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Development of Efficient Object Detection Techniques for Image Fusion Application

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ABSTRACT
Image fusion is a process of combining images, obtained by different sensors (generally optical and Infra Red) which uses different wavelengths of electro magnetic spectrum, to form a composite image. Object detection is the procedure of detecting the object from image or video. This paper presents an innovative object detection technique, which is based on segmentation on fused image or video. K-means clustering algorithm has been used for segmenting the objects from fused image and fused video information. The segmentation over fused images are very important for detecting hidden objects in scenes and our results show the effectiveness of the proposed approach.

Keywords: *Image fusion, Video fusion, Object detection, Video to frame, K-means, Clustering, Segmentation, Histogram*

I. INTRODUCTION
Image or video fusion is a process of combining images or videos, obtained by sensors of different wavelengths simultaneously viewing the same scene, to form a composite image or video. The composite image or video is formed to improve image content and to make it easier for the user to detect, recognize, and identify targets in different environmental condition and to increase the situational awareness. In [1, 2, 3, 4] refers the image fusion technique where each sensor is processed by algorithms specialized for that sensor. These algorithms are designed for: Noise reduction: Linear and non-linear filtering, Image enhancement: Histogram equalization, edge enhancement, Uncertainty (Noise) Estimation: Estimation of variability and consistency within and across sources, Prediction: Recursive estimation of expected and observed image. Object detection is an important activity in image processing applications and object detection in fused images is thus is a challenging field.

The general problem of object detection in images is a difficult one as the object detection system is required to distinguish a particular class of objects from all others. This calls for the system to possess a model of the object class that has high interclass and low intra class variability. The problem of detecting people in images; such a system could be used in surveillance systems, driver assistance systems, and image indexing.

The proposed work is unsupervised segmentation based and it is applicable for any types of image, video and fused image and fused video. Our work focuses to establish a suitable segmentation technique for object identification in fused images and video. This is an important application in context to scenarios in computer vision based security and surveillance systems where detection of hidden objects is crucial.

The organization of this paper is as follows. Section (II) presents a review of the existing image fusion and object detection technique. Proposed methodology is discussed in section (III). Then a detailed of the Experimental setup is presented in section (IV). Section (V) briefs the result and analysis and the concluding remarks are in section (VI).

II. REVIEW OF PREVIOUS WORKS

The object detection systems that have been developed to date fall into one of three major categories [5]. The first category consists of systems that are model-based, i.e., a model is defined for the object of interest and the system attempts to match this model to different parts of the image in order to find a fit. The second type are image invariance methods which tries a matching on a set of image pattern relationships (e.g., brightness levels) that, ideally, uniquely determine the objects being searched for. Their example-based learning algorithms characterize the final sets of object detection systems.

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These systems learn the salient features of a class from sets of labeled positive and negative examples. Example-based techniques have been also successfully used in other areas of computer vision, including object recognition.

III. PROPOSED METHODOLOGY

At first we take videos to generate difference image, it gives very low response for sable edge detection algorithm in the portions of image for random noise instead of moving objects. Furthermore, we apply segmentation algorithm on difference images to get more perfect result. This reduces the noise. As a result, these noisy edge segments are automatically excluded from the moving edge list. K-means segments can play very important role to represent image & video segmentation for moving objects which is essential for recognition, tracking or event detection in automated video surveillance systems.

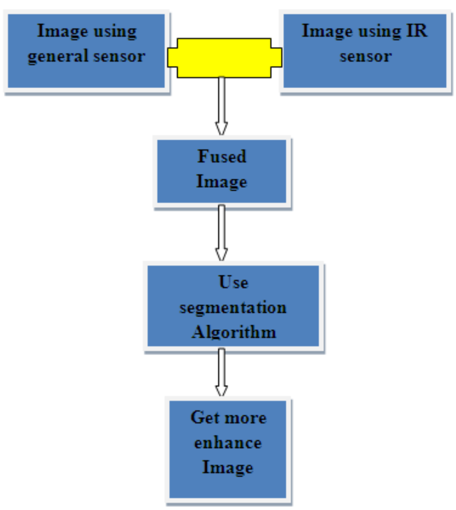


Fig.1 Flow chart of image fusion and segmentation

For video fusion three stages are needed:

(i) The measures are transformed in such a way that one is allowed to combine them. This stage is the modeling of the problem where one has to choose a theoretical framework with acceptable properties, and inside this framework a convenient representation of the data (for instance, within probability theory, model the signal as a Gaussian Markov process).

(ii) The data as transformed by the representation are combined according to the allowed rules for the chosen framework (for instance the Bays rule). If many rules are possible, choose the best one for the problem.

(iii) From the resulting combination a decision is taken in agreement with the problem. Here again many rules are possible (for instance one may prefer the maximum a posteriori or the maximum likelihood). Several such frames exist which have been created to manipulate measures and information.

Then segmentation, it refers to the process of partitioning a digital image into multiple segments (sets of pixels, also known as super pixels). The goal of segmentation is to simplify and change the representation of an image into something that is more meaningful and easier to analyze. Image segmentation is typically used to locate objects and boundaries (lines, curves, etc.) in images. More precisely, image segmentation is the process of assigning a label to every pixel in an image such that pixels with the same label share certain visual characteristics.Then implement k-means on image for segmentation of image. It is the most well-known and commonly used clustering method. It takes the input parameter, *k*, and partitions a set of *n* objects into *k* clusters so that the resulting intra-cluster similarity is high whereas the inter cluster similarity is low.

A. Steps for Fuzzification of image

Image fuzzification is the first processing step. Generally three various type of image fuzzification can be distinguished:

- Intensity based fuzzification.
- Local neighborhood fuzzification.
- Feature fuzzification.

In our technique, we have used histogram-based fuzzification technique. The shape of the membership function of an infra-red image and a normal visual image defined as follow

$$\mu_{IR}(i,j,k) = 1-((G_{max} - H_{IR}(i,j,k))/s);$$

Where $\mu_{IR}(i,j,k)$ is membership functional value of infra-red image and i,j,k indices represent the R,G,B planes of the color image, G_{max} is maximum intensity value, H_{IR} is intensity matrix of the input of infra-red image, and S is scaling factor whose value is defined as 1200<S<1500.

Similarly we also define membership function for normal visual image as

$$\mu_{NV}(i,j,k) = 1-((G_{max} - H_{NV}(i,j,k))/s);$$

Where μ_{NV} (i,j,k) is membership functional value of normal-visual image, G_{max} is maximum intensity value which control image contrast and image quality, H_{NV} is the intensity matrix of the normal-visual image, and S is scaling factor whose value is defined as 400<S<600. We implement the above defined function for our technique using Matlab.

1. Two images are taken by different sensors (generally optical and Infra Red).
2. Let us refer the two images as O (optical) and I (Infra-red). To fuse these images we have adopted the Fuzzy technique.
3. For Fuzzyfication μ_{IR} (i, j, k) is membership function infra-red image. For Fuzzy techniques have to perform for image fusion.
4. Membership function of image NV is μ_{NV} (i, j, k).
5. The resultant fused image is prepared to undergo the K-means clustering in the next step.

B. Steps for Segmentation using K-means

In its most general form, the k-means method generates a set of k cluster *d*-dimensional centroids {C} for a set of points {P} in real *d*-dimensional space *R d*, for any integer k ($k \geq 2$). The cluster centroids define a partition of the points in the space because a point P_i is assigned to a cluster centerCj if Cj is the closest centroid to Pi; that is, if the following condition is true

$$D(Pi,Cj)\ ) = MINK\ [D(Pi,Ck)]\ . . (2)$$

Where D (Pi, Cj)) distance from point Pi to cluster centroid Cj. The quality of the k-means clustering is often expressed as the sum of squares of distances of each point from its cluster center

$$E = \sum_{j=1}^{k} \sum_{P_i \in C_j} |P_i - C_j|^2 \quad . . (3)$$

Generally speaking, the lower the value of E in Eqn. 3, the better is the clustering.

1. We take an image and work out its intensity matrix A.
2. For creating two clusters we define A (i, j) and A (i, j+1) as two initial clusters.
3. Then we try to arrange the remaining points in the following manner, if it near to A (i, j) then this point remain on this cluster. If not then the point remain on A (i, j+1).

C. Modifications for implementation on fused video

1. At first have to convert this video into frames.
2. The fusion and clustering over the image frames are performed in the same way as described in sub sections A and B.
3. After that we have to combine all the fused frames to generate the fused video.

