Vol.5, No.1 ISSN:2349-0012

INNOVATIVE RESEARCH ORGANISATION

International Journal of Advance Research in Education, Technology & Management

(Scholarly Peer Review Publishing System)

ENHANCED OBJECT DETECTION TECHNIQUE USING GUIDED FILTER & PCA BASED DYNAMIC THRESHOLDING

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Abstract— Image saliency is a conception from bodily processes that makes the areas of concern explode away of individual visual fields. Object detection is one of the gigantic challenges of computer apparition, having received incessant consideration from the time of origin of the field. This paper has proposed a new approach has utilized level set based segmentation to detect objects in more promising manner. The proposed technique is tested on various low intensity and complex background images. The result clearly indicates that the proposed technique outperforms over the available methods.

Keywords— Guided filter, Level set, PCA, Dynamic thresholding.

I. INTRODUCTION

Image segmentation [1] is an important in the most automatic scene analysis applications and pattern recognition. Segmentation subdivides an image into its essential objects or regions. The selection of one segmentation practice over another is selected mostly by the type of the problem being considered. Most of the segmentation algorithms are based on one of two vital properties of intensity values: discontinuity and similarity. In the first type, an image is partitioned based on unexpected changes in intensity, such as boundaries. The second type is based on partitioning an image into its regions that are related to a set of predefined criteria. Region growing, thresh holding and region splitting & merging are examples of the later.

Edge detection is based on detecting sharp and abrupt changes in intensity. Edge detection is done by using image features like inaccessible points, lines, and edges. Edges are set of linked edge pixels, at which the intensity of an image function changes locally. Edge detectors are intended to identify edge pixels. It is a local image processing method.

The line detection is the next level of edge segmentation. For line detection, there are two derivatives used. The first derivative is used to produce thinner lines and Second order derivative of line detection gives result in the form of double-line effect. For line detection, the laplacian mask is used and the double-line result of the second derivative must be handled properly. The double line effect is clearly visible in the magnified region. The laplacian detector is isotropic and free from direction.

Edge detection scheme is used mainly for segmenting an image, based on local changes in intensity. Edge models are divided into their intensity profiles. A step edge type schedules over the distance of one pixel. Step edge occurring in images like solid modeling and animation.Digital step edges are used regularly as edge models within algorithm enhancement. Digital images have edges that are unclear and noisy. The noise level of digital images is determined by the electronic components of the imaging system.

The purpose of region-based segmentation is to divide an image into regions. It is based on discontinuities in intensity levels, and segmentation was practiced via threshold based on the sharing of pixel properties, such as intensity values or color.Region growing is a process that groups pixels into outsized regions. It is based on predefined criteria for expansion. Basically, it begins with a set of “seed” points and then grows region by connecting to each seed from those adjacent pixels that have predefined properties related to the seed like specific ranges of intensity values or color.

Region splitting and merging method subdivides an image primarily into a set of displace regions and then merge. This splitting technique is also known as quad trees, i.e. trees in which each node has exactly four descendents.

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International Journal of Advance Research in Education, Technology & Management

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Filters are used for noise diminution and for blurring. Blurring is used in pre processing task such as exclusion of small facts from an image prior to object removal, and bridging of small gaps in lines or curves. Noise reduction can be practiced by blurring with a linear filter and also by nonlinear filtering. The linear spatial filter is mainly the average of the pixels enclosed in the neighborhood of the filter mask. These filters are called averaging filters. There are low pass filters and mean filters used for degradation present in the image i.e. noise. Guided filter is used to remove Gaussian noise without edge degradation.

II. PROPOSED MODEL

Our novel and efficient approach which uses the morphological operations for salient object detection. In thissection, we first introduce the building process of the modified technique.

A. Guided Filter

Guided filter can be used as an edge preserving smoothing operator like bilateral filter. It does not suffer from the gradient reversal artifacts. Guided filter performs very well in a great variety of applications, including image smoothing/enhancement,matting/feathering,jointup sampling etc.

For guided filter, a general linear translation–variant filtering process, which involves a guidance image I, an filtering input image p, and an output image. The filtering output at a pixel I is expressed as a weighted average:

$$q_{i} = \sum_j w_{ij}(I) p_j$$

Where,Iand j are pixel indexes. The filter kernel $W_{ij}$is a function of the guidance image I and independent of p. This filter is linear with respect top. The guided filter is also known as local linear model.

B. Random Forest

Object detection in extensive real-world scenes requires capable multi-class detection approaches. Object detection for real world applications is still a difficult problem.Random forests are ensembles of randomized decision trees that can be applied for regression, classification tasks and even both at the same time. The most important application of random forest is the detection of human body parts from depth data.

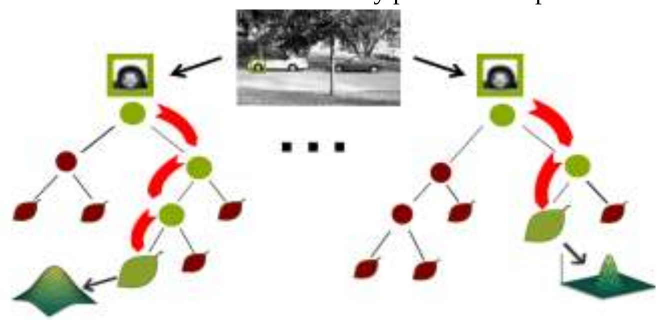

Fig 1.3: A random forest consists of a set of trees that map an image patch to a distribution stored at each leaf.

A random forest consists of a set of trees T_t where each tree consists of split nodes and leaves as illustrated in Figure 1. The split nodes calculate each new image patch and according to the appearance of the patch, pass it to the left or right child. Each leaf L stores the information of the image patches that arrived throughout training. For a classification task, it is the possibility for each class c, denoted by p(c|L). For a regression task, it is a sharing over the continuous parameter x $\in \mathbb{R}^H$.

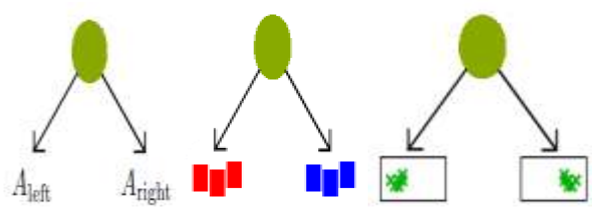

Fig (a) (b) (c)

Fig 1.4: (a) Each split function separates the training data at a node (b) The classification objective aims to separate patches with different class labels (c) The classification objective aims to separate patches with different class labels

A set of training patches $\{P_i = (I_i; c_i ; d_i)\}$ that are arbitrarily sampled from the examples where,

I_i are the extracted image features of the patch,

c_i is the class label for the pattern and the patch is sampled from it,

d_i is a balance vector from the patch center to the reference point.

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International Journal of Advance Research in Education, Technology & Management
(Scholarly Peer Review Publishing System)

Patches sampled from background images have a pseudo offset, i.e., $d_i = 0$. Here, specify the set of randomly sampled training patches for a tree T_t by

$$A = \{ p_i \}$$

So, as to train a tree that can be used for object detection, one has to get a split function

$$f_\emptyset(p) \in \{0,1\} (1)$$

for each non-leaf node that separates the training patches in the finest way. The split functions are therefore also termed as weak learners.

The split function assesses one or more image features of the patch P and sends it to the left (f_ϕ (P) = 0) or right child (f_ϕ (P) = 1) of the node;

The split functions are parameterized by a set of parameters ϕ that need to be optimized during training. Each tree can be trained in parallel using the general random forest frame-work. Starting at the source node with the training setA_{node} = A, a tree grows recursively:

1. Produce a random set of parameters $\Phi = \{\phi_k\}$.
2. Partition the set of patches A_{node} into two subsets A_L and A_R for each $\phi \in \Phi$:

$$A_L (\phi) = \{P \in A_{node} \mid f_\phi(P) = 0\} \quad (2)$$

$$A_R(\phi) = \{P \in A_{node} \mid f_\phi(P) = 1\} \quad (3)$$

3. Select the splitting parameters ϕ^* that maximize the gain g:

$$\phi^* = {}^{argmax}_{\phi \in \Phi} g(\phi, A_{node}) (4)$$

Where

$$g(\phi, A_{node}) = \mathcal{H}(A_{node}) - \sum_{S \in \{L,R\}} \frac{|A_S(\phi)|}{|A_{node}|} \mathcal{H}(A_S(\phi)) (5)$$

Depending on the task, $\mathcal{H}(A)$ is chosen such that g measures the gain of the regression or classification performance of the children in comparison to the current node.

