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An Hybrid Approach of Detection of Multiple Objects from the Videos

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ABSTRACT: This research paper proposes a novel method of detection of multiple objects from the video streams using SURF feature detection algorithm. One of the main advantage of the work done in this paper is the simplicity of the algo developed. The simplicity lies in the process of adding any object with ease and no prior knowledge of the object is a prerequisite for the machine to identify or recognize the object. The scope and application of this paper does not simply end with the detection or recognition of the object, but the undeniable fact that machines can finally look into the real world closer to how human beings view it. This work serves as a generic application which can be further transformed into object specific detection application, for instance traffic cameras connected to a central server may use a modified version of the detection application with back-end processing to detect, recognize and track the registered vehicles, which makes the search for the required vehicle much more easier than the traditional lookout. The precision graph for different objects along with the average precision graph for multiple objects is also plotted from where it can be justified that there is detection of multiple objects from the videos captured. Thus, the proposed method shows the efficacy of the methodology developed by us which can be verified from the simulated results, both in graphical form as well as in the form of quantitative results depicted in the form of numerical tables.

KEYWORDS: Image, Object, Multiple, Video, Detection, Surveillance, Cluster, CNN, KNN, Identification, Tracking, Shadow, Logical Reasoning, Multiple Objects, k-means, Segmentation, Histogram, Foreground, Background.

I. ORGANIZATION OF THE RESEARCH PAPER

The organization of the paper is developed as follows. A brief introduction to the related work is presented in the introductory section I. The section II presents a overview of the literature related to the work done by various others in the relevant field till date along with their advantages & dis-advantages. The existing model available is depicted in the section III. The section IV explains the proposed methodology, whereas the section V gives a brief description of the multiple object detection methods. The experimental results using the OpenCV software is presented in the section VI. Finally, the results, discussions & the final summary of the paper along with the concluding remarks of the research work done is presented in the Section VII. This is followed by a exhaustive number of references that were used in the development of this review paper.

II. INTRODUCTION

Multiple object tracking consists of detecting and identifying objects in video. In some applications, such as robotics and surveillance, it is desired that the tracking is performed in real-time. This poses a challenge in that it requires the algorithm to run as fast as the frame-rate of the video. Today's top performing tracking methods run at only a few frames per second, and can thus not be used in real-time. Further, when determining the speed of the tracker, it is

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common to not include the time it takes to detect objects. We argue that this way of measuring speed is not relevant for robotics or embedded systems, where the detecting of objects is done on the same machine as the tracking. We propose that one way of running a method in real-time is to not look at every frame, but skip frames to make the video have the same frame-rate as the tracking method. However, we believe that this will lead to decreased performance [100].

When a video contains multiple moving objects that we wish to track, we refer to this as multiple object tracking. In some sense, the task is an extension of object detection, since in addition to detecting objects, we need to connect detections between frames to get a consistent tracking. Object detection is still an unsolved problem, and the most powerful methods are limited by their speed. Adding tracking capabilities on top of the detector usually slows down the algorithm further. Because of this, multiple object tracking is difficult to do in real-time, since the best algorithms can only analyse a few frames per second at best, even on powerful hardware. For such algorithms to run in real-time, it would be necessary to skip multiple frames in order to prevent an ever-increasing delay. To the best of our knowledge, not much work has been done to investigate how sampling of frames would affect the tracking performance [100].

As the name suggests, multiple object tracking consists of keeping track of objects in a video as they move around. A formal description would be: for each frame in a video, localize and identify all objects of interest, so that the identities are consistent throughout the video. In other words, a good model has to accurately detect objects in each frame, and provide a consistent labelling of them. Challenges arise when objects are partially or completely occluded, or temporarily leave the field of view, since ideally the objects should keep their former IDs when reappearing. Furthermore, objects whose paths intersect might confuse the model and cause it to erroneously switch their IDs [100].
Different scenarios exist that allow for different types of models. An important distinction is that of online versus offline models. An online model receives video input on a frame-by-frame basis, and has to give an output for each frame. This means that, in addition to the current frame, only information from past frames can be used. Offline models, on the other hand, have access to the entire video, which means that information from both past and future frames can be used. The task can then be viewed as an optimization problem, where the goal is to find a set of paths that minimize some global loss function. This has been solved using linear programming and k-shortest path optimization methods. Since offline trackers have access to more information, one can expect better performance from these models. It should be noted, however, that real-time usage requires online models, as future frames are obviously unavailable. For a discussion on real-time models [100].

Models can be further categorized into single class and multiple class models. In the former, all tracked objects are of the same class, e.g. person, while in the latter, multiple classes are present, e.g. pedestrian, bicycle and car. On one hand, having multiple classes introduces the problem of classifying each object. On the other hand, this could act as a distinguishing feature when the paths of objects of separate classes intersect [100].

A greatly improved portrayal for the obvious state of items can be accomplished by finding the outlines of articles. As opposed to edges, outlines as of now give a theoretical portrayal of the picture substance and can be utilized to separate the picture into closer view articles and foundation. In addition, it is a fascinating inquiry of PC vision to separate the area of a picture in closer view and foundation, yet in addition in semantic portions [11]-[20].

Item identification in unconstrained pictures is a significant picture understanding issue with numerous potential applications. There has been little accomplishment in making a solitary calculation that can recognize discretionary articles in unconstrained pictures; rather, calculations commonly should be tweaked for every particular item. Therefore, it commonly requires an enormous number of models (for unbending articles) or a lot of human instinct (for nonrigid items) to build up a powerful calculation [21]-[30].

In the field of video & image processing applications, colored object tracking plays a vital role [1]. The coloured object detection and tracking are both most dynamic research area with number of applications including computerized video surveillance, robotic vision, traffic detection, vehicle navigation, object identification, in defense establishments, in industrial zones and much more. It should be noted that a video signal is having both spatial as well as temporal information, whereas an image is having only spatial information as such a video is considered as a sequence of images, each is called as frame [31]-[40].

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There are both moving and static object in sequence of images. Moving object which can be a person, bird, vehicle etc. also called as foreground object and background object can be the static things. Detecting the semantically meaningful moving object is the task of moving object detection [2]. To track object, we must first detect an object. Tracking is carried out to check the presence of object in videos. Basically, there are three steps included in object tracking. Object detection, classification and tracking of an object [41]-[50].

It is a well-known concept that videos are always 2 dimensional in nature, whereas an image is 2 dimensional in nature. In general, video is defined as - basically the time wise collection of image frame with audio data. Frame is the unit of the video. Video processing is the image by image processing. As per the motion detection and tracking concern its deals with frames. For the motion detection frame processed one by one from video [51]-[60].

Identifying the moving object is the basic operation in video. As object is detected we can operate that object by using their characteristic & parameter. In any video, for the processing we have to follow the 3 important steps, viz., moving object identification, in all the frames object has to be tracked wherever that object presents in that frame & finally, the detected object has to be analyzed to take suitable action as per the requirement like behavior classification, velocity estimation & other characteristics [61]-[70].

III. LITERATURE SURVEY

A large number of researchers have worked on the chosen topic [1]-[100]. In this research paper, some relevant ones which have been used are being cited & referenced. Multiple objects in the videos & its identification with tracking plays a very important role in the modern-day surveillance mission, especially in the country's security point of view to identify the terrorists as it will be very difficult to identify from black & white scenes [71]-[80].

Machine learning is getting computers to program themselves. The process in machine learning is automated when programming is automatic. Writing Software is very difficult without good developers. It minimizes the work of people and increases data work. Machine learning makes program accessible and data are executed to create a program and they are used in traditional programming. Machine learning is like gardening. Seeds are algorithm, nutrients are data, the gardener is we and plant are the program. Computers has the ability to learn without being explicitly programmed [81]-[90].

It is developed by the recognition of patterns and from the computational theory (artificial intelligence), machine learning discovers the study and structure of algorithm that learn from and make estimate on date and is employed in a domain of calculating tasks. Example applications include email filtering, detection of network stalkers or malicious insiders working towards a data breach, learning to rank and computer vision. The existing model has the following limitations & are overcome by using SURF algorithm. SURF is fastest and it is used for object recognition [91]-[100]. The existing models available in the literature used a large number of databases such as [1]-[10]

- The Existing model uses roughly 700 images per object for positive detection with higher accuracy, thereby making a huge object sample space.
- The trained object is neither 2-Dimensional nor 3-Dimensional angle tolerated.
- Human intervention is required for the training process, thus making object identification and recognition a very expensive task both in time and resource.
- No sustainable method of input for the computers in terms of image frame or video has been developed yet; but the scope and need for it increases day by day, existing recognition system cannot fulfill the task.
- Template matching is predominantly old and weak compared to feature selection and extraction.
- Overlapped objects are not properly recognized with the use of existing system, which is a serious issue in real time object detection.

