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Comparative Analysis of Video Processing Object Detection

Tareek Pattewar[1], Amit Chaudhari[2], Mrunal Marathe[3], Moushumi Bhol[4]

[1]Assistant Professor, Dept. of Information Technology, R. C. Patel Institute of Technology, Maharashtra, India
[2,3,4]Student Professor, Dept. of Information Technology, R. C. Patel Institute of Technology, Maharashtra, India

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Abstract - *Object detection mechanisms have become fundamental parts of robot navigation, medical diagnosis, security, industrial inspection and automation, and their popularity is increasing at a surprising rate every day. Human can recognize any object in the real world without any efforts, But computerize recognition of objects in image or Video is not an easy task. Growing popularity of this object detection systems had forced us to take a step of interest towards building such project which has attracted the attention of attackers who were careless of being identify or alarmed while doing any suspicious activity or attempting to manipulate anything. The proposed method involves the input as a video. The video has been deframed and background is subtracted so as to extract objects. The complete feature extraction has been carried out with labeling so as to classify by various classifiers such as SVM, J48, AdaBoost*

Key Words: **Image processing, background subtraction, mask, morphological operations, object, labelling**

1. INTRODUCTION

1.1 Overview

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. Well-researched domains of object detection include face detection and pedestrian detection. Object detection has applications in many areas of computer vision, including image retrieval and video surveillance. An approach to building an object detection is to first build a classifier that can classify closely cropped images of an object.

The goal of object detection is to detect all instances of objects from a known class, such as people, cars or faces in an image. Typically only a small number of instances of the object are present in the image, but there is a very large number of possible locations and scales at which they can occur and that need to somehow be explored. Each detection is reported with some form of pose information. This could be as simple as the location of the object, a location and scale, or the extent of the object denied in terms of a bounding box.

Images of objects from a particular class are highly variable. One source of variation is the actual imaging process. Changes in illumination, changes in camera position as well as digitization artefact, all produce significant variations in image appearance, even in a static scene. The second source of variation is due to the intrinsic appearance variability of objects within a class, even assuming no variation in the imaging process.

1.2 Benefits of Object Detection

Humans can easily detect and identify objects present in an image. The human visual system is fast and accurate and can perform complex tasks like identifying multiple objects and detect obstacles with little conscious thought. With the availability of large amounts of data, faster GPUs, and better algorithms, we can now easily train computers to detect and classify multiple objects within an image with high accuracy.

This technology has the power to classify just one or several objects within a digital image or video at once. And, few of its advantage are listed below:

1. objects that are not visible to humans can be identified.
2. Simultaneously multiple objects of different kind can be detected.
3. Noisiness can be eliminated while detection.
4. With availability of large amount of Faster GPUs and algorithms faster moving objects can also be recognized.
5. Database of recognized objects can be maintained.

2. RELATED WORK

There are various researchers who have contributed their work for object detection systems. The researchers have proposed novel techniques with suitable implementations. Now we concentrate on few researchers works as given below.

1. Liming Wang et.al, have developed an object detection method combining top-down recognition with bottom-up image segmentation. . There were two main steps in there method: a hypothesis generation step and a verification step. In the top-down hypothesis generation step, they design an improved Shape Context feature, which is more

robust to object deformation and background clutter. The improved Shape context was used to generate a set of hypotheses of object locations and figure ground masks, which had high recall and low precision rate. In the verification step, they first compute a set of feasible segmentations that were consistent with top-down object hypotheses, then they proposed a False Positive Pruning (FPP) procedure to prune out false positives. They exploit the fact that false positive regions typically do not align with any feasible image segmentation [1].

2. Divya Patel et.al, had presented different techniques and methods for detecting or recognizing object with various benefits like efficiency, accuracy, robustness etc. They stated that Object detection is a computer technology that connected to image processing and computer vision that deal with detecting instance objects of certain class in digital images and videos. Object detection is a challenging problem in vision based computer applications. It is used to identifying that whether in scene or image object is been there or not [2].
3. Xinyi Zhou et.al, had discussed application of deep learning in object detection task. There were simple summary of the datasets and deep learning algorithms commonly used in computer vision. On the other hand, a new dataset are building according to those commonly used datasets, and choose one of the network called faster r-cnn to work on this new dataset. They carried out that experiment to strengthen the understanding of these networks through the analysis of the results they learned the importance of deep learning technology, and the importance of the dataset for deep learning [3].
4. Meera M K et.al, have formulate a Object detection technique into two stages. For the first stage, the query image was categorized using a classifier. For classifier optimization they had implemented two types of classifiers- Support Vector Machine(SVM) classifier that make use of GIST features and k-nearest neighbor(kNN) classifier that make use of Scale Invariant Feature Transform(SIFT). GIST based SVM classification was done using different kernels such as linear kernel, Polynomial kernel and Gaussian kernel. SIFT features are invariant to affine transformations of the images. SIFT features of the images were extracted and a similarity matrix was formed by matching these SIFT features. Then a k-nearest neighbor(kNN) classifier was implemented on the similarity matrix. GIST feature based SVM classifier with Gaussian kernel showed better classification accuracy than SIFT feature based kNN classifier. The image datasets considered for this work were Coil-20P and Eth80 [4].
5. Shuai Zhang et.al, had proposed that Object detection and tracking were two fundamental tasks in multicamera surveillance. They also proposed a framework for achieving these tasks in a no overlapping multiple camera network. A new object detection algorithm using mean shift (MS) segmentation was introduced, and occluded objects were further separated with the help of depth information derived from stereo vision. The detected objects were then tracked by a new object tracking algorithm using a novel Bayesian Kalman filter with simplified Gaussian mixture (BKF-SGM). It employs a Gaussian mixture (GM) representation of the state and noise densities and a novel direct density simplifying algorithm avoids the exponential complexity growth of conventional Kalman filters (KFs) using GM. When coupled with an improved MS tracker, a new BKF-SGM with improved MS algorithm with more robust tracking performance was obtained. Furthermore, a non-training-based object recognition algorithm is employed to support object tracking over non overlapping network [5].
6. Sheng Ding et.al, have applied the deep learning algorithm to the detection of daily objects, and some progress has been made in that direction. Compared with traditional object detection methods, the daily objects detection method based on deep learning were faster and more accurate. The main research work of their article were : 1. collect a small data set of daily objects; 2. in the Tensor Flow framework to build different models of object detection, and use this data set training model; 3. the training process and effect of the model are improved by fine-tuning the model parameters. They also studied with the rapid development of deep learning, great breakthroughs were been made in the field of object detection [6].
7. Liming Wang et.al, had developed an object detection method combining top-down recognition with bottom-up image segmentation. There were two main steps in their method: a hypothesis generation step and a verification step. In the top-down hypothesis generation step, they designed an improved Shape Context feature, which was more robust to object deformation and background clutter. The improved Shape Context was then used to generate a set of hypotheses of object locations and figure ground masks, which had a high recall and low precision rate. In the verification step, they first compute a set of feasible segmentations that are consistent with top-down object hypotheses, then they proposed a False Positive Pruning (FPP) procedure to prune out false positives. They also exploit the fact that false positive regions typically

do not align with any feasible image segmentation. Experiment showed that simple framework was capable of achieving both high recall and high precision with only a few positive training examples and that their method can be generalized to many object classes [7].

8. Palak Khurana at.al, have analyzed the Object Recognition and Segmentation techniques in context with images and videos. They stated that Object segmentation used today in diversified fields such as: image processing, video recognition, shadow detection, Human Activity Recognition and many more. Their research consists of systematic analysis of various existing object recognition and segmentation skills, with precise and arranged representation. While doing the research they had identified that recognition and segmenting an object can be scrutinized from the perspective of static and moving objects. Most of the used techniques were based on mathematical and algorithmic models. They wind up their results with the merits and demerits of existing methods and the liabilities of future scope in this area [8].
9. Xiaofeng Ning et.al, had addressed the recognition, object detection and segmentation issues in white background photos with deep learning method. In particular, they first trained a recognition model based on Google Net to judge whether a photo is white background. Then they proposed a main object detecting algorithm to eliminate unnecessary elements such as logos, characters with Faster R-CNN. Eventually a main object segmentation method combining both CRF-RNN network and Grabcut was adopted to smoothly eliminate the shadow area and obtain the fine segmentation results. All exploring algorithms were implemented in real time with Caffe and Tesla K80 from Nvidia [9].
10. Sanjana Yadav et.al, had proposed a precise approach for image matching in real time scenario and also in the field of ROBOTICS. They had constructed an application based Image matching model that was able to detect images that are exactly the same, as well as images that have been edited in some ways. Implementation of that Image Matching and object recognition system was based on tracking an object, calculating its feature Points, and classification with the help of trained Data Sets. The system was capable to perform matching of images, both automatically and manually. On the other hand, to operate the proposed system manually, user itself takes the images of an object or something, and will store it in database. After that system will through some steps, and image matching will be performed. Black White point calculation of an image, Chamfer matching Algorithm, 3-4 Distance Transformation with canny edge detector was applied in the application which was well suited for calculating the pixel values [10].
11. Palak Khurana et.al, have analyzed the Object Recognition and Segmentation techniques in context with images and videos. Object Recognition can be used in various fields such as Robot navigation, Medical diagnosis, Security, Industrial inspection and automation, Human-computer interface, Information retrieval. Object segmentation is today used in diversified fields such as: image processing, video recognition, shadow detection, Human Activity Recognition and many more. Their work consists of systematic analysis of various existing object recognition and segmentation skills, with precise and arranged representation. While doing the research they have identified that recognizing and segmenting an object can be scrutinized from the perspective of static and moving objects. Most of the used techniques were based on mathematical and algorithmic models. They wind up their results with the merits and demerits of existing methods and the liabilities of future scope in that area [11].
12. Sukanya C.M et.al, had presented a survey of different techniques in the field of computer vision and object recognition. Mainly that paper was to review and study of the different methods of object detection. In this survey we discuss background subtraction, optical , point detector, frame differencing to detect objects. We also compared accuracy and limitations of these methods. The research paper includes various approaches that have been used by different researchers for object detection. They studied Object recognition was an important part of computer vision because it was closely related to the success of many computer vision applications. A number of object recognition algorithms and systems were been proposed for a long time in order to address this problem [12].
13. K. R. Reddy et.al, stated that object tracking is one of the major fundamental challenging problems in computer vision applications due to difficulties in tracking of objects can arises due to intrinsic and extrinsic factors like deformation, camera motion, motion blur and occlusion. Their paper proposes a literature review on several state-of-the-art object detection and tracking algorithms in order to reduce the tracking drift. Their paper introduces a model based object detection method which uses only shape-fragment features. The object shape model is learned from a very small set of training images. And the object model is composed of shape fragments. The model of the object is in multi-

scales. The results presented in their paper are competitive with other state-of-the-art object detection methods. The major contributions of their paper is the application of learned shape fragments based model for object detection in complex environment and a novel two-stage object detection framework [13].

14. Verschae et.al, stated that Object detection is a key ability required by most computer and robot vision systems. The latest research on this area has been making great progress in many directions. In the current manuscript, we give an overview of past research on object detection, outline the current main research directions, and discuss open problems and possible future directions. They also proposed that object localization is required which may make use of this technique. Detecting foreground to separate these changes taking place in the foreground of the background. It is a set of techniques that typically analyze the video sequences in real time and are recorded with a stationary camera. Background subtraction is generally based on a static background hypothesis which is often not applicable in real environments [14].
15. Aastha Tiwari et.al, have stated that FE is one of the most popular research areas in the field of image analysis as it is a prime requirement in order to represent an object. An object is represented by a group of features in form of a feature vector. That feature vector is used to recognize objects and classify them. Previous works had proposed various feature extraction techniques to find the feature vector. Their paper provides a comprehensive framework of various feature extraction techniques and their use in object recognition and classification. It also provides their comparison. Various techniques were considered and their pros and cons along with the method of implementation and detailed experimental results were discussed [15].
16. J. Ponce et.al, stated that appropriate datasets are required at all stages of object recognition research, including learning visual models of object and scene categories, detecting and localizing instances of these models in images, and evaluating the performance of recognition algorithms. Current datasets are lacking in several respects, and this paper discusses some of the lessons learned from existing efforts, as well as innovative ways to obtain very large and diverse annotated datasets. It also suggests a few criteria for gathering future datasets. Detecting foreground to separate these changes taking place in the foreground of the background. It is a set of techniques that typically analyze the video sequences in real time and are recorded with a stationary camera. Their paper provides a comprehensive framework of various feature extraction techniques and their use in object recognition and classification [16].

3. SYSTEM IMPLEMENTATION

3.1 Introduction to Proposed System

In today's world there exist various techniques for detecting object in Video or Image using Existing available APIs or Neural Network . The concept of this system is Easy to understand and less time taking when it comes to train model and test it on new video. The technique has been proposed in [32] using Neural Network for input video and having the training time over hours. We have implemented and improved the work to game of minutes by using different features of Objects like their Width and Height. Fig-1

3.2 Objectives

Object Detection and their Recognition is very important in various fields. It is important to identify them in short period of time and with each detailing . The main aim of the work is to design a model for object detection using Background Subtraction technique . To get faster detection

1. To eliminate redundant frames while processing and considering frame other by consecutive frame.
2. To implement a system that machine learning approach classifies object depend on features.
3. To implement the simple and easy method to achieve good detection rate.

3.3 System Architecture

Various Step which are been carried in this system are been illustrated as a block diagram below in which each block denotes the step and arrow denotes transition from one process to another. Also detailed description and code snippet associated with each block is been given below the Fig-1.

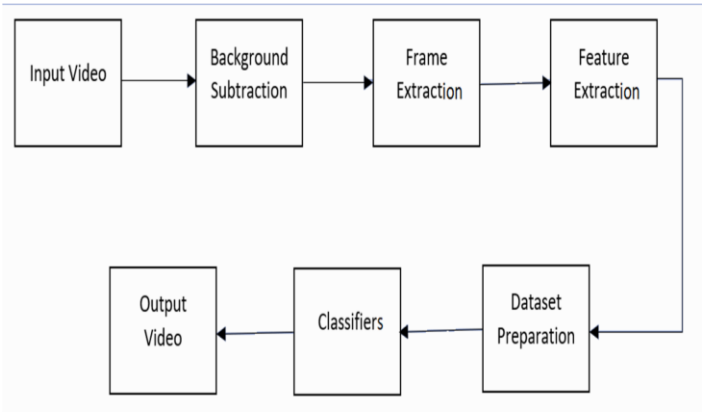

Fig -1: System Block Diagram

3.3.1 Input Video

In this module we have imported the input video. Package being used to import video in system was opencv which allows us to take video as an input. When this video is being import then frame is been extracted from the video so as to perform our algorithm on a single frame and detect objects first in that frame. In order to eliminate redundancy, we use to consider the odd number of frames for processing and this is done using the modulus arithmetic operation which allows to pick odd number frames only. Also, the problem of compression can be eliminated using this concept so as to create output video of as possible as of less size. There is no compulsion related to the extension of the input video as changing the extension of the video cant affect the processing of the frames in it. But instead of using low resolution video as an input a high-resolution video will be preferable. After importing the video, it is given to the next block called as Background subtraction block which is model to be trained in this system using the first number of frames from the inputted video. Background subtraction is done to each frame in order to extract objects from each frame and extract their features.

3.3.2 Background Subtraction

Background subtraction is any technique which allows an image's foreground to be extracted for further processing (object recognition etc.). Background subtraction is a widely used approach for detecting moving objects in videos from static cameras. The rationale in the approach is that of detecting the moving objects from the difference between the current frame and a reference frame, often called "background image", or "background model". Foreground detection is one of the major tasks in the field of computer vision and image processing whose aim is to detect changes in image sequences. Many applications do not need to know everything about the evolution of movement in a video sequence, but only require the information of changes in the scene, because an image's regions of interest are objects (humans, cars, text etc.) in its foreground. After the stage of image preprocessing (which may include image denoising, post processing like morphology etc.) object localization is required which may make use of this technique. Detecting foreground to separate these changes taking place in the foreground of the background. It is a set of techniques that typically analyze the video sequences in real time and are recorded with a stationary camera. Background subtraction is generally based on a static background hypothesis which is often not applicable in real environments. With indoor scenes, reflections or animated images on screens lead to background changes. Similarly, due to wind, rain or illumination changes brought by weather, static backgrounds methods have difficulties with outdoor scenes.

The background is assumed to be the frame at time t. This difference image would only show some intensity for the pixel locations which have changed in the two frames. Though we have seemingly removed the background, this approach will only work for cases where all foreground pixels are moving and all background pixels are static.
A threshold "Threshold" is put on this difference image to improve the subtraction. Model Equation can be given by:

$$\text{mod}(P[F(t)] - P[F(t+1)]) > T \qquad (3.1)$$

Where,T is Threshold ,F(t) and F(t+1) are two Consecutive frames with possible change in pixel(s) intensities Which means that the difference image's pixels' intensities are 'threshold' or filtered on the basis of value of Threshold. Also, the accuracy of this approach is dependent on speed of movement in the scene. Faster movements may require higher thresholds [17].

3.3.3 Frame extraction

Every video or animation we see on our television, computer, phone, tablet or even at the movie theater is made up from a succession of still images. These images are then played one after the other several times a second which fools your eye into thinking the object is moving. Greater the speed of displaying images will result in greater smooth transition of objects in the video. Most movies and TV programs are filmed at around 24-30 images per second, each individual image is called a frame which is where you see the term frames per second (FPS). A video file on a computer simply stores all the frames together and plays them in order, and the total frames stored for a typical movie reaches into the hundreds of thousands. If we want to extract a succession or range of frames or even all frames from a short video clip, capturing the images one at a time is incredibly inefficient and time consuming. For that purpose, we need a program that can extract however many video frames you want and save them to image files automatically, like jpg or png [18].And the same program is the module

called frame extraction which extract frames from the inputted video.

3.3.4 Feature extraction

FE is an important component of every Image Classification and Object Recognition System. Mapping the image pixels into the feature space is known as feature extraction [19]. For automatic identification of the objects from remote sensing data, they are to be associated with certain attributes which characterize them and differentiate them with each other. The similarity between images can be determined through features which are represented as vector [19]. FE is concerned with the extraction of various attributes of an object and thus associate that object with a feature vector that characterize it. FE is the first step to classify an image (frame in our case) and identify the objects. The various contents of an image such as color, texture, shape etc. are used to represent and index an image or an object. Therefore, we have considered the shape as a feature among the features of objects in the Image. When the bounding box is been drawn around the object after the previous steps then its width and height are considered as features and are to be saved in dataset which further provided for classification process. As an Feature the Height and Width of the Rectangle around the objects are been taken. And this features are been written to Dataset so that classifier can use it to build model and also as an Training Testing Dataset by splitting it.

3.3.5 Dataset preparation

Image frame(s) are an essential element of object recognition research. They are required for learning visual object models and for testing the performance of classification, detection, and localization algorithms. This contextual information might prove useful in recognizing some object classes; however, the risk is that the system may fail to distinguish the object from the context and thus show poor generalization to other environments, for example recognizing a car in a street vs. in a field. The most important note should be taken while preparing dataset is the noisy value or missing value which are being retrieve while filling out the dataset. Also, as a part of preprocessing various operations can be done. In our project as a preprocessing purpose morphological operation are being carried out [20].As an Dataset CSV file is being created which is further provided as an input to the classifier for the Evaluation purpose. Dataset contain Width, Height and Class Label as an Attribute.

3.3.6 Classifiers

Three Classifiers are being used in this system for Comparison purpose so that classifier providing the best Accuracy Detection rate can be used further.

1. AdaBoost

   AdaBoost, short for Adaptive Boosting, is a machine learning meta-algorithm formulated by Yoav Freund and Robert Schapire, who won the 2003 Globel Prize for their work. It can be used in conjunction with many other types of learning algorithms to improve performance. The output of the other learning algorithms ('weak learners') is combined into a weighted sum that represents the final output of the boosted classifier. AdaBoost is adaptive in the sense that subsequent weak learners are tweaked in favor of those instances misclassified by previous classifiers. AdaBoost is sensitive to noisy data and outliers. In some problems it can be less susceptible to the overfitting problem than other learning algorithms. The individual learners can be weak, but as long as the performance of each one is slightly better than random guessing, the final model can be proven to converge to a strong learner.