IV. EXPERIMENTAL SETUP

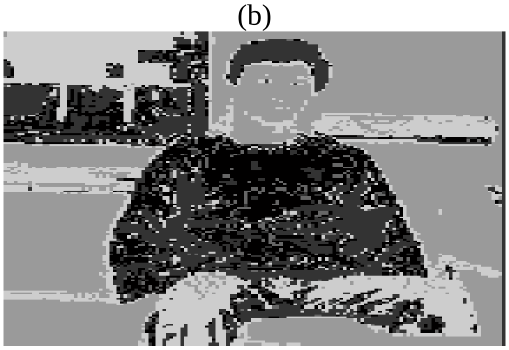
Experiments were carried out with several video sequences captured from indoor as well as outdoor environment to verify the effectiveness of the proposed method. We applied our proposed method on video formats of size 320x260 and used Intel(R) Core (TM) 2 duo CPU 1.83 GHz processor and 1.99GB of RAM. Mat lab R2009b used as of our working environment tools for implementation.

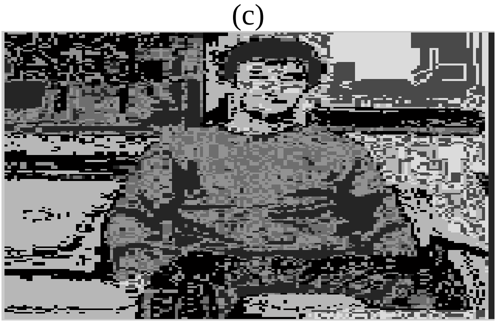
V. RESULT AND ANALYSIS

We show our results on a benchmark image as shown in Figure 2(a). It shows the image of a man who has hidden an object under his dress. Figure 2(b) to Figure 2(c) shows the results of our segmentation algorithm applied for different cluster values (k). From the results it can be seen that k=5 (Figure 2(b)) and k=7 (Figure 2(c)) gives the best results. Through this, it is clear that the hidden object is not identified as a segment. The results in Figure 3 shows the effect of segmentation on fused image as generated in Figure 3(c). It can be seen that the segmentation result as well as the identification of the hidden object is done best in the Figure 3(f) for k=7. The experimental results clearly show the need of image fusion for identification of hidden objects which is very critical in surveillance and security applications. Our results also show that our proposed technique of segmentation is successful to identify objects in fused image.


(a)


(b)


(c)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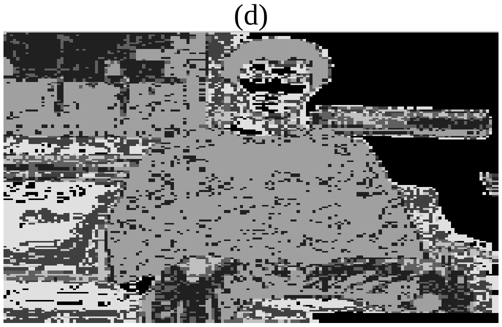
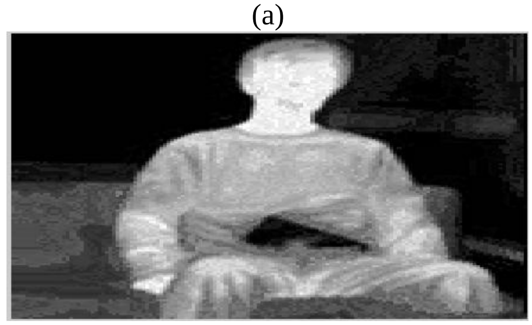

(e)

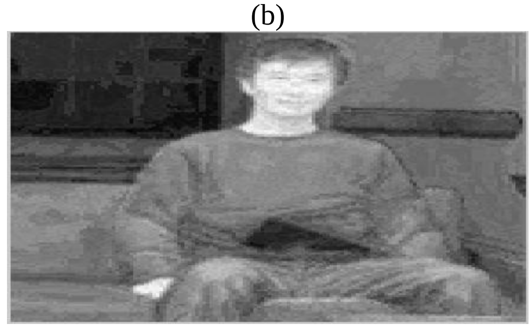

(f)

Fig.2 (a)Original image (b) k-means using 3 cluster (c) k-means using 5 cluster (d) k-means using 7 cluster (e) k-means using 8 cluster (f) k-means using 8 cluster

After using the segmentation algorithm on fused image we get the following results.


(a)


(b)


(c)

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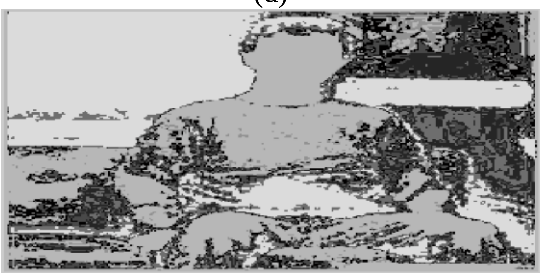
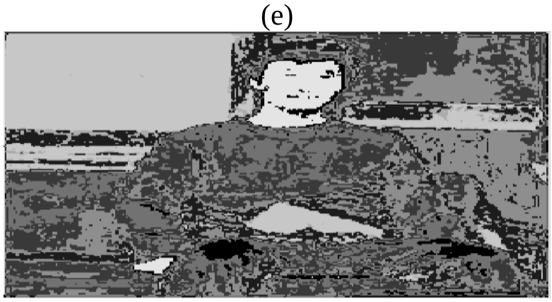
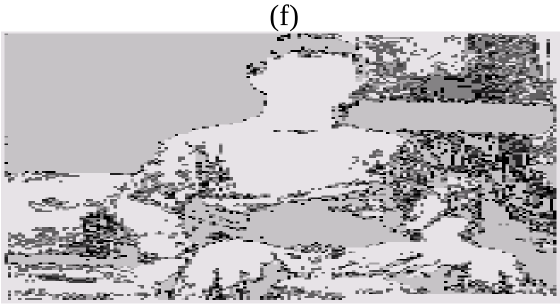
(d)


(e)


(f)


(g)

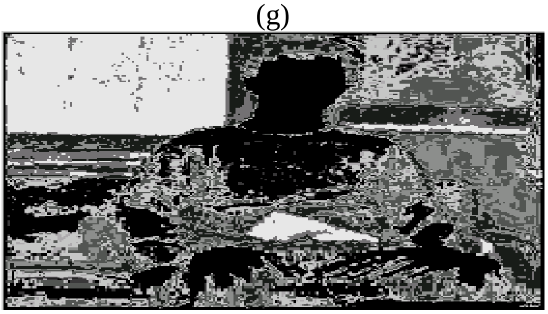
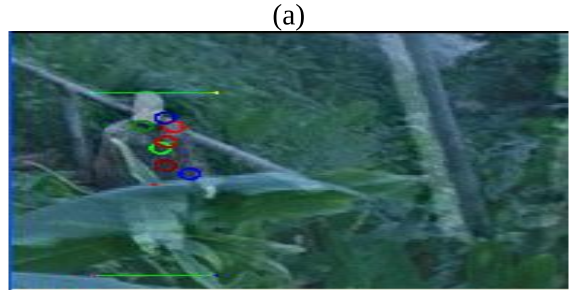
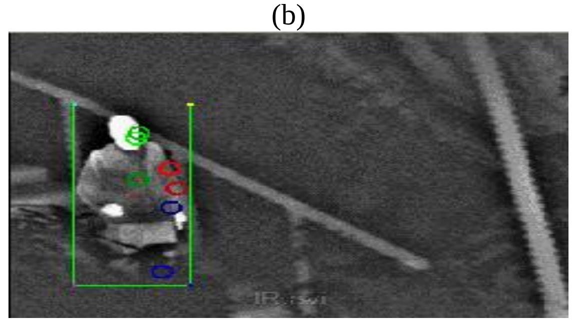

(h)

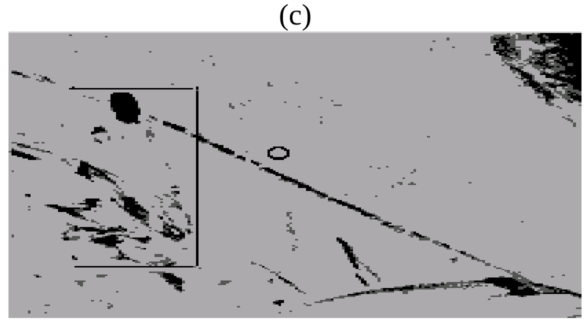
Fig.3 (a)Original image (b) IR image (c)Fused image (d) k-means clustering using 3 cluster on fused image e)k-means clustering using 5 cluster on fused image (f) k-means clustering using 7 cluster on fused image (g)k-means clustering using 8 cluster on fused image (h) k-means clustering using 9 cluster on fused image

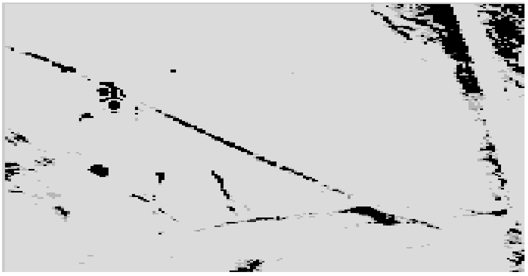
Now if we use k-means on fused image then we get much more informationable result. From this result it is clear that in fused image hidden object is so clear than k-means clustering of original image. Here edges are sharply detected and human being is also clear. As K-means is trial basis, k-means using cluster 7 gives so good result. Result of segmentation algorithm on fused video are below


(a)

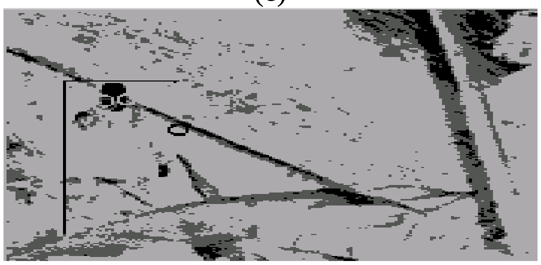

(b)


(c)

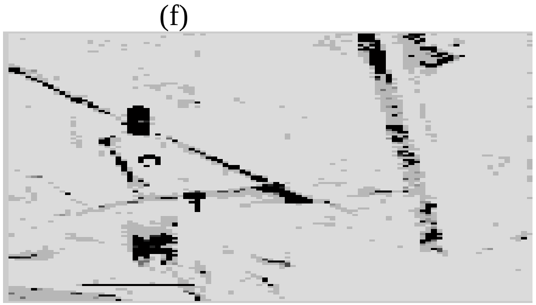

(d)



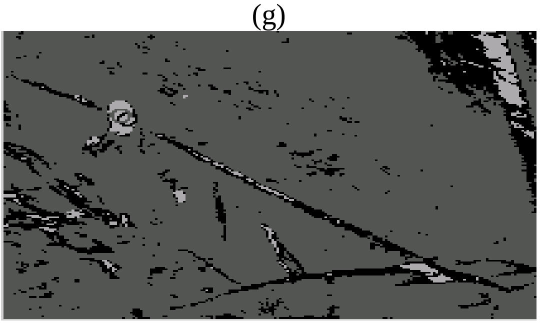
(e)



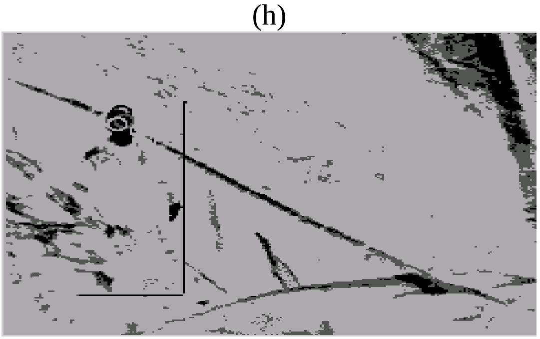
(f)



(g)



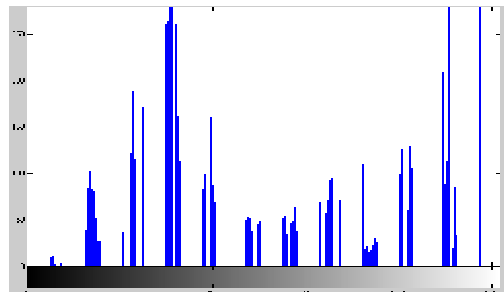
(h)



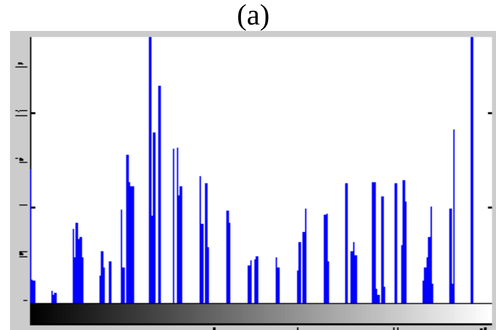
(i)

Fig 5. Fig. a: Original RGB image, Fig. b: Original IR image, Fig. c: Fused image of fig.5.a and fig 5. b, Fig. d: k-means on fused video, frame no 4 Fig. e: k-means on fused video, frame no 36 Fig. f: k-means on fused video, frame no 46 Fig. g: k-means on fused video, frame no 73 Fig. h: k-means on fused video, frame no 87 Fig. i: k-means on fused video, frame no 104

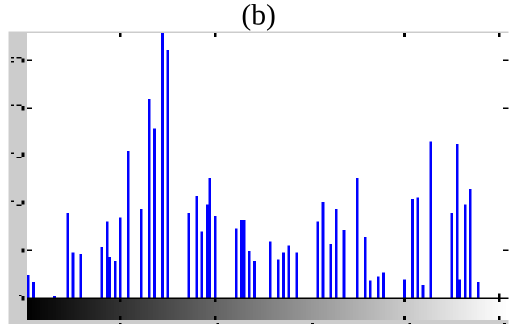
K-means is a unsupervised learning segmentation, here number of clusters is inserted by the users. So we have to try a number of times to get our expected result. K-means is used on video to detect the object and it is a very efficient technique.



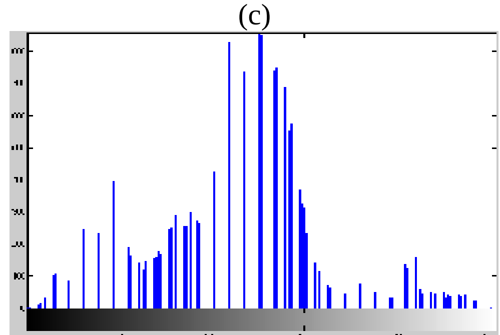
(a)



(b)



(c)



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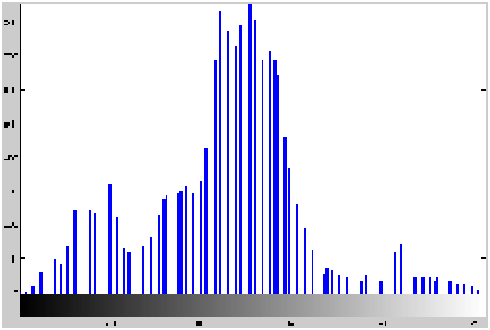
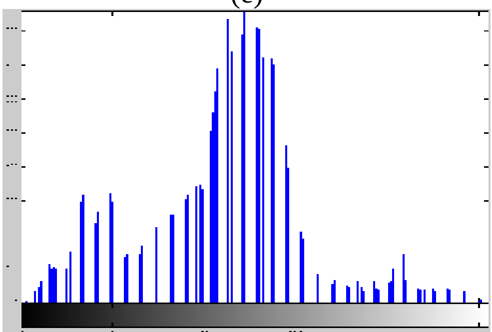


(e)



(f)

Fig. 6: Fig. a: histogram of Fig-3.c, Fig. b: histogram of Fig.3.d, Fig. c: histogram of Fig. 3.e, Fig. d: histogram of Fig. 4.c, Fig. e: histogram of Fig. 4.d and Fig. f: histogram of Fig. 4.e

Figure a,b,c are represent the K-means of a general image but figure d,e,f are represent the K-means on fused image. Figure d,e,f pick up and pick down is comparatively high than figure a,b,c as those figures carry more information (frequency,edge, segmentation) than figs. a,b,c.

VI. CONCLUSION AND FUTURE WORK

The proposed algorithm has been tested over several videos. This paper explains the proposed methodology of object detection on fused video and it can use all domains. K-Means include its sensitivity to outliers, and that need to specify the number of clusters as an input to the algorithm. This algorithm begins with an initial random assignment of data points to clusters. It iteratively refines this assignment in a two-step process. In the first step, it computes the centroid (in other words, the mean) of each cluster by averaging all the points assigned to that cluster. In the second step, it reassigns data points to the cluster represented by the closest centroid. The refinement eventually converges, at which point the clustering process is complete. Here user insert the cluster number that's for it is a trial basis algorithm. In future we would try to establish much effective algorithm for segmentation.

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