

Basic Object Detection Implementation Using Matlab

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Abstract - Image processing and Object detection are one of the most popular areas in the field of engineering and science. Various platforms are being used for designing and implementation of object detection algorithm. It includes C programming, MATLAB, Simulink, open CV etc. Among these, MATLAB is most popular because of its extensive features and ease of use. These features include data processing using matrix, set of toolboxes and Simulink blocks covering all technology field, Help topics and sample codes. This paper presents the basic implementation of object and face detection using MATLAB. It demonstrates the basic block diagram of object detection and explains methods to detect objects and faces in the given input Image/Video File. This paper helps new researchers in object detection field to design and implement algorithms using MATLAB.

Index Terms - Object detection, Features, MATLAB.

1. INTRODUCTION

Object detection is a computer technology related to computer vision and image processing that deals with detecting instances of semantic objects of a certain class (such as humans, buildings, or cars) in digital images and videos. It is a computer vision technique that allows us to identify and locate objects in an image or video. With this kind of identification and localization, object detection can be used to count objects in a scene and determine, and track their precise locations, all while accurately labelling them. In Video analytics or real time object detection and recognition, Object detection is a critical step. The performance of this step is important for scene analysis, object matching and tracking, activity recognition. Over the years research is flowing towards innovating new concept and improving or extending the work done in this field till now. Various object detection approaches have been developed based on statistic, fuzzy, neural network etc. Most approaches involve complex theory. These

approaches can be evolved further by thorough understanding, implementation and experimentation. All these approaches can be learned by reading, reviewing, and experimentation with ideas. However, Implementation and experimentation requires good programmer.

Various platforms are being used for the design and implementation of object detection and tracking algorithm. These platforms include C programming, Open CV, MATLAB etc. The object detection system to be used in real time should meet two conditions. First, system code must be short in terms of execution time. Second, it must efficiently use memory. However, programmer must have good programming skill in case of programming in C and OpenCV. Moreover, it is time intensive too for new researcher to develop such efficient code for real time use. Assuming all these facts, MATLAB come out to be the most simple and easy to learn programming language. It has sample codes of all the basic programs like face detection, object detection etc. It contains more than seventy toolboxes covering all possible fields in technology. All toolboxes are rich with predefined functions, system objects and simulink blocks. This feature helps to write short code and saves time in logic at various steps in system. MATLAB supports matrix operation which has a huge advantage during processing of an image or frame in video file. MATLAB coding is simple and easily learned by any new researcher or student.

2. BLOCK DIAGRAM OF OBJECT DETECTION

This section explains the general Block diagram of object detection explaining the function of each block. Common Object detection mainly include Video/Input, Preprocessing object segmentation and post processing.

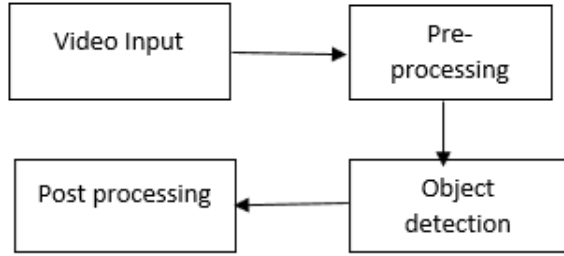


Fig 1: Basic Block diagram of object detection
 The Function of each block is as follows,
 Video Input: - It can be a stored video or a real time video.

Pre-processing: - It mainly involves temporal and spatial smoothing such as intensity adjustment, removal of noise, contrast adjustment etc. For real time systems, frame – size and frame – rate reduction is commonly used. It highly reduces computational cost and time.

Object detection: - It is the process of change detection and extracts appropriate change for further analysis and qualification. Pixels are classified as foreground, if they changed. Otherwise, they are considered as background. This process is called as background subtraction. The degree of "change" is a key factor in segmentation and can vary depending on the application. The result of segmentation is one or more foreground blobs, a blob being a collection of connected pixels.

Post-processing: - Remove false detection caused due to dynamic condition in background using morphological and speckle noise removal.

3. DIFFERENT METHODS TO DETECT SUBJECT IN AN IMAGE

In First method we detect a random object (Like a playing card) in an image. This can be done by giving Reference image and comparing it with the test image. What MATLAB algorithm does is that it first detects all the main features like edges and gradients from the reference image and detect those features in test image by matching them. If the features are matched, then the algorithm locates the subject in the test image and enclose it within a box using a localizer.

The other subjects which are quite specific in nature like faces and people come under Categorical object detection. This type of object detection uses feature detection and machine learning based classifiers to detect the desired subject in the give image.

In next section both these methods of object detection are briefly explained.

a. Object detection with Features

- Use SURF features to represent Object: They are unique features in the image. It looks for the features that are worth grabbing. With SURF basically what it's looking for are blobs, particularly blobs with some contrast on the edges of them. The features are also invariant to scaling and rotation so we could move the object/subject around and still detect it.
- Detect features in video.
- Match features from two sources: Matches the surf features of Reference image and test image. And matches them to detect the object in the test image.
- Use Localizer to localize the detected object: "estimate Geometric Transform" is a function that is used to localize the subject in the image.



Fig 2: Reference Image



Fig 3: Test Image

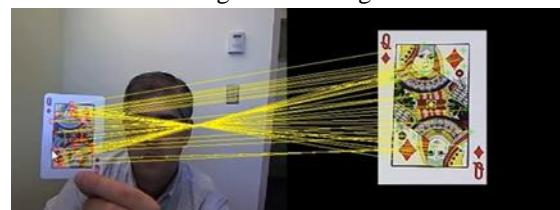


Fig 4: Matching Features.



Fig 5: Object is detected and localized.

3.1 Categorical Detection = Feature matching + Machine learning

Previous algorithm we used was limited to the object we took as the reference at the first place. This approach is very limited and quite inefficient for detecting different set of objects in an image. You could build a library for different features in accordance with the different objects.

To make this process simpler categorical object detection comes into picture which detect objects on the basis of categories like faces or Upright people. It uses Machine learning classifiers to reject undesired features and detect the features giving most accurate results. What machine learning does is that it recognizes which features are basically are the ones which represent faces. We train this on very large set of data so for example for face detection

we might use 5000 images of faces, for people detector we might use several thousands of images.

The typical machine learning algorithms that we use are,

- SVM (Support Vector Machine): Used in People detection.
- Adaboost: Used in Face detection.
- Cascade of Adaboost: Cascade of the classifiers are used in order to remove false positives in the detections.
- K-nearest neighbour.

Table 1: Useful function/Object for object detection.

Tool-box	Function /Object	Name	Use
CV	Object	vision.Cascade Object Detector	Used to detect face, nose, mouth in the image using HOG algorithm and adaboost classifier.
CV	Object	vision.Optical flow	This function can be used for the estimation of object velocities using the Horn-Schunck or the Lucas-Kanade method.

CV	Object	vision.People Detector	It detects upright people in the image using Histogram of oriented gradient algorithm and SVM classifier.
CV	Object	vision.Template Matching	It is used to perform Object detection based on template matching.

3.1.1 People Detection

- vision.PeopleDetector function detects upright people.
- Uses HOG (Histogram of oriented Gradient) features and trained SVM classifier to detect people.
- Histogram of oriented gradient is a regional descriptor. Here, region means the region of the input image.
- The gradient image of input image is taken. Then this data break into the cells. These cells are a non-overlapping rectangular grid. Then the histogram of each cell is taken. This histogram data is considered as the feature in the classification scheme. The histogram data becomes the representation of our input image.
- If we have a larger image that contains many people or larger scene, in order to be able to find a person. In order to find a person, we slide the histogram of oriented gradient algorithm over all the windows and regions of an image to find the features that are most relevant.
- This data is then goes through the SVM classifier which rejects most of the false positives, giving the most accurate detections.

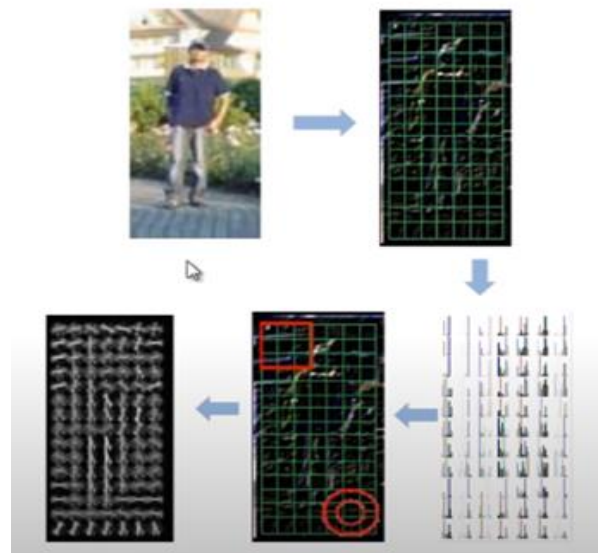


Fig 6: Histogram data extraction from the input image.

3.2.2 Face detection

- Voila –Jones algorithm is used to detect faces in an given image.
- vision.CascadeObjectDetector function detects face, nose, mouth.
- Uses Haar like features and cascade adaboost classifier to detect Faces in an image.
- A Haar-like feature considers adjacent rectangular regions at a specific location in a detection window, sums up the pixel intensities in each region and calculates the difference between the sums. This difference is then used to categorize subsections of an image.

For example, with a human face, it is common observation that among all the faces the region of eyes is darker than the region of the cheek. Therefore, a common Haar feature for face detection is a set of two adjacent rectangles that lie above the eye and cheek region.

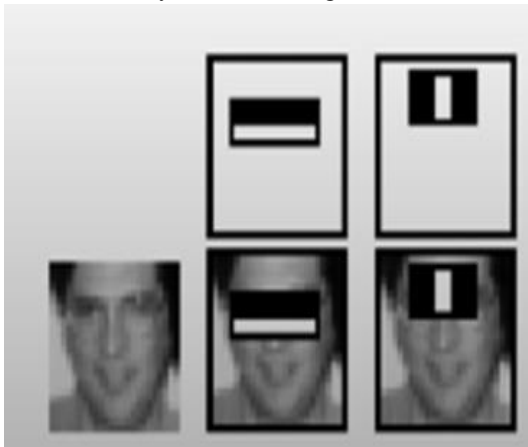


Fig 7: Haar like features detected.

- Generally, hundreds of thousands of Haar like features are detected in an image; Consisting of large number of false positives. That is where the cascade adaboost classifier comes into picture.
- Each stage of cascade is Gentle Adaboost, an ensemble of weak learners.
- Each stage rejects negative samples using weighted vote of these weak learners.
- The samples not rejected are passed to the next stage.
- Positive detection means the sample passed all the stages of cascade.
- These positive detections are the faces detected in the image.

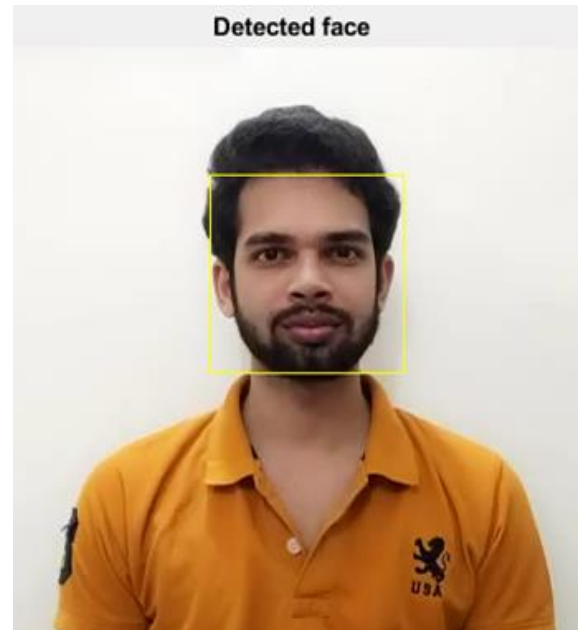


Fig 8: Detected Face

4.CONCLUSION

This paper presents basic object detection implementation using MATLAB. In this paper we discussed basic object detection and face and people detection. We discussed about various different MATLAB functions and objects which can be useful at various stages. Different Toolboxes of MATLAB mainly includes image acquisition, image processing and Computer vision. Due to availability of predefined functions and toolboxes programming in MATLAB becomes very easy. This paper may help new students to get the idea about object detection in MATLAB.

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