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A Novel Method of Foreground Object Detection using Clustering & Machine Learning Approach Used in Videos

Soumya L M, Venkatesh A, Sachin S Gowda

Lecturer, Department of Electrical & Electronics Engineering, Government Polytechnic, Mirle, Mysore,
Karnataka, India

Lecturer, Department of Electronics & Communication Engineering, Government Film & Television Institute,
Hesaraghatta, Bangalore, Karnataka, India

Lecturer, Department of Electronics & Communication Engineering, Government Polytechnic, Mirle, Mysore,
Karnataka, India

ABSTRACT: This research paper proposes a novel method for detection and segmentation of foreground objects from a video which contains both types of objects, viz., stationary and moving background objects using a new hybrid combination of clustering & machine learning approaches. Supervised learning & Unsupervised learning approaches of machine learning concepts are being used in this work for training & finding the hidden patterns in the videos. The issue of finding moving frontal area questions in an unsupervised way is a dull errand in reconnaissance checking, traffic observing framework recordings and furthermore in moving article in a static foundation video. Low-level division is done in past methodologies while in this methodology object level division is finished by separating key edges. Every single key edge are prepared to remove include vector dependent on shading and surface. At that point K-means calculation is utilized to group the pixel dependent on the component vector. Group map is produced dependent on bunching calculation. Difference and Spatial signals are figured to produce a saliency map. At long last forefront object is sectioned dependent on the saliency map produced. Image Clustering and Cluster Matrix Generation concept is used for grouping the image pixels based on the feature vector and distance vector. Computation of Contrast and Spatial Cues is also carried out & its mathematical models being developed. Next, the Saliency Map Generation and Object Segmentation is carried out using the 4-hybrid combination of CNN, KNN, LR & SVM methodologies. Feature extraction (object identification) of single objects & multiple objects is also proposed in our work. Coding is done in the Matlab environment & the simulation results are observed. From these results, a conclusion can be drawn that the supervised approach of support vector machines is more applicable for use in object recognition on satellite images than the unsupervised k-means clustering. 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, 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 section III explains the machine learning & its types. The proposed methodology adopted in the research work is shown in the section IV. The section V elaborates the mathematical modelling of the keyframe followed by the feature extraction & its model generation in section VI & in the further sections, this math model is used for the extraction process. The image clustering & cluster

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matrix generation is explained in the section 7 followed by the computation of contrast & spatial cues in section 8. The saliency map generation and object segmentation is depicted in section 9. The machine learning algorithms, viz., supervised & un-supervised algorithms are briefed up in sections 10 & 11 respectively. The overview of the experiment that is going to be conducted along with its analysis is given in section 12. The key frame extraction process is shown in the section 13 followed by the image clustering techniques in section 14. The foreground object segmentation procedure is explained in the section 15, followed by the classification of the featured & identified objects using SVM & k-means clustering approaches in section 16. Concluding remarks of the research work done is presented in the conclusion section in Section 17. This is followed by a exhaustive number of references that were used in the development of this review paper.

II. INTRODUCTION

Foreground object detection & segmentation of the objects from a video is one of the essential tasks in any type of video processing applications, that too understanding, the object-based video encoding process. Some of the commonly used approaches to extract the foreground objects from the digital images is through background suppression technique or what do you call it as the background subtraction and its variants, especially when the video is grabbed from a stationary normal camera. These concepts & approaches have been widely used in RT video processing applications, especially in the surveillance missions in the defense sectors [1]-[100].

However, the task becomes very very tedious & difficult when the background of the video contains shadows, moving objects, large number of objects, that too in a complex clustered environment where many of the objects are occluded in nature, undergoing various changes, such as illumination, lighting, changes and moved or partially hidden objects. Hence, in such cases, our research work is considered to identify the foreground (region of interest-ROI) & segment it properly using the clustering & different types of machine learning approaches using the hybrid concepts [1]-[50].

In any video, for the processing we have to follow the 3 important steps [51]-[100],

1. Moving object identification.
2. In all the frames object has to be tracked wherever that object presents in that frame.
3. Detected object has to be analyzed to take suitable action as per the requirement like behavior classification, velocity estimation & other characteristics.

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. Video tracking is the process of locating a moving object or multiple objects over time using a camera.

The incredible growth of vision-based application in recent years such as video surveillance, content-based video analysis, traffic monitoring and analysis of sports video, etc., has many problems in segmenting object of interest. Segmentation of object of interest from a video sequence is one of the basic and essential operations in computer vision. Video object segmentation has been defined as the problem of sub diving the video sequence into coherent regions with respective to features and properties of the object. Foreground object segmentation is useful for several computer vision tasks including video analysis, object tracking, object recognition, video retrieval and activity recognition [1]-[100].

A common issue in the Video Foreground Object Segmentation is categorized in two approaches, viz., the supervisory approach & the un-supervisory approach. Supervised method of object segmentation is one in which user needs to select an object area which is to be segmented. Unsupervised method of object segmentation is a technique which extracts the object without having any prior knowledge about the object. There are many approaches for supervise object segmentation whereas intensively less approaches focusing on unsupervised method of object segmentation. Unsupervised method of object segmentation is more trivial and it can be applied in many fields such as video analysis, video indexing, video retrieval and activity understanding [1]-[100].

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Recently many approaches have been developed to extract the foreground object. Gu et.al. [32] and Wang et.al. [33] proposed a video scene segmentation approaches with content coherence and contextual dissimilarity. Brox et.al. and Malik et.al. [34] propose a method based on foreground object trajectory. A series of trajectories are extracted and then processed by spectral clustering. Ochs and Brox et.al. [35] extend the trajectory method to acquire a denser foreground region. Lee et.al. [36] showed that these methods want an explicit notion of how a foreground object should look like in video data and low-level grouping of pixels, which results in over segmentation. Visual saliency has been used to form the foreground object segmentation. [37] This Method explore object-based segmentation in static image and achieve significant progress. Those methods generate multiple object hypotheses and rank hypotheses according to their scores. The model is learned for the generic foreground object using image features such as color, texture and boundary which then object category independent.

A saliency-based strategy to section the frontal area object from the unlabeled information has been proposed. First key casings are produced by utilizing the strategy [38]. At that point shading, surface highlights are removed and given as contribution to k-implies calculation. In light of the bunch produced by k-implies grouping calculation differentiates prompt and spatial signs are registered and component astutely increased to create the saliency map dependent on the strategy [39]. Saliency map demonstrates the frontal area object which is should be portioned.

Machine learning trains the system to learn from experience. Computational methods are utilized in machine learning algorithms as without relying on a predetermined equation as a model and to learn information directly from data. The performance of the algorithms adaptively improves as the number of samples available for learning increases [21]-[30]. Gu Mei Hua Wu Li et.al. in [32] worked on the energy minimization-based video scene segmentation process & created a revolution in the segmentation of the video process. In the research paper in [33], Wang et.al. did optimization of the scene segmentation process & produced good results. Similarly, Brox et.al. [34] also worked on the segmentation of objects in the video images by using long term analysis of point trajectories, which yielded good results. Ochs et.al. [35] also worked on the development of a novel hierarchical variational approach forturning point trajectories into dense regions w.r.t. the object segmentation in the video processing technology. Key segments for video object segmentation was done by Lee et.al.in [36]. In the research paper in [37], Endres et.al. worked on the category independent object proposal concepts in the video imaging which was extended by Sheena et.al. in [38] to develop a key-frame extraction by using the analysis of histograms of video frames using statistical methods by taking a large number of video images & experimenting over it. Huazhu et.al. [39] used the cluster-Based Co-Saliency Detection approaches to detect multiple objects in the video images.

IV. MACHINE LEARNING & ITS TYPES

Machine learning (ML) is the scientific study of algorithms and statistical models that computer systems use in order to perform a specific task effectively without using explicit instructions, relying on patterns and inference instead. It is seen as a subset of (AI) artificial intelligence. As shown in Fig. 1 machine learning techniques are divided into two methods and used clustering, classification & the regression approaches, i.e., [31]-[50]

- Supervised learning: model can be trained by known input and output data so that future outputs can be predicted.
- Unsupervised learning: Findings of hidden patterns or intrinsic structures in input data.

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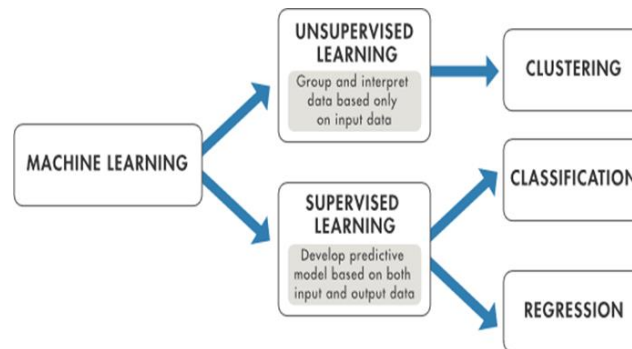


Fig. 1 : Machine Learning Techniques

The most contemporary research done by Xiaochuncao et.al. [40] and Zhang et.al. [41] proposed a technique to remove closer view object consequently with no earlier information about the item. First article like districts are sectioned as an item competitor, then based on the corresponding map between the items in the progressive casings the article division is changed over into diagram demonstrate. Correspondence map is determined between items in progressive edges dependent on their appearance and movement. At that point the briefest way calculation investigated to get worldwide ideal arrangement from the chart show. GMM is connected in iterative way to create more registered to produce a saliency map. At long last closer view refine results, when the GMM is coordinated with the outcomes, at that point the cycle gets halted and restores the frontal area object.

Lei fan et.al. [42], which focuses video segmentation, is a task of grouping pixels in successive video frames into perceptually coherent regions is achieved. Video segmentation is a useful tool for extracting relevant and interesting content from a video sequence for analysis and understanding. This is graph based approach which effectively models the data in a high dimensional feature space, which emphasizes the correlation between similar pixels while reducing the inter class connectivity between different objects. The graph model combines appearance, spatial and temporal information to break a large video sequence into semantic spatio-temporal key segments. Continuous grouping of video sequence able to extract a moving object of interest from a video sequence based on its unique properties.

Rother et.al. [43] addressed the problem of an object is segmented based on the saliency map generated. Efficient extraction of a foreground object in a problematic situation background cannot be subtracted easily. GrabCut is an extension of the graph cut approach it has iterative version of optimization. The power of the iterative algorithm is used to simplify the user interaction needed for a given quality of result. Ma and Latecki et.al. [44] endeavor to address this video object division issue by using connections between item proposition in contiguous edges. The item locale hopefuls are chosen at the same time to build a weighted area diagram.

Dong Zhang et.al [45], proposed a novel way to deal with concentrate essential items in recordings. The separated essential item areas are then used to construct object models for enhanced video division. DAG based system is investigated in this methodology for location and division of the essential item in video. Articles are spatially firm and portrayed by locally smooth movement directions. To remove the essential item from the arrangement of every single accessible proposition movement, appearance and shape properties are utilized.

To detect objects in large size images proposed in [46] is an automatic approach which was performed by calculations to show that the proposed technique provides faster recognition. A similar attempt was made in [47] to improve the accuracy of object detection in complex satellite images. GIS-based application [49] is to detect ships in high resolution satellite images. This is used for monitoring maritime activities. Using hierarchical recognition methods [48], the task of identifying type of aircraft in satellite imagery was done by comparing different approaches, a superior method was recommended.