   It is the classifier which is being import from sklearn package in the python. also, various sub packages like train test split, accuracy score and classification report can be import in the system. Confusion matrix is being used as a Evaluation criteria while adaboost classifier evaluates the dataset. The data which must be feed to Adaboost must be qualitited in nature. Also, Outliers and Noisy data must be avoided while feeding data to the adabost classifier.

2. SVM

   A Support Vector Machine (SVM) is a discriminative classifier formally defined by a separating hyperplane. In other words, given labeled training data (supervised learning), the algorithm outputs an optimal hyperplane which categorizes new examples. In two dimentional space this hyperplane is a line dividing a plane in two parts where in each class lay in either side. One more parameter is kernel. It defines whether we want a linear of linear separation.

   The Regularization parameter (often termed as C parameter in pythons sklearn library) tells the SVM optimization how much you want to avoid misclassifying each training example. And finally last but very important characteristic of SVM classifier. SVM to core tries to achieve a good margin. A good margin is one where this separation

is larger for both the classes. Images below gives to visual example of good and bad margin. A good margin allows the points to be in their respective classes without crossing to other class. It is also being import from sklearn package in the python. also, various sub packages like train test split, accuracy score and classification report can be import in the system. Confusion matrix is being used as a Evaluation criteria while SVM classifier evaluates the dataset. The data which must be feed to SVM must be qualitative in nature. Also, Outliers and Noisy data must be avoided while feeding data to the SVM classifier.

3. J48 Decision tree

Decision tree J48 is the implementation of algorithm ID3 (Iterative Dichotomiser3) developed by the WEKA project team. R includes this nice work into package RWeka. Behind the idea of a decision tree there is called information gain, a concept that measures the amount of information contained in a set of data. It gives the idea of importance of an attribute in a dataset.J48 algorithm is been used to create Univariate Decision Trees. It is also being import from sklearn package in the python. also, various sub packages like train test split, accuracy score and classification report can be import in the system. Confusion matrix is being used as a Evaluation criteria while J48 classifier evaluates the dataset. The data which must be feed to J48 must be qualitative in nature. Also, Outliers and Noisy data must be avoided while feeding data to the J48 classifier.

4. EXPERIMENTAL RESULTS

Given below in the table are the metrics which are used for Evaluating the Accuracy and Error percentage of the respective classifiers. Classifiers used in system are AdaBoost, Support Vector Machine(SVM), J48 Decision Tree respectively, of which SVM had achieved most Accuracy while detecting the Objects classifying them correctly.

Table -1: Classifiers Accuracy & Error Comparison

	Ada Boost	SVM(Support Vector Machine)	J48
Accuracy (%)	98.3	100	90.5
Error (%)	1.7	0	9.5

Fig -2: Comparison of Classifiers

Above in the table is the bar chart illustrating the comparison between classifiers and their Accuracy and the Error Percentage. Classifiers used in system are AdaBoost, Support Vector Machine(SVM), J48 Decision Tree respectively, of which SVM had achieved most Accuracy while detecting the Objects classifying them correctly.

4. CONCLUSION

So far about the project we have used a Background Subtraction model which uses opencv functions and involves deframing and Feature Extraction. Also various Classifiers are been used along with Dataset containing Object Features, class label and which is in CSV format. We have successfully implemented Object Detection System . We have successfully Build the Model and Trained it , so as it can be tested on the new Video and Dataset. The Classifiers are showing results and Classifying rate and Accuracy are been very surprising throughout the System. We observed that Back Ground Subtraction Technique can be Effectively used in Extracting Frame as well as Training the Model on its own. The Object detection Classification rate are quite high and less Time taking. In this Project we have considered the Object Width and Height as a Features and on which Basis model is Trained. The various feature of Object can be used to Classify and Recognise it quickly. Our System can be used with different Security areas Research in future work.

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