Dah-Jye-Lee et.al. [72] introduces Evolution – Constructed (ECO) features are object detection approach using feature constructed method. Here features are built automatically to showcase series of transform of high discriminative by using predefined genetic algorithm but other approaches of object recognition require human intervention to build the

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features. ECO features have ability to produce specialized features from dissimilar objects and it has no restriction to any sort of image sources. ECO features serve better with hand – crafted state – of – the art object recognition algorithm.

An ECO feature also contains visualization of features and enhancements made to algorithm. Joa Carreira et.al. [73] proposed a recognition on a pipeline that incorporates numerous figure-ground hypotheses with huge object spatial support based on object-class segmentation which is obtained by bottom-up computing techniques that do not maneuver knowledge of particular categories, and subsequent prioritization based on linear estimation of the spatial overlap between the putative class and image segment hypotheses.

It uses a feed-forward fashion from which a good object segments are obtained. Other than focusing on a one-vs.-all winning margin that may not sustain the ordering of segment qualities inside the non- maximum (non-winning) set, this research methodology constructs a globally persistent ranking with immediate ties to segment quality, thus to the level of whole object or part hypotheses are subjected to spatially overlap under the ground truth. Dah-Jye-Lee et.al. says that current method depends on human experts. In this paper it automatically finds features that can be used to classify fish into a taxonomy based on the method Evolution-Constructed (ECO) features. By using ECO features can easily change to new environments and fauna. 99.4% of classification rate is achieved in ECO features.

Hiroshi Motoda et.al. [74] proposed Feature selection is a process that feature space is optimally reduced to a certain criterion and the subset are chosen from the original features. Feature extraction is a process that the new features are created and are used either in isolation or in combination. All try to improve the accuracy, visualization and comprehensibility of learned knowledge. Basic approaches for this three are reviewed giving pointer to reference for further studies.

Beau Tippetts et.al. in [72] developed a new feature construction methodology for the general object recognition system in videos with 3D concepts. Joao Carreira et.al. [73] did a novel object recognition system by using the sequential figure-ground methods and implemented it on all types of video images. The feature selection, extraction and construction of objects in the videos was also worked by Motoda et.al. in [74].

The use of segmentation as selective search for object recognition process in any type of video images was developed by Gevers et.al. in [75]. Efficient hierarchical graph-based video segmentation methodology was developed by Grundmann et.al. in [76].

Video object segmentation and tracking framework with improved threshold decision & diffusion distance algorithm development was carried out by Chien et.al. in [77]. Video-based tracking, learning, and recognition method for multiple moving objects, their tracking & other subsidiary process was developed by Sakaino et.al. in [78]. Pulare et.al. [79] worked on the hardware implementation of real time multiple object detection and classification of HEVC Videos on the real time platform. An hybrid video object tracking in H.265/HEVC video streaming was developed by Giil et.al. in [80].

IV. EXISTING MODEL

The Existing model uses either classifiers or templates to match the sample object with the object in the scene, the current system achieves an acceptable degree of accuracy in detection or identification of the object [76].

Template matching or the use of classifiers is the simplest way to achieve object detection or recognitions in the machines. The source image is converted into matrix for further transformations and application of filters.

Use of appropriate filters and matching the matrix coordinates with the template yields the position of object in the source image, provided a sample object image already.

The above system can be scaled for identifying multiple objects, but the use of classifiers or templates is

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computationally expensive if done for each frame of the source video or multiple images for multiple objects. The disadvantages of the system are as follows

- It requires human intervention to train the system to detect and identify the objects
- Higher degree of accuracy is not obtained with the current system
- Intolerant to angle variance
- Large sets of XML data generated by the training images
- The entire object should be visible in the scene for it to be detected

V. PROPOSED METHODOLOGY

In the proposed methodology for the detection of multiple objects in the videos, first we have to give the raw image or the video as the input to our algorithm, then the algorithm what we have proposed uses a list of module operations such as feature extraction, creating a descriptor, feature detection from multiple scenes using machine learning concepts & finally, classifying the objects based on each frame of the input given.