Using active learning, the usage of support vector machine for classification in satellite images [49] which is

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shown in the algorithm can be faster and more accurate. According to [50], in the place of satellite images, infra-red images were used and a sea-land segmentation algorithm was proposed. Grayness and texture of surface were studied to arrive at a Gray Smoothing Ratio as a feature descriptor around which an algorithm was developed to classify and segment the images into sea and land.

Using CNN based approaches focuses on retrieving images from high resolution satellite images, were multiple datasets used with strong CNNs to observe strong improvement over existing approach. In a large set of image data performing surface object recognition, two methods based on CNN and SVM are proposed and compared [51] and found CNN had better performance. Isolated airstrips are identified in satellite images using SVM [52] after preprocessing the images the algorithm providing an accuracy of 94%.

Finally, the Unsupervised Pixel-Level Foreground Object Segmentation via Shortest Path Algorithm approach was put forth to the globe by Xiaochun et.al. in [40] & implemented on different types of videos. The segmentation of video objects using the concepts of shortest path algorithm was developed by Bao Zhang et.al. in [41]. A group of researchers led by Lei Fan et.al. proposed a Graph-based Framework for video object segmentation and feature extraction process in feature space in [42], in which they took a large number of examples & proved the same. Carsten Rother et.al. [43] used the Interactive Foreground Extraction Using Iterated Graph Cuts method to separate the foreground & background objects in the video imaging. Similarly, Ma et.al. in [44] developed a maximum Weight Cliques with mutex constraints & used that developed process for video object segmentation present in the 3D videos. Dong Zhang et.al. [45] and their group worked on the Video Object Segmentation using the concepts of Spatially Accurate and Temporally Dense Extraction of the Primary Object Regions present in the video streams in an excellent transactions paper. In [46], Tsutsumi et.al. proposed a hybrid approach of video indexing & machine learning concepts for the rapid indexing and highly precise recognition of objects in video streaming. Sina et.al. [47] also developed the object recognition concepts, but they worked on the satellite images with using some biologically inspired computational methodologies. Similarly, another group extended the work of videoing to the aeronautics section and developed novel approaches for the detection / recognition of any type of aircrafts in the satellite images. Sun developed active learning algorithms with SVM concepts in remotely sensed image classifications in [49]. The work was extended by Veni et.al. [50] w.r.t. the image processing edge detection improvements and its applications in majority of the engineering applications.

A sea-land segmentation algorithm (iterative) based on gray smoothness ratio concepts was developed by Huihui et.al. in [51]. Ishii et.al. in [52] did the surface object recognition using convolution neural networks with classification using the support vector machine in a group of Landsat 8 images & compared with the work done by others to prove the efficacy of their algorithm development.

V. PROPOSED METHODOLOGY

The main objective of the proposed framework is to detect the foreground object using the clustering approach & a hybrid combination of machine learning techniques. The issue of finding moving frontal area questions in an unsupervised way is a dull errand in reconnaissance checking, traffic observing framework recordings and furthermore in moving article in a static foundation video. Low-level division is done in past methodologies while in this methodology object level division is finished by separating key edges. Every single key edge are prepared to remove include vector dependent on shading and surface. At that point k-means calculation is utilized to group the pixel dependent on the component vector.

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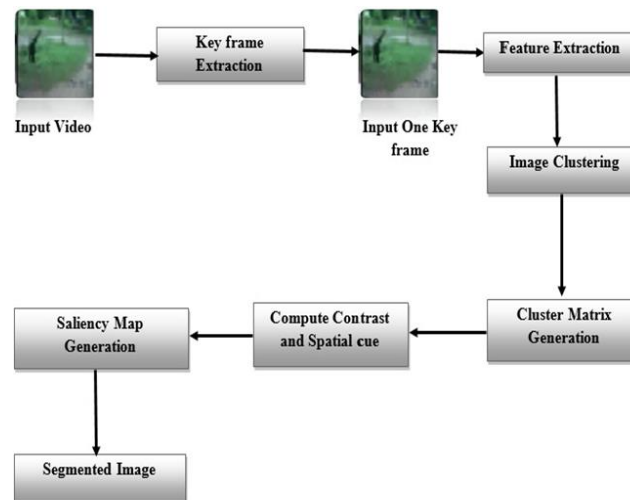


Fig. 2 : Proposed Architecture

Group map is produced dependent on bunching calculation. Difference and Spatial signals are figured to produce a saliency map. At long last forefront object is sectioned dependent on the saliency map produced. The Fig. 2 shows the proposed architecture for segmenting foreground objects from video in an unsupervised method of object segmentation. In this chapter the system is implemented using FBMS dataset. It is an extension of the BMS dataset with 33 additional video sequences. A total of 720 frames are annotated. The pictorial diagram also shows the overall block-diagram of the proposed approach used for the foreground object detection in our research work, the diagram explains step by step process for the detection phenomenon's.

VI. MATHEMATICAL MODELING OF KEYFRAMES

Keyframe is the reference frame of the video sequence which is representative and able to reflect the summary of a video content. The key-frame is used to express the main content of video data clearly and reduce the amount of memory needed for video data processing and complexity greatly. Video data which contains multiple shots it is necessary to identify individual shots for key- frame extraction. Visual features and temporal information are used to determine the keyframe. Key frames are extracted to reduce the number of frames in the given video sequence. Key frames are extracted based on setting a threshold value and comparing all frames with the threshold value, frames which satisfy the threshold condition are considered as key frame. Threshold T is computed using Eq. (1) as

$$T = \mu + \sigma \quad (1)$$

where, μ and σ is mean and standard deviation of absolute difference. The following are the steps for key frame extraction. The algorithm steps are explained as below.

1. Extract frames one by one
2. Compute histogram difference between two consecutive frames
3. Calculate mean and standard deviation of absolute difference
4. Compute threshold
5. Compare the mean with threshold
6. If it is greater than threshold set it as a key frame
7. Continue till end of a video.

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VII. FEATURE EXTRACTION & ITS MODEL

Feature extraction is the process of extracting the features of a single object or that of multiple objects present in any image or in an video stream using different types of approaches. Feature extraction includes minimizing the amount of resources used to denote a huge set of data. When performing analysis of complex data one of the major problems is the number of variables involved. Exploring with a huge number of variables generally requires a more amount of energy and power. This process is containing a feature vector containing color and texture features. Gabor filter is employed to get a feature vector with texture features. Distance vector for each pixel is also calculated and original key frame is resized for further processing. Distance vector is calculated based on the Euclidean distance. The Euclidean distance is given in the Eq. (2).

$$d(p, q) = \sqrt{(q_1 - p_1)^2} + \sqrt{(q_2 - p_2)^2} + \dots + \sqrt{(q_n - p_n)^2} \quad (2)$$

where, p and q are the Euclidean vectors.

VIII. IMAGE CLUSTERING & CLUSTER MATRIX GENERATION

Image clustering is the task of grouping individual pixels to the corresponding cluster based on the color, texture feature of pixels and distance vector is also calculated to find out the centroid of the image cluster. Image clustering can be achieved using many algorithms for grouping similar pixels in an unsupervised manner. In this chapter Centroid based clustering is done to group the image pixels based on the feature vector and distance vector. k-means algorithm is applied to cluster the image. The following are the steps of k-means algorithm.

1. Select k.
2. Select k points as an initial centroid.
3. From initial centroid and observation value calculate Euclidean distance.
4. Assign to the cluster based on the maximum distance.
5. Update the initial centroid based on the cluster assignment.
6. Again compute Euclidean distance for updated centroid and next observation.
7. Repeat the steps until all observations fit to the k cluster.

Cluster matrix is generated using K-means clustering algorithm. It is one of the simplest unsupervised clustering algorithm and its steps shown above. The grouping is done by minimizing the sum of squared distance between items and corresponding centroid. Euclidean distance for K-means algorithm is calculated using Eq. (2) and cluster centroid is updated using Eq. (3)

$$cp(x_1, x_2, \dots, x_n) = \frac{\sum_{j=1}^n x_1}{n}, \frac{\sum_{j=1}^n x_2}{n}, \dots \quad (3)$$

IX. COMPUTATION OF CONTRAST & SPATIAL CUES

In this section, the computation of the contrast & the spatial cues is presented along with the mathematical model which is used in the coding approaches to observe the outputs. The contrast cue and spatial cue are called as global cues. The biological vision system is sensitive to contrast in visual signaling. So saliency of the pixels its color contrast to all other pixels in the image is well defined in Eq. (4) as

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$$S_{CC}(I_k) \propto \sum_{\forall I_i \in I}^n D(I_k, I_i) \quad (4)$$

where $D(I_k, I_i)$ is the color difference metric between pixels I_k and I_i in Lab color space. Pixels with same color have the same saliency value based on the equation defined in color space. To compute same color saliency pixel value another equation is defined in Eq. (5).

$$S_{CC}(I_k) \propto \sum_{j=1}^n f_i D(C_i, C_j) \quad (5)$$

where C_i is the color value of pixel I_k , n is the number of distinct pixel colors and f_j is the occurring probability of pixel color C_j in the image I . The color difference metric is proposed as a Gaussian system as given in Eq. (6) as

$$D(C_i, C_j) = 1 - e^{\frac{-d(C_i, C_j)^2}{2\sigma}} \quad (6)$$

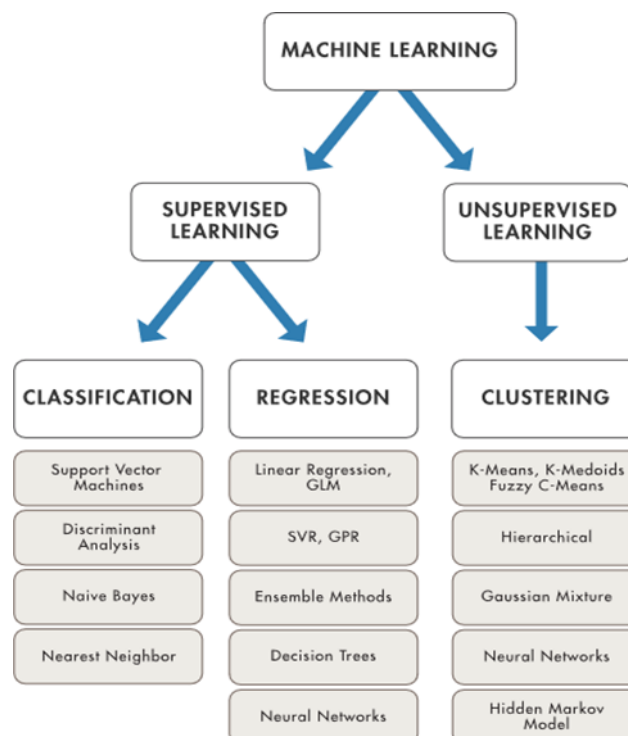


Fig. 3 : Machine Learning Algorithm

Spatial cue information can be used to distinguish foreground and background in the given frame. The pixels of salient object often lay more compactly and the pixels of background often distribute more dispersedly. The colors distributing more compactly would have higher probability belonging to the salient object. Spatial cue is defined in Eq. (7) as

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$$U_{sv}(I_k) \propto \frac{1}{m} \sum_{j=1}^n \left(x_{c_l}^{(i)} - x_{c_l} \right)^2 + \left(y_{c_l}^{(i)} - y_{c_l} \right)^2 \quad (7)$$

where c_l is the color value of pixel I_k m is the number of pixels that have color value $(x^{(i)}, y^{(i)})$ is the coordinate of one of these pixels and (x_{c_l}, y_{c_l}) is the average coordinate of these pixels. $U_{sv}(I_k)$ represents the degree of non-salient.

X. SALIENCY MAP GENERATION AND OBJECT SEGMENTATION

Saliency map is generated to segment the foreground object. Saliency map is generated by computing spatial cue and contrast cue. Both cues are computed and element wise multiplication is done to generate the saliency map. Element wise multiplication notation is given in Eq. (8) as

$$z = x.*y \quad (8)$$

There are more numbers of machine learning algorithms under supervised and unsupervised learning, where each has different learning approach.

Literature review was performed to analysis the existing learning algorithms and to choose the suitable supervised and unsupervised method for object identification in an image. It is a process of trial and error by selecting one among the machine learning algorithm, which also a trade-off between specific characteristics of the algorithms as shown in Fig. 4 such as the 4 points given by speed, memory & the accuracy as

- Speed of training
- Memory usage
- Predictive accuracy on new data
- Interpretability

Let's take a closer look at the most commonly used classification and regression algorithms. Further the Fig. 4 also explains the use of 4 specific characteristics of the algorithm that we have developed.

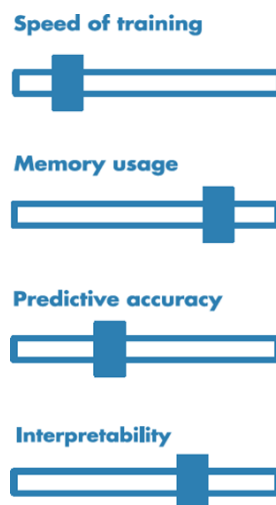


Fig. 4 : Specific characteristics of the algorithms

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XI. SUPERVISED ALGORITHMS IN ML

Various supervised learning algorithms for object recognition were identified during review of literature. Kausar et.al. [53] did the automatic recognition of isolated airstrips in multiscale satellite images using radon transformation & used the SVM concept to do the classification process along with Cortes et.al. in [54]. The most commonly used algorithms are listed below.

1. Support Vector Machines (SVM): Support vector machine is vector based method, in order to perform classification [53] the boundaries between the classes in a feature space are identified using the training data.
2. Convolutional Neural Networks (CNN) : The Convolutional neural networks are feed forward networks which perform the pooling and convolution calculations alternatively for multiple times [54].
3. Logistic Regression : Logistic regression is a statistical method for binary classification that uses a sigmoid function. The coefficients for the function are generated from the training data.
4. k-Nearest Neighbors (k-NN) : k-Nearest neighbors is an instance based learning method where the classification is based on the closeness to the majority of the instances.

There have been multiple studies where the researchers investigated how several supervised algorithms performed in object recognition. Various supervised algorithms were evaluated on multiple performance measures. It was clear that the performance of logistic regression was poorer compared to other methods. On comparing k-NN and SVM on image classification, it was found that SVM outperformed k-NN by a slight margin. Based on these observations, Support Vector Machine was selected as the supervised learning algorithm to be implemented.

XII. UNSUPERVISED ALGORITHMS IN ML

Under unsupervised methods, the various unsupervised learning methods can be categorized into the following. The IP group led by Bishop et.al. worked on the Pattern Recognition & used the Machine Learning approaches for the refurbishments of the video imaging process in [55].

Similarly, Subbiah et.al. & their group [56] also worked on the image classification through integrated k-means algorithm and used the k-clustering approaches for the classification process.

- Clustering – Clustering [55], [56] involves grouping the instances into subsets called clusters based on the similarities they share.
- Anomaly detection – Anomaly detection involves the identification of instances which do not fit into the patterns obtained from rest of the instances.

Anomaly detection [57] was found to work well in applications where a large portion of the data has some similar qualities and few instances deviate from this. The deviating instances can be identified well using anomaly detection. This method is not suitable to classify instances of roughly the same size. Clustering, on the other hand, partitions the data into regions based on similarities [58]. There exist several implementations of clustering. Several clustering methods were found in the literature which include k-means [59], branch and bound methods [60], and graph based clustering methods [61]. K-Means clustering was found to be the most widely used approach and also effective in generating reliable clustering in most practical applications [56]. As a result of this review, it was determined to select k-means clustering as the unsupervised algorithm for experimentation.

Support vector machines and k-means clustering were chosen as the two algorithms for which the performance was to be evaluated. MATLAB implementations for these algorithms were used in the experiment.

XIII. EXPERIMENTAL ANALYSIS

The dataset used for the development of the proposed system is Freiburg-Berkeley Motion Segmentation Dataset. It is an extension of the BMS dataset with 33 additional video sequences. A total of 720 frames is annotated. The data set contains ground truths and preprocessed video frames. This Freiburg-Berkeley Motion Segmentation Dataset is an open source and publically available for all research purposes. The dataset has been invented by scholars of the University of Freiburg.

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XIV. KEY FRAME EXTRACTION

Keyframes are extracted to reduce the number of frames in the given video sequence. Keyframes are extracted based on setting a threshold value and comparing all frames with the threshold value, frames which satisfy the threshold condition are considered as the key frame. The Figs. 5 and 6 shows the key frame extraction and it stored in a separate folder.



Fig. 5 : Threshold Calculation

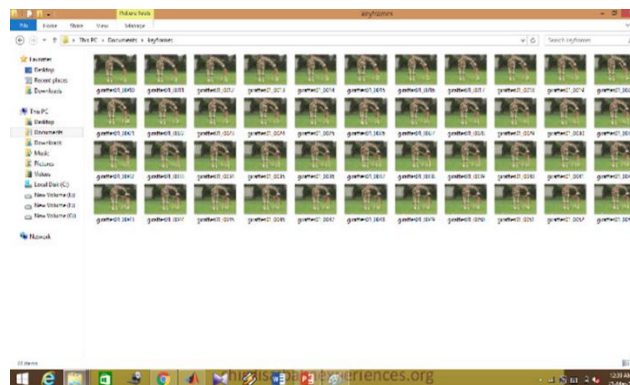


Fig. 6 : Extracted Frames are stored in Separate Folder

XV. IMAGE CLUSTERING

Image clustering and categorization is a means for high-level description of image content. The goal is to find a mapping of the archive images into classes (clusters) such that the set of classes provide essentially the same information about the image archive as the entire image-set collection. This procedure is containing an element vector containing shading and surface highlights. Gabor channel is utilized to get an element vector with surface highlights. Separation vector for every pixel is additionally determined and unique key casing is resized for further handling. Image clustering is done using k-means algorithm. This algorithm clusters n objects based on attributes into k -partitions, where $k < n$. cluster bin number is given to cluster the pixels. The grouping k-means algorithm is done by maximizing the sum of squared distance between the items and the corresponding initial centroid. In this clustering process, 2 steps are required, i.e.,

- A. Cluster Matrix Generation
- B. Computation of Cues and Saliency Map Generation

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A. Cluster matrix is generated to cluster each and every individual pixel based on the k-means algorithm. Based on the number of bins and feature vector, cluster matrix is generated.

B. The contrast cue is computed based on the Eq. (4) and it is normalized between 0 and 1 based on the Gaussian normal distribution. The spatial cue is computed on the Eq. (7) and it is also normalized between 0 and 1 based on the Gaussian normal distribution. It is computed based on cluster index, bin number, distance vector and width of the frame. And it is stored in an array. Saliency map is generated based on the contrast cue and spatial cue. The global cues are combined to produce a saliency weight array for generating saliency map. Cluster map, saliency weight array and bin number are given as an input to generate saliency map.

XVI. OBJECT SEGMENTATION

In computer vision, image segmentation is the process of partitioning a digital image into multiple segments. The goal of segmentation is to simplify and/or change the representation of an image into something that is more meaningful and easier to analyze. The item division is done dependent on the saliency map created and it is additionally standardized to deliver fine aftereffects of article division. The Fig. 7 demonstrates the single item division, by figuring contrast and spatial prompt. In light of the cue single saliency map is created to portion the article.

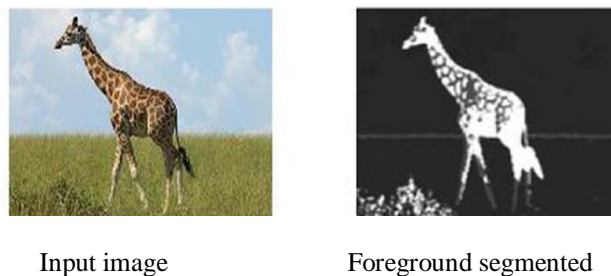


Fig. 7 : Single Object Segmentation

The Fig. 7 demonstrates the numerous item division on consecutive keyframes. Differentiation and spatial prompts for all edges are figured and consolidated component carefully to create a saliency map. In view of the saliency map produced item is portioned on successive keyframes.

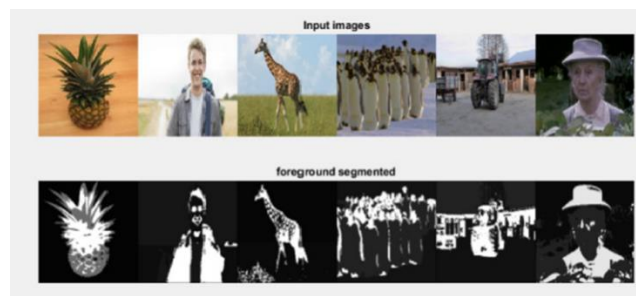


Fig. 8 : Multiple Object Segmentation

The evaluation of the segmentation process is carried out as follows. The dataset used for the development of the proposed system is the famous dataset given by the Freiburg-Berkeley Motion Segmentation Dataset. It is an extension of the BMS dataset with 33 additional video sequences. Dataset is evaluated based on proposed algorithm. The Fig. 9 shows the performance evaluation for the dataset which has been used for developing the proposed system. It also shows that the proposed system produces average precision, recall and with a f-score of 83 %, 92 % and 87 %. The

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accuracy of the system is about 95.43 %.

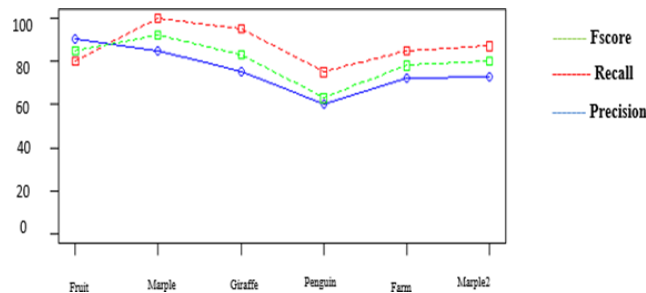


Fig. 9 : Performance Evaluation

The proposed system is available dataset ECSSD evaluated on publicly and MSRA and their performance and results are given in Figs. 6, 7, 8, 9 & 10 respectively.

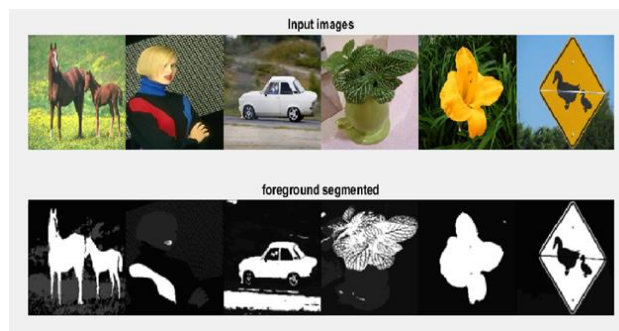


Fig. 10 : Results of ECSSD Dataset

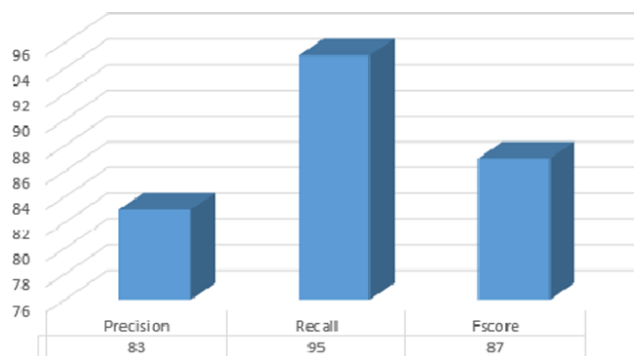


Fig. 11 : Evaluation of ECSSD Dataset

The results and evaluation of ECSSD Dataset shows that the system produces precision of 83%, recall of 95%, f-score of 87% and accuracy of 94.01%.

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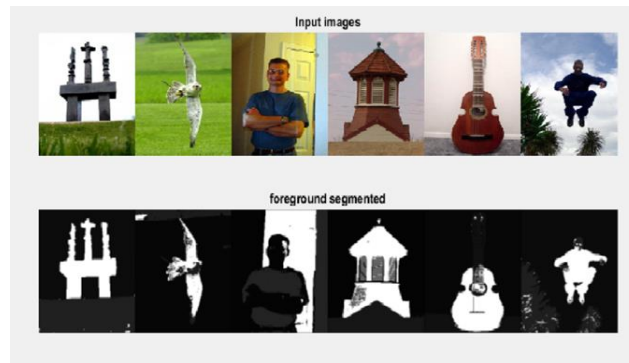


Fig. 12 : Results of MSRA Dataset

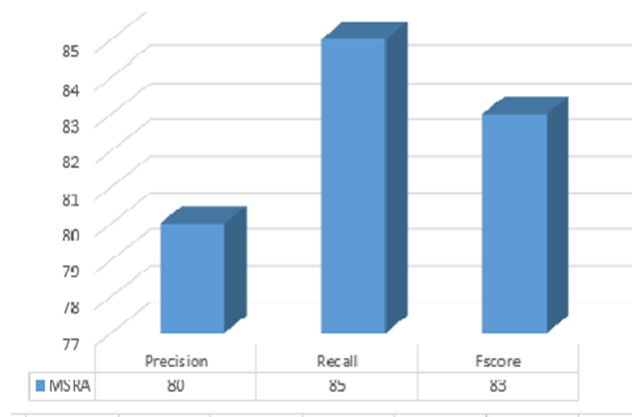


Fig. 13 : Results of MSRA Dataset

The result and evaluation of MSRA Dataset shows that the system produces precision of 80%, recall of 85%, f-score of 83% and accuracy of 91.05 %. The output and evaluation results show that the proposed system works well for all state of art dataset and produces most accuracy for all dataset. The data set was generated manually by using online mapping websites Flight Radar 24 [62] for flights.



Fig. 14 : Sample images from the data set

In [62] contains satellite imagery augmented with flight images which are available in the form of graphically augmented images of flights. The goal is to perform object recognition in such a scene. This format was used as no compression is the PNG format. Finding the groups in the data sets of videos with an introduction to the cluster analysis was put forth by Kaufman et.al. in [62].

XVII. CLASSIFICATION USING SVM

Image classification refers to the task of extracting information classes from a multiband raster image. The resulting raster from image classification can be used to create thematic maps. Image classification is a process of grouping

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pixels into several classes of land use/land cover (LULC) based on the application of statistical decision rules. There are numerous methods of image classifications. Two of the methods used in our work is the famous SVM method & the k-means clustering.

SVM : The Support Vector Machines is implemented for classification as in Fig. 15. A statistical method of evaluating and comparing the algorithms, known as Cross-Validation is processed by dividing the data into two segments as to learn or train the model and other to validate the model. The confusion matrix is the classical method for evaluation of classification. Further calculations can be made on the elements in the confusion matrix to identify accuracy, precision, sensitivity, and specificity. Accuracy was chosen as the metric as the classes are of equal sizes and there is no possibility of class imbalance.

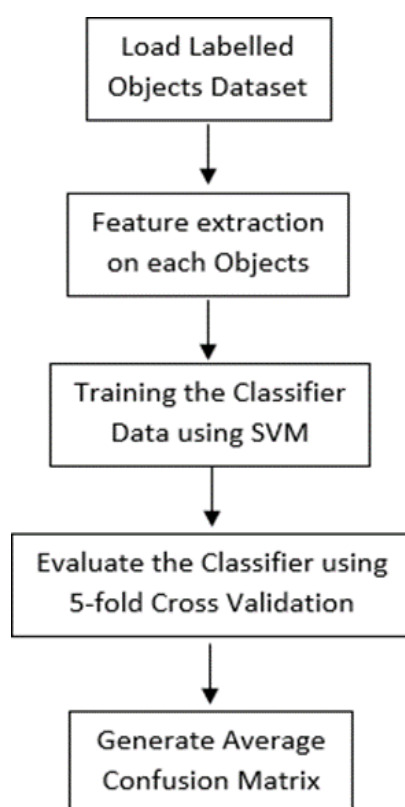


Fig. 15 : Support vector machine classification experiment

The experimental task of object classification was performed on the dataset with 500 images and the SVM model was evaluated using 5-fold cross validation performed two times. The confusion matrices for each of the folds of this evaluation are presented in Table 1.

Iteration	Folds	Prediction Error	Prediction of Flight
Iteration 1	Fold 1	1.00%	99.00%
	Fold 2	0.60%	99.40%
	Fold 3	1.00%	99.00%
	Fold 4	0.50%	99.50%
	Fold 5	0.80%	99.20%

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Iteration 2	Fold 1	0.60%	99.40%
	Fold 2	1.00%	99.00%
	Fold 3	0.80%	99.20%
	Fold 4	0.50%	99.50%
	Fold 5	1.00%	99.00%

Table 1 : Confusion matrices for SVM classification

k-means clustering : The quality of the cluster is calculated using Silhouette score, for k-means clustering as in Fig. 16. The measurement of the quality of the cluster is done through evaluating the closeness of the samples in each of the generated clusters. Experimental review has shown that silhouette score shows better performance with respect to evaluation of clusters [63]. A branch & a bound clustering algo concept was developed by Koontz et.al. in [61], the same authors developed a graph based theoretic approach to the non-parametric cluster analysis in [63].

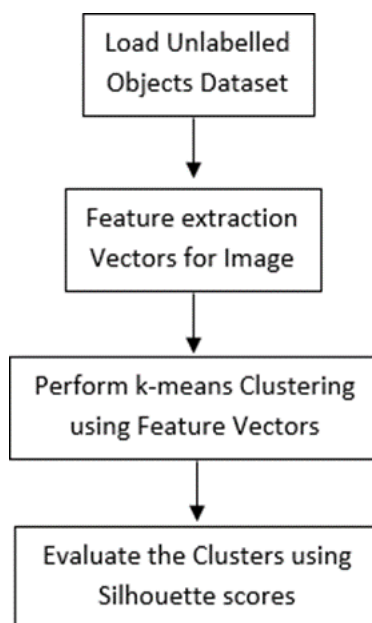


Fig. 16 : k-means clustering experiment

The clustering was performed for 5 iterations and the average silhouette score was computed. These results are presented in Table 2.

Iteration	Silhouette Value
Iteration 1	0.3241
Iteration 2	0.3234
Iteration 3	0.3243
Iteration 4	0.3234
Iteration 5	0.3235

Table 2 : Silhouette values for k-means clustering

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Fig. 17 : Flight Radar identification 1

Normalization of results using the SVM & the k-means is carried out next. The results obtained for the two methods SVM and k-means belong to different scales. For performing comparison, they were normalized to a common scale of 0 to 100 using Equation. The normalized values are presented in Table 3. The normalized values were found to be 99.30 % for the supervised SVM classifier and 66.18 % for the unsupervised k-means clustering.

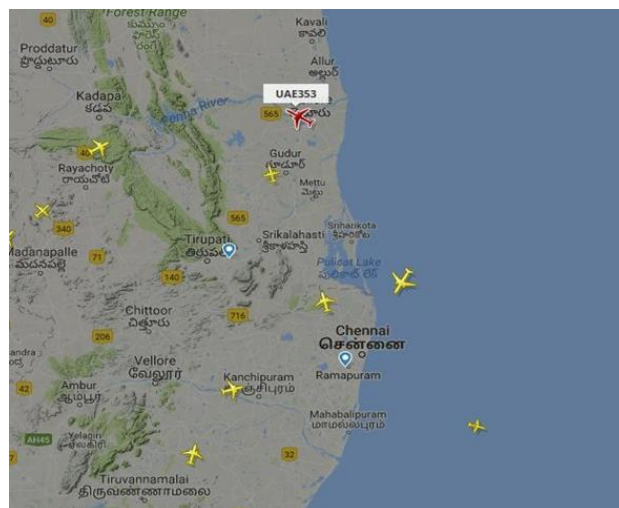


Fig. 18 : Flight Radar identification-2

$$\text{normalized value} = \left(\frac{\text{observed value} - \text{range min}}{\text{range max} - \text{range min}} \right)^{(9)}$$

XVIII. SUMMARY & CONCLUSIONS

An unsupervised approach for video foreground object segmentation system is designed in such way that it provides efficient foreground object segmentation. The result shows that segmentation is done based on the saliency-based

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clustering method. An effective clustering method is involved to avoid serious learning. The contrast and spatial cues are computed effectively for the given dataset to segment the foreground object. The video foreground object segmentation approach is an automatic and effective preprocessing step for many vision applications.

Satellite imagery holds a large amount of information. However, to use this information, it needs to be extracted from the raw image data. Object recognition is a method that can help the extraction of information from satellite images. Two object recognition approaches, one supervised and one unsupervised, were chosen based on their performance observed in earlier studies.

These algorithms were then evaluated on satellite images as a part of this study. Support vector machines and k-means clusters were used on a two-object data set to evaluate their performances and identify the approach which is comparatively better. Using the normalized values, it was found that k-means clustering performed poorly in comparison to support vector machine. From these results, a conclusion can be drawn that the supervised approach of support vector machines is more applicable for use in object recognition on satellite images than the unsupervised k-means clustering. The quantitative results presented shows the power & efficacy of the methodology developed by us. The number of iterations & the silhouette values are also checked & compared with the work done by others mentioned in the survey, thus showing the efficacy of the proposed method by us.

This research paper proposes a novel method for detection and segmentation of foreground objects from a video which contains both types of objects, viz., stationary and moving background objects using a new hybrid combination of clustering & machine learning approaches. Supervised learning & Unsupervised learning approaches of machine learning concepts are being used in this work for training & finding the hidden patterns in the videos.

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