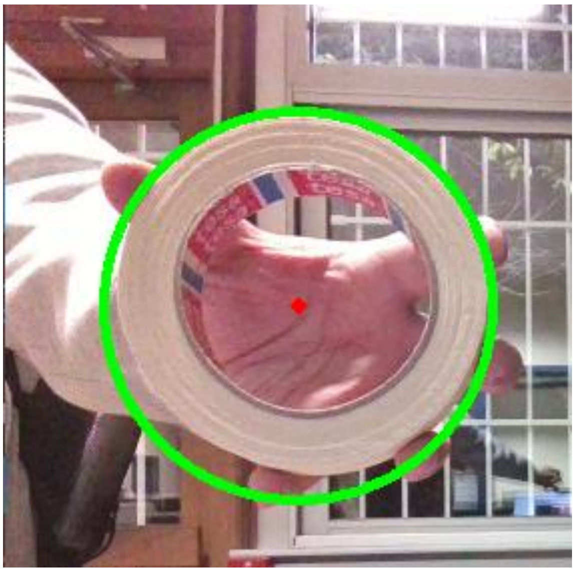
4/Hough Transform

The Hough method for circle detection is a technique we use to identify circular shapes in an image based on edges and intensity gradients. Before applying this method, we preprocess the image by applying a Gaussian blur to reduce noise and smooth the edges, which makes detection more accurate. We then use the function cv.HoughCircles, which transforms the points of the image into a parameter space where each point represents a possible circle defined by its center and radius; circles are then detected where multiple votes accumulate in this space. We also apply morphological opening and closing operations before detection: closing, which consists of a dilation followed by an erosion, allows us to fill small holes and unify disjoint regions, while opening, an erosion followed by a dilation, serves to remove small spots and imperfections caused by noise. By combining these two processes, we clean and reinforce the contours of objects, which facilitates more reliable and accurate circle detection using the Hough method.



5/Video

In this program, we perform real-time circle detection from a video stream. For each frame captured by the camera, we convert it to grayscale and then apply a Gaussian blur to reduce noise. We then use morphological opening and closing operations to clean the image and reinforce the edges. Once this preprocessing is complete, we apply the Hough method to detect circular shapes present in the scene. Finally, we draw these circles directly on the video, allowing us to observe the detection of round objects in real time, even under imperfect visual conditions.



6/Conclusion

In conclusion, we experimented with several detection methods to locate a ball in an image and then in a video. Color-based approaches, although intuitive, proved sensitive to variations in lighting and to colors similar to the background. In contrast, the Hough transform, combined with preprocessing through morphological opening and closing, proved to be much more robust and accurate for detecting circular shapes. Applying this method to a real-time video stream allowed for effective and stable detection, thus confirming its usefulness for the automatic detection of simple-shaped objects.