The proposed block-diagram shown in the Fig. 1 gives a clear cut picture of how the process is being designed by us in the detection of multiple objects from the videos. The system model makes use of 4 modules, viz.,

- Feature Extraction from the object image
- Creating a descriptor for the object image
- Feature detection from the scene image for single object
- Feature detection from the scene image for multiple objects

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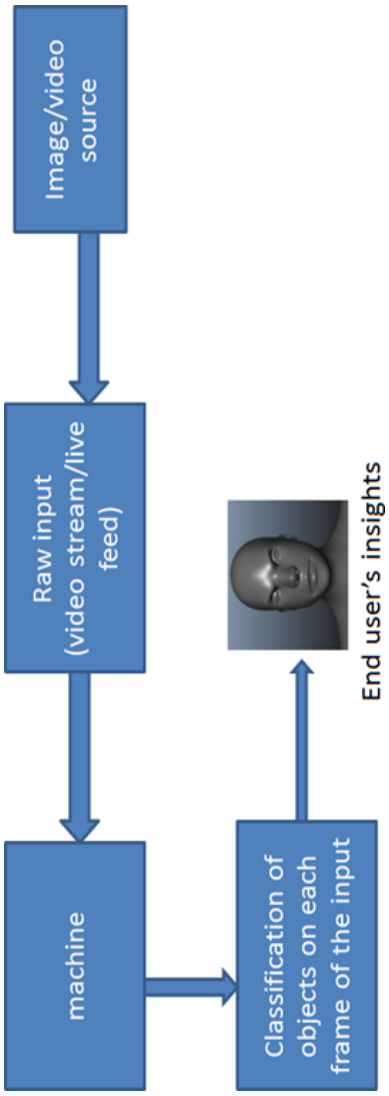

Fig. 1 : System architecture of the proposed algo

The above Fig. 1 shows the system architecture how the raw input frame is transformed into a useful data without the user having to analyze the footage for hours.

VI. MULTIPLE OBJECT DETECTION

The proposed methodology as depicted in the block diagram shown in the Fig. 1 is explained one after the other in 4 modules after which the multiple objects can be detected in the captured videos.

Module 1 : Feature Extraction from the object image
A pre defined object is used as training image for the descriptor. From the image, the key points are extracted. These keys points are used to generate a descriptor which is later used with the matcher to match key points with the scene image.

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Module 2 : Creating a descriptor for the object image
The descriptor for the training object is obtained using the extracted key points. A KN matcher which is a K-neighborhood matcher is used for key points matching. Number of neighbors is fixed as 2.

Module 3 : Feature detection from the scene image for single object
The camera view is opened using the OpenCv functions and each frame is fetched and converted into matrix from which the key points are extracted and are stored in a vector. Using the key points of the scene image, the descriptor for the scene image is obtained. Both object image and the scene image descriptors are given to KN matcher which uses a KD tree to obtain the best match for each key point of the object image in the scene image. This is repeated for every frame fetched from the camera. The object is detected when the number of inliers in the scene image is more than or equal to 10. This process is done only for a single image.

Module 4 : Feature detection from the scene image for multiple objects
Multiple objects are trained by providing the images of different object images from which the key points are extracted and are stored in vectors. The process for the multiple object detection is as same as that of a single object detection except that many descriptors are used.

VII. EXPERIMENTAL RESULTS

The algorithm written in the form of 4 modules to detect the multiple objects is converted in the Linux / Ubuntu / Fedora platform using the OpenCV software and the code is run after which the multiple object detection can be seen from the GUIs developed highlighting the multiple objects in different colours in the form of rectangles.
The Figs. 1, 2, 3 and 4 shows the result obtained for a trained object under the openCV functions.
The above Fig. 5 shows the precision graph for 5 different trained objects
Fig. 6 shows the Average precision graph of a single object, multiple objects and overlapping objects

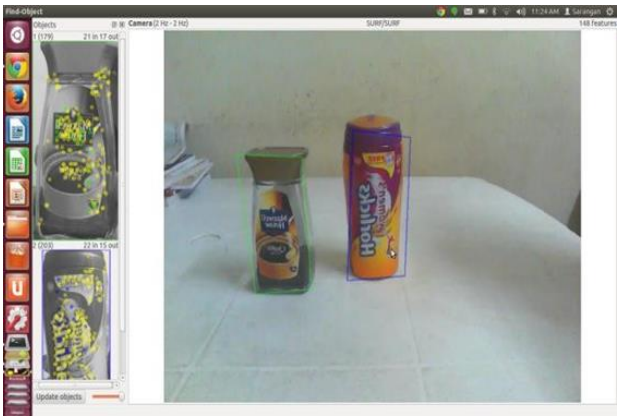

Fig. 2 : Detection of objects

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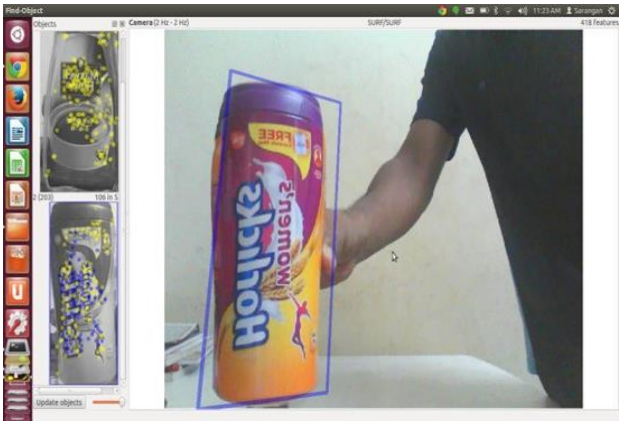

Fig. 3 : Detection of multiple objects

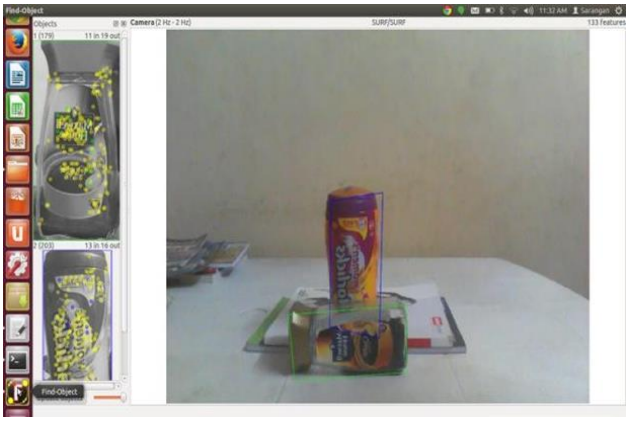

Fig. 4 : Detection of objects when they are overlapped

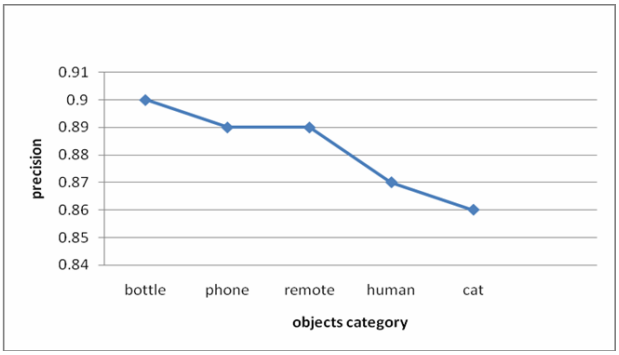

Fig. 5 : Precision graph for various objects

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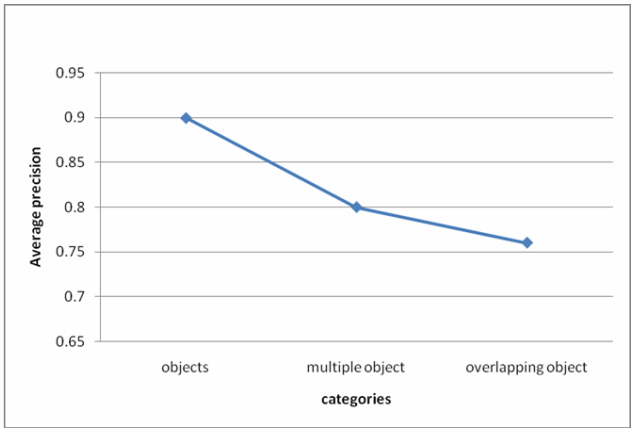

Fig. 6 : Average Precision graph for various categories of objects

VIII. SUMMARY & CONCLUSIONS

In this paper, a novel method of multiple object detection in video streams using machine learning with 4-hybrid combination of feature detection is being proposed. We have introduced a simpler yet powerful object detection method using SURF feature detection algorithm. The simplicity lies in the process of adding any object with ease and no prior knowledge of the object is a prerequisite for the machine to identify or recognize the object. The scope and application of this chapter does not simply end with the detection or recognition of the object, but the undeniable fact that machines can finally look into the real world closer to how human beings view it. This work serves as a generic application which can be further transformed into object specific detection application, for instance traffic cameras connected to a central server may use a modified version of the detection application with back-end processing to detect, recognize and track the registered vehicles, which makes the search for the required vehicle much more easier than the traditional lookout. The graphical results presented shows the power & efficacy of the methodology developed by us.

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