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The Optimum Encryption Method

Classification of Hyperspectral Image

Highlights

Features for Rotated Objects Detection

Tracking using Watershed Segmentation

Discovering Thoughts, Inventing Future

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Classification of Hyperspectral Image using SVM Post-Processing for Shape Preserving Filter and PCA

By Aditi Chandra & Narayan Panigrahi

Abstract- This paper is based on an experimentation to preserve shapes of the natural classes in a hyperspectral image post classification of the image using SVM. The classifier classifies the vegetation types present in the hyperspectral image and then estimates the crop types present in the image. In doing so it preserves the spatial shapes of the vegetation types spread in the image using an Edge-preserving filter. The shape-preserving filter was applied prior to dimension reduction where by the low information content spectral components are discarded using Principal Component Analysis. The classification of the features is performed using SVM. The result has been found very effective in characterizing significant spectral and spatial structures of objects in a scene..

Keywords: *classification, support vector machine, edge preserving filter, PCA.*

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CLASSIFICATIONOFHYPERSPECTRALIMAGEUSINGSVMPOSTPROCESSINGFORSHAPEPRESERVINGFILTERANDPCA

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Classification of Hyperspectral Image using SVM Post-Processing for Shape Preserving Filter and PCA

Aditi Chandra [α] & Narayan Panigrahi [σ]

Abstract- This paper is based on an experimentation to preserve shapes of the natural classes in a hyperspectral image post classification of the image using SVM. The classifier classifies the vegetation types present in the hyperspectral image and then estimates the crop types present in the image. In doing so it preserves the spatial shapes of the vegetation types spread in the image using an Edge-preserving filter. The shape-preserving filter was applied prior to dimension reduction where by the low information content spectral components are discarded using Principal Component Analysis. The classification of the features is performed using SVM. The result has been found very effective in characterizing significant spectral and spatial structures of objects in a scene.

Keywords: classification, support vector machine, edge preserving filter, PCA.

I. Introduction

Classification of images is performed to segregate different class of objects present in a remotely sensed image imaged by the remote sensing sensor. Generally, Image classification is performed to classify and estimate the natural resources available within a geographical extend. One of the popular criteria of image classification is vegetation index. Through vegetation index-based classification one can obtain different types of vegetation with in an area. But vegetation index-based classification cannot yield accurate estimation of different varieties of vegetables of similar class such as rice, pulse, wheat sharing close segregated radiometric characteristics. After hyper classifying these similar type crops as well as vegetations of diverse type, hyperspectral imaging captures finer signature of different types of vegetation or natural classes within a geographical extend. But hyperspectral images suffer from high radiometric resolution where 95 percent of information is encoded in first few spectral bands. Spectral dimensionality has been found a major challenge. Therefore, dimension reduction before classification becomes important. The possibility of accurate classification of materials increments due to the detailed spectral information provided by these images. The two properties imbibed by hyperspectral sensors like AVIRIS, HYDICE, Hyperion, etc., are dominant to multispectral devices. The first covers the solar reflective wavelengths of 400-2400nm, producing complete continuous coverage of spectral reflectance characteristics and the second is the ample number of bands with high spectral resolution to represent distinct features. Among the hundreds of bands some are noisy and dispensable. Many adjoining bands are highly corresponding due to the gradual changing in spectral reflectance of materials over certain regions leads to redundant measurements.

Hyperspectral images are ill edge preserving images be- cause of low spatial resolution. Therefore, in this experiment we have applied an edge preserving filter to the spectral images after reducing the spectral dimensions using PCA. Finally, the image is classified using Support Vector machine which proves to be a better classifier for hyperspectral images containing mixed vegetation classes. SVM helps in compounding the classification since it is flexible with the high dimensional data like hyperspectral images.

Various classification techniques have been introduced for different type of geospatial images. Hyperspectral images provide applications like estimating biomass and biodiversity, recuperating physicochemical mineral properties, determining changes happening in wetland characteristics, in precision agriculture, determining water and land quality, etc., making it easier to study the various aspects of earth responsible for sustaining the lives on it [1]. Thus, classification becomes the base foundation of the algorithms for these applications and plays a major role. [2] proposed algorithm to enhance profile of the satellite image to classify terrain of different dimensionality using Gaussian and Hessian computations. Classified images become the major source of Geographic Information Systems (GIS) for generation of thematic map. Also, other forms of cartographic activities such as R2V and registration can be performed using the classified images better than an unclassified image [3-4].

The Ideas for applying the dimension reduction techniques before classification of hyperspectral image has been discussed in [5]. The research illustrates about the dimension reduction techniques which are

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separately evaluated with the hyperspectral imagery for classification purpose.

The complication in handling hyperspectral images under supervised classification comes with the small ratio between training samples and the number of features. We take [6] the research forward and propose the classification of hyperspectral images using SVM after applying the preserving shape (PS) features on low spatial datasets. Dimension reduction on hyperspectral dataset was done to obtain the bands with highest information and eliminate the bands with low information content so as to reduce the feature dimension. This was obtained by using Principle Component Analysis which allows figuring out the patterns in a data converting into a lower dimension data set without loss of any important information and successfully giving principle bands. The experiment is conducted using MATLAB 2016 and in a system with quad core Intel CPU.

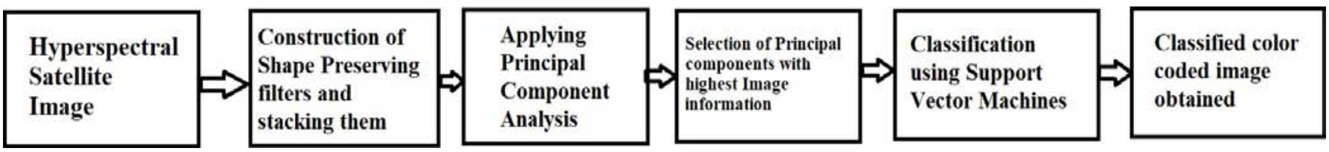

Fig. 1: A Block diagram of the classification method

II. Proposed Experimental Method

The proposed method is divided into four discrete steps besides input and display to the program. The first part illustrates the edge preserving features followed by second part which is application of PCA for dimension reduction. Third part explains the joint working of PCA and preserving filters and finally the fourth part describes the application of SVM for classification of the image pixels based on the feature vector. The shape preserving filter are successively built and stacked together. On these stacked filters, Principle component analysis is applied to calculate the mean square and point the spectral distinctness in the pixels. The final filters after PCA are classified with the help of SVM. The results obtained after testing on hyperspectral datasets prove that this method can efficiently classify the hyperspectral images.

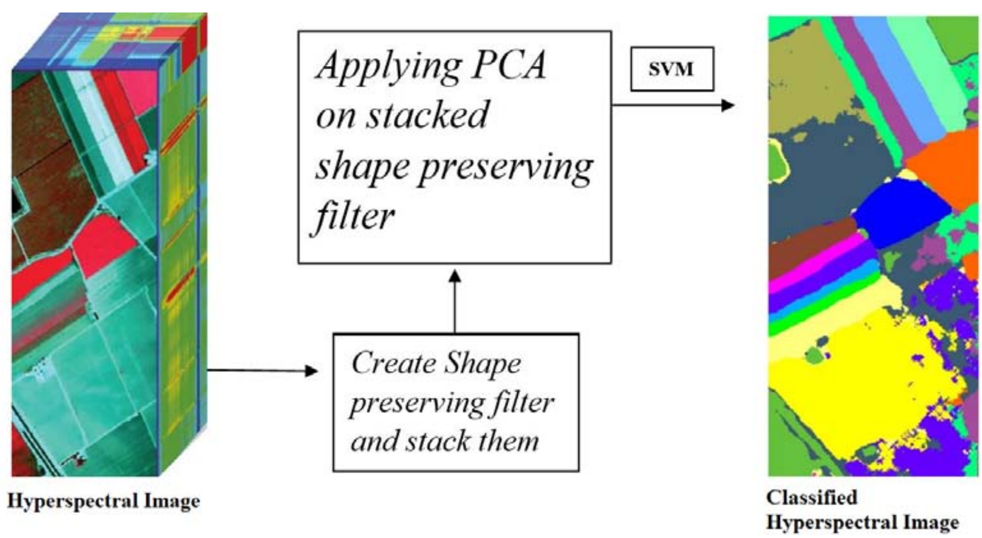

Fig. 2: Pictorial Methodology of Classification

a) *Shape Preserving Filter*

The Shape or edge preserving filters have gained noticeable progress in the fields of computer vision and image processing [7-8]. Also, some of the algorithms related to this filter have been used for hyperspectral imagery [9-12]. The image processing algorithm, which preserves the geometric features of the image while cancelling out the noise in the content of the image is generally referred as the shape preservation filter. It works for the restoration of lines, edges and other geometric shapes of objects present in an image. The edge preserving filter was first reported in [12] which was used for pixel wise classification of digital images imbibing the spectral and spatial information.

The sum of spatial difference and the intensity among the two pixels is given as approximation. Considering a one- dimensional signal 'K' as input the overall (approx.) distance- preserving transformation can be given by eq(1)

$$M_i = K_o + \sum_{m=1}^{n} \left(1 + \frac{P_s}{P_r} |K_j - K_{j-1}|\right) \tag{1}$$

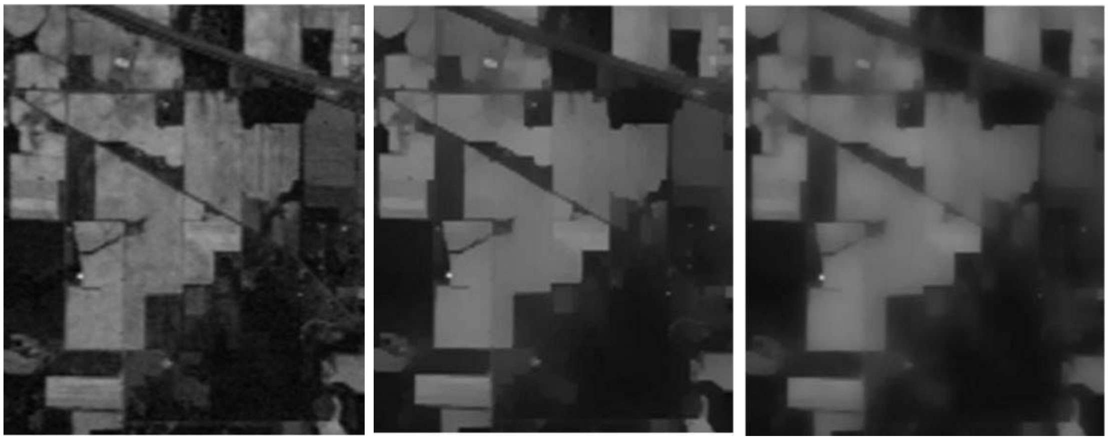

Fig. 3: a) Hyperspectral Band; (b) and (c) Shape preserving filter bands with distinguished settings

Where M is converted domain signal and Ps, Pr are parameters to balance the amount of smoothness. Thus, signal given as input can be produces by recursive filtering and can be given by eqn-2.

$$N_i = (1 - p^q)\,K_i + p^q N_{i-1} \tag{2}$$

Where Ni is the filter taken as output of the ith pixel and p is the feedback constant whereas q gives the distance between two adjacent samples.

$$p = exp(-\sqrt{2}/P_s)\epsilon[0,1] