

ONLINE RECOGNITION OF MOBILE OBJECTS

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Abstract. *The system designed for the recognition of geometrical figures that are moving on a conveyor belt was developed by using the Canny edge detection algorithm, where the objects are identified with the maximum accuracy. The Canny algorithm provided a 88% accuracy result, alongside the Bilateral Filtering and Thresholding algorithms, which were also used for image processing experiments. To enable the training of machine learning models to classify the objects according to the defined labels, the AutoML Vision was used as a part of the system brain - Artificial Intelligence. The current project describes the flow of implementing the system with real images of the results and deductions.*

Keywords: *object detection, internet of things, machine learning, classification, computer vision*

Introduction

The importance of online data transmission has risen considerably in the last decade by bringing the convenience and easiness the modern societies need in order to function, especially when it comes to the Internet of Things and Artificial Intelligence. As together they have the power of changing the world.

In a system where data about mobile objects is detected, identified, registered and transmitted, internet of things devices will play the digital role of a nervous system while artificial intelligence will be the brain. Given a set of object classes, object detection consists in determining the location and scale of all object instances, if any, that are present in an image. Thus, the objective of an object detector is to find all object instances of one or more given object classes regardless of scale, location, pose, view with respect to the camera, partial occlusions, and illumination conditions [1].

Nowadays, object detection is being used in many applications, with the most popular ones being human-computer interaction, robotics, consumer electronics, security, retrieval and transportation.

Object detection techniques solve the general problem of object presence classification. In this project, the focus is on mobile objects, represented by geometrical figures, moving on a conveyor belt, recognized in a tridimensional way and sent as data for the next step of classification. The entire system will simulate the automation process of trash sorting at a specialized facility.

Implementation

In order to implement the project requirements, the OpenCV library was used as it's designed to solve computer vision problems, based on Python bindings [2].

First of all, it was needed to add a real photo (Fig.1) which will be processed by different techniques.

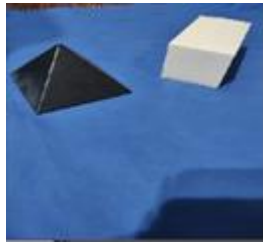


Fig. 1 The original Image

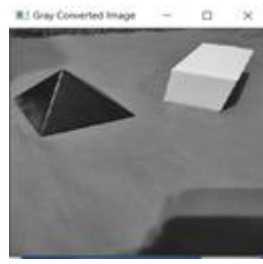


Fig. 2 Gray Converted Image

The image should be converted into a gray image (Fig 2), in order to be processed. The first algorithm is Canny (Fig.3), which is used for Edge Detection.



Fig 3. Canny edge detection algorithm

The next algorithm is “Bilateral Filtering” (Fig.4). It is highly effective in noise removal while keeping edges sharp. But the operation is slower compared to other filters. The Gaussian filter takes the neighbourhood around the pixel and finds its Gaussian weighted average. This Gaussian filter is a function of space alone, that is, nearby pixels are considered while filtering. It doesn't consider whether pixels have almost the same intensity. It doesn't consider whether a pixel is an edge pixel or not. So it blurs the edges also, which is not convenient [3].

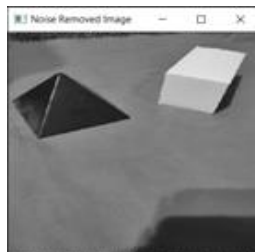


Fig. 4 Noise Removed Image

The next one is “Thresholding” (Fig.5). It is quite a simple algorithm that for every pixel, the same threshold value is applied. If the pixel value is smaller than the threshold, it is set to 0, otherwise, it is set to a maximum value [4]. But this method is not ok for us, because the color of the objects matters. Also, a big influence will be how much light is in the room.



Fig .5 Thresholding

Dilation (Fig.6) is a basic morphological operation. It has a wide array of uses:

- Removing noise.
- Isolation of individual elements and joining disparate elements in an image.
- Finding of intensity bumps or holes in an image.

The formula is: $dst(x,y)=\max(x',y'):\text{element}(x',y')\neq 0\text{src}(x+x',y+y')$ [5].



Fig. 6 Dilation

Results and discussions

In order to correctly identify the object, the quality of images and object detection accuracy are very important. As a result of many experiments, the Canny edge detection algorithm provided the most representative results (Fig.3).

As mentioned above, the brain of the IoT system, where data about mobile objects is detected and identified, is Artificial Intelligence (AI). Thus, as it is important for the algorithm to identify objects with maximum accuracy, the cloud services for AI, like AutoML Vision, were used. It met the requirements of the project and provided a correct result with accuracy of 0.88 or 88% (Fig.4) for test image (simple geometric figure) (Fig.5).

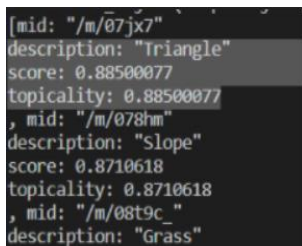


Fig. 4 AutoML Vision result



Fig. 5 Test image

Conclusions

Waste is such a mundane thing in people's lives that they rarely think about its impact on the environment. And the sorting of waste is critical to increasing the amount of waste that is recycled, as well as the quality of recycled materials.

The initial goal of this project was just that, to find an efficient approach to the task of waste sorting. Waste can be roughly categorized into a few geometrical figures. This led to the simplification of the problem into sorting geometrical shapes. As can be seen above, for this project, a machine learning solution was chosen with a classification model. The approach presented has proven to be efficient and have a high accuracy for the given study case, which is why it is believed it will be of great help in waste sorting facilities. A solution like this one will speed up sorting and free up people that can take care of more complex jobs.

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