4. Continue growing with the training subsets A_L and A_R if the stopping criteria are not fulfilled; otherwise, create a leaf node and store the figures of the training data A_{node}.

Step 1 is an additional source of randomness that reduces training time whereas estimating all parameters ϕ would be infeasible in many cases. While the family of splitting functions $f\phi$, the measure $\mathcal{H}$, and the stopping criteria will be discussed.

In the context of object detection, we are interested in the class possibility and the spatial distribution of the training patches for each class. The class Probability p(c|L) can be estimated by

$$p(c|L) = \frac{|A_c^L| . r_c}{\sum_c (|A_c^L|) . r_c}; \; r_c = \frac{|A|}{|A_c|} \qquad (6)$$

Where, A^L is the set of training patches reaching the leaf L after training, A the entire training set used for training the tree, and A_c the patches in A with class label c. The factor r_c compensates for the sample bias that might have been introduced when the number of training examples is not well distributed among classes. The spatial distribution for each class, p (**d**|c, L), is obtained by estimating the continuous distribution from the offset samples $d \in D_C^L$ of the patchesA_C^L.

C. Level Set Method

Image segmentation methods based on the admired level set structure to handle random number of regions. Some level set processes are presented that can at least deal with a fixed amount of regions greater than two, there is very few work on how to improve the segmentation also with regard to the number of regions. Based on a variational model, A very fine tool to deal with variational energy minimization problem handled with the introduction of level sets that forcefully optimizes the energy in a level set framework, as well as the number of regions.One application to image segmentation has been the active contour model, which is fully edge based, and therefore, it is a local approach to image segmentation. Level set based segmentation that takes the region information into account has been projected later.

D. Active Contour

Active Contours are connectively-preserving relaxation methods. This is applicable to the image segmentation and motion tracking problem. The basic idea is to start with initial boundary shapes represented in a form of closed curves, i.e. contours:

$$C(s) = \{ (x(s), y(s)) : 0 <= s < 1\} \qquad (1)$$

and iteratively modify them by applying shrink/expansion operations according to the constraints of the image. Those shrink/expansion operations, called contour evolution$\partial C/\partial t$,

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International Journal of Advance Research in Education, Technology & Management

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can be performed by the minimization of an energy function or by simulation of a geometric partial differential equation (PDE). Active contours have been considered as attractive image segmentation methods because they partition an image into sub-regions with continuous boundaries, while edge detectors based on local filtering. Active contours provide more reasonable segmentation results because they rely on not only the image intensity but also the geometric properties of the sub-regions.

E. Principal Component Analysis

PCA is a geometricpractice concerned with elucidating the covariance structure of a set of variables. In particular it allows us to recognize the principal directions in which the data varies.In computational terms the principal components are set up by calculating the eigenvectors and eigenvalues of the data covariance matrix. This process is equivalent to finding the axis system in which the co-variance matrix is diagonal. The eigenvector with the largest eigenvalue is the direction of greatest variation, the one with the second largest eigen value is the (orthogonal) direction with the next highest variation and so on. To see how the computation is done we will give a brief assessment on eigenvectors/ eigenvalues.

Let A be an $n \times n$ matrix. The eigenvalues of A are defined as the roots of:

$$\text{Determinant}(A - \lambda I) = |A - \lambda I| \quad (1)$$

From eq.1, I is $n \times n$ identity matrix. This equation is called the characteristic equation (or characteristicpolynomial) and has n roots.

Let λ be an eigenvalue of A. Then there exists a vector x such that:

$$Ax = \lambda x \quad (2)$$

The vector x is called an eigenvector of A associated with the eigenvalueλ..

F. Dynamic Thresholding

Thresholding is the course of separating an imageinto different regions based upon its gray level distribution. Key to the selection of a threshold value is an image'shistogram, which defines the gray level distributionof its pixels. The bimodal nature of this histogram is typicalof images containing two principal regions of twodifferent gray levels as objects and background. Whendealing with digital pictures, most images are having nonstopintensity variation and if only a single thresholdlevel is used then many important regions are lost. Itbecomes difficult to identify significant regions of suchimages having multimodal histogram. A better methodof Thresholding the gray level image is thus to use multilevelThresholding instead of bi-levelthresholding.This is the approach that is taken in the implementationof optimal thresholding. In this,we calculate the optimalnumber of threshold levels by computing the number ofsignificant peaks from image's histogram.

If the input image is a gray level image then the boundaryextracted image could be in gray level. To convert theimage into a binary image we threshold the image. Forthresholding, we compute multilevel thresholds adaptive (dynamic) of local intensity variations.

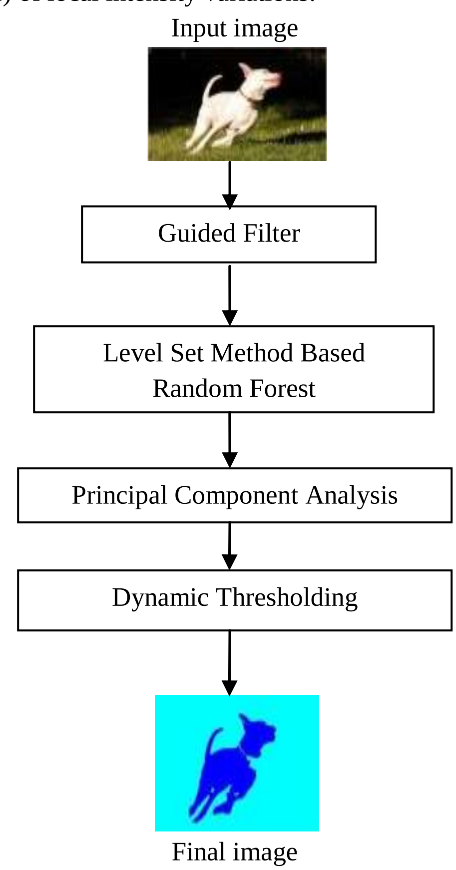

Fig 1.5:Block diagram of proposed methodology

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III. EXPERIMENTS

The proposed algorithm is tested on various images. The algorithm is applied using various performance indices F-measure, Peak signal to noise ratio (PSNR), Accuracy, Sensitivity and Specificity.

As shown in the below given figures, we are comparing the results of existing and proposed approach. As results show that our proposed approach results are much better than exiting approaches.

A. Experimental set-up

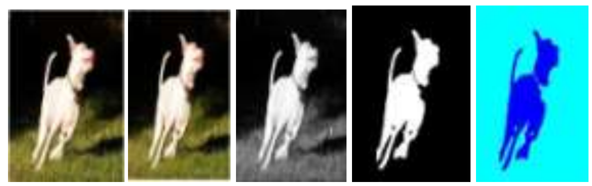
In order to implement the proposed algorithm, design and implementation has been done in MATLAB using image processing toolbox. In order to do improved salient object detection we have implemented the MLSBRF technique, PCA and dynamic thresholding for enhancement. The developed approach is compared against some well-known object detection techniques available in literature. After these comparisons, we are comparing proposed approach against some performance metrics. Result shows that our proposed approach gives better results than the existing techniques.

B. Experimental results

The overall objective is to combine relevant information from multiple images into a single image that is more informative and suitable for both visual perception and further computer processing. Below figures 1.6 and 1.7 show the results of existing and proposed technique respectively.

(a) (b) (c)(d)

Fig 1.6:(a) shows the input image (b) Gray image (c) Binary segmented image (d) Final segmented image.



(a)(b) (c) (d) (e)

Fig.1.7:(a)shows the input image (b) Guided filtered image (c) Gray image (d) Binary segmented image (e) Final segmented image.

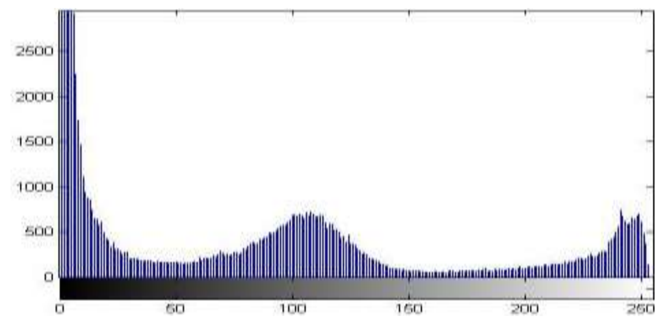


Fig1.8: Histogram image

C. Performance analysis

This section analyzesthe performance of salient object detection between existing and proposed techniques. Some well-known image performance parameters for digital images have been selected to prove that the performance of the proposed algorithm is quite better than the existing methods.

F-Measure

The table 1and fig 1.9 (a) is showing the comparative analysis of the F-Measure. The F_1-score or F-score or F-measure is a measure of test's accuracy. It considers both the Precision P and Recall R of the test to compute the score: P is the number of correct results divided by the number of all returned results and R is the number of correct results divided by the number of results that should have been returned. So, the F- measure can be interpreted as weighted average of the Precision and Recall. F-measure reaches its best value at 1 and worst score at 0. The conventional F-measure or balanced F-score is the harmonic mean of Precision and Recall.

Table 1 F-measure analysis

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International Journal of Advance Research in Education, Technology & Management

(Scholarly Peer Review Publishing System)

Image name	Extension	Existing Technique	Proposed Technique
image1	.jpg	88.5155	96.9905
image2	.jpg	94.9236	97.9876
image3	.jpg	70.4870	86.6522
image4	.jpg	97.2397	98.7693
image5	.jpg	70.6737	85.2497
image6	.jpg	87.0995	98.1214
image7	.jpg	95.2118	97.1303
image8	.jpg	98.9541	99.8022
image9	.jpg	81.7904	87.8869
image10	.jpg	77.0623	81.2649
image11	.jpg	64.7502	84.3698
image12	.jpg	74.0048	95.1027
image13	.jpg	82.9705	91.0017
image14	.jpg	89.1679	91.2608
image15	.jpg	42.3525	88.0624

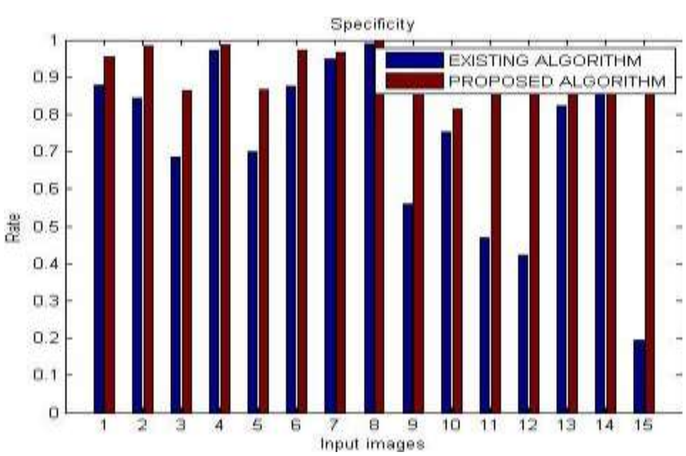

Fig 1.9: (a) F-Measure of MLSBRF, PCA & Proposed Approach for different images

The table 2 and fig 1.9(b) is showing the comparative analysis of the Accuracy. Accuracy of a measurement system is the degree of closeness of measurements of a quantity to that quantity's actual (true) value. It is the proximity of measurement results to the true value. The following table has shown the improve result of accuracy over the existing approach.

Table 2 accuracy analysis

Image name	Extension	Existing technique	Proposed Technique
image1	.jpg	0.8389	0.9512
Im0age2	.jpg	0.9696	0.9878
image3	.jpg	0.7962	0.8897
image4	.jpg	0.9607	0.9820
image5	.jpg	0.8321	0.9390
image6	.jpg	0.7944	0.9660
image7	.jpg	0.9285	0.9550
image8	.jpg	0.9915	0.9984
image9	.jpg	0.8576	0.9137
image10	.jpg	0.8003	0.8227
image11	.jpg	0.6544	0.8935
image12	.jpg	0.8434	0.9775
image13	.jpg	0.8565	0.9367
image14	.jpg	0.8724	0.8823
image15	.jpg	0.5642	0.9645

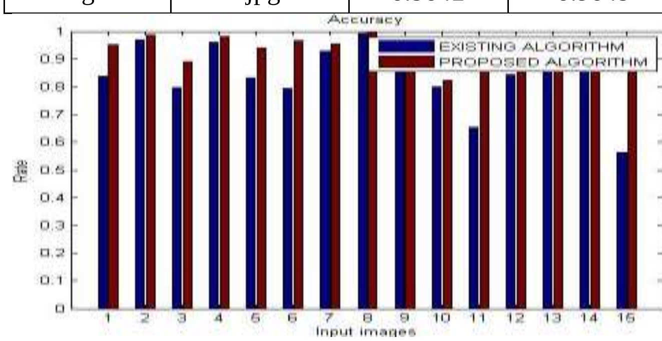

Fig 1.9(b): Accuracy of MLSBRF, PCA& Proposed Approach for different images

Peak Signal to Noise Ratio Evaluation

The table 3 and fig 1.9 (c) is showing the comparative analysis of the Peak Signal to Noise Ratio (PSNR). As PSNR need to be maximized, so the main goal is to increase the PSNR as much as possible. It is the ratio between the maximum possible power of a signal and power of corrupting noise that affects the fidelity of its representation. PSNR is usually expressed in terms of the logarithmic decibel scale.

PSNR is the most commonly used to measure the quality of reconstruction of lossy compression on codec's for instance image compression. The signal in this case is the original data, and the noise is the error introduced by compression.

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When comparing codec's, PSNR is an approximation to human perception of reconstruction quality.
Table has clearly shown that the PSNR is maximum in the case of the proposed algorithm, and proposed algorithm is providing better results than the available methods.

Table 3 Peak signal to noise ratio

Image name	Extension	Existing Technique	Proposed Technique
image1	.jpg	7.9284	13.1170
image2	.jpg	15.1666	19.1459
image3	.jpg	6.9089	9.5756
image4	.jpg	14.0604	17.4569
image5	.jpg	7.7490	12.1496
image6	.jpg	6.8703	14.6835
image7	.jpg	11.4589	13.4666
image8	.jpg	20.6888	27.8870
image9	.jpg	8.4638	10.6422
image10	.jpg	6.9958	7.5137
image11	.jpg	4.6137	9.7279
image12	.jpg	8.0518	16.4692
image13	.jpg	8.4326	11.9837
image14	.jpg	8.9431	9.2925
image15	.jpg	3.6068	14.5002

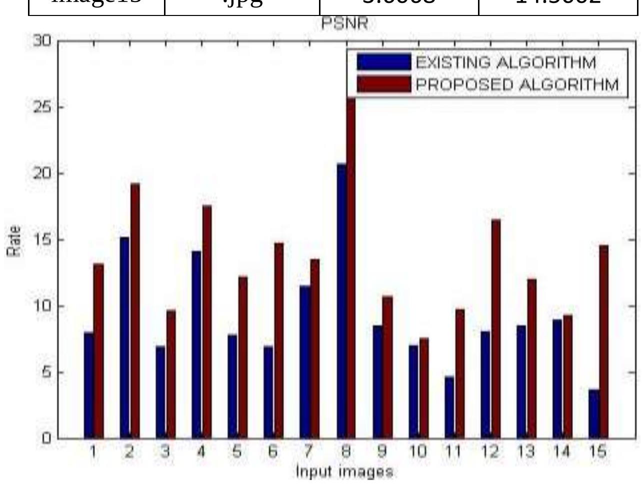

Fig 1.9:(c) PSNR of MLSBRF, PCA & Proposed Approach for different images

Sensitivity

The table 4 and fig 1.9 (d) is showing the comparative analysis of the Sensitivity. Sensitivity relates to the test's ability to identify a condition correctly or also called true positive rate or the recall rate. It measures the proportion of actual positives which are correctly identified. This is also very important parameters for better quality of image.

Table 4 Sensitivity analysis

Image name	Extension	Existing Technique	Proposed Technique
image1	.jpg	0.7587	0.9651
image2	.jpg	0.9628	0.9840
image3	.jpg	0.8484	0.8978
image4	.jpg	0.9348	0.9763
image5	.jpg	0.7415	0.9074
image6	.jpg	0.5851	0.9696
image7	.jpg	0.8694	0.9363
image8	.jpg	0.9922	0.9984
image9	.jpg	0.8318	0.8318
image10	.jpg	0.8322	0.8324
image11	.jpg	0.6918	0.8675
image12	.jpg	0.7664	0.9615
image13	.jpg	0.8420	0.9288
image14	.jpg	0.8562	0.8896
image15	.jpg	0.5183	0.9580

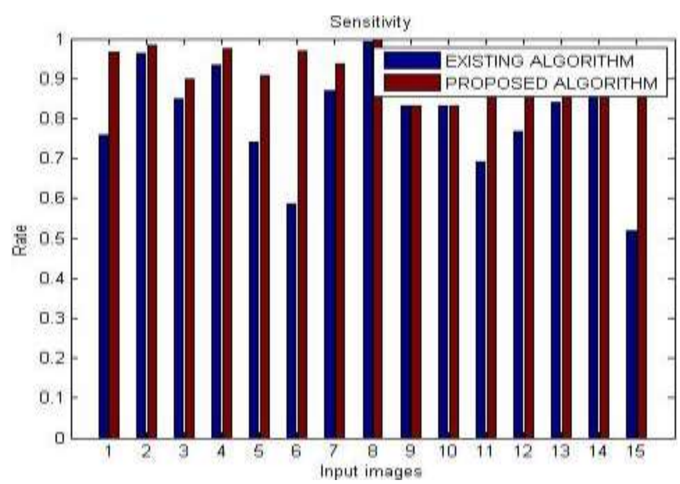

Fig 1.9:(d) Sensitivity of MLSBRF, PCA & Proposed Approach for different images

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Specificity

The table 5 and fig 1.9 (e)is showing the comparative analysis of the Specificity. Specificity sometimes, are called true negative values. For instance, it is correctly identified as such healthy people who are correctly identified as not having condition. It is not predicting anyone from the healthy group as sick.

Table 5 Specificity analysis

Image name	Extension	Existing Technique	Proposed Technique
image1	.jpg	0.8779	0.9544
image2	.jpg	0.8434	0.9832
image3	.jpg	0.6855	0.8653
image4	.jpg	0.9729	0.9874
image5	.jpg	0.6990	0.8680
image6	.jpg	0.8756	0.9734
image7	.jpg	0.9480	0.9658
image8	.jpg	0.9908	0.9989
image9	.jpg	0.5599	0.8951
image10	.jpg	0.7543	0.8144
image11	.jpg	0.4679	0.8634
image12	.jpg	0.4221	0.9264
image13	.jpg	0.8221	0.9293
image14	.jpg	0.8695	0.9242
image15	.jpg	0.1941	0.9012

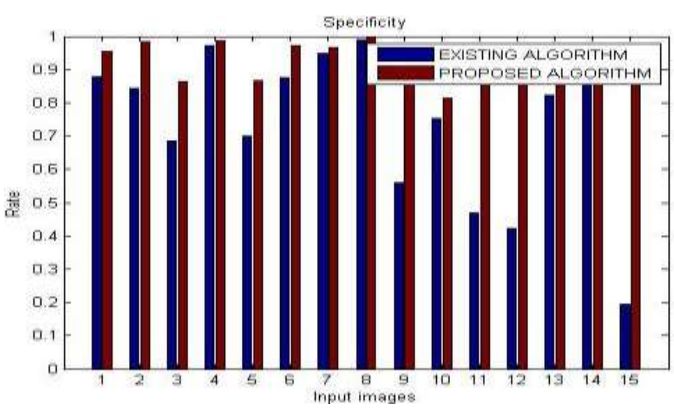

Fig 1.9:(e)Specificity of MLSBRF, PCA & Proposed Approach for different images

IV. CONCLUSION

The main objective of object detection is to situate significant region or objects in digital images. This paper has shown that the still much improvement, can be done to improve the object detection accuracy.This Paper has also shown the capability to handle the complex background images and also show the targeted object which has more information.This research work aims to improve the salient object detection accuracy by modifying the random forest based approach and by using improved level set method and PCA. Also further enhancement has been done by using the dynamic thresholding.

In near future, we will consider hazyimages to evaluate the effectiveness of the proposed algorithm. Also, evolutionary algorithm based binarization may also be used in near future instead of dynamic thresholding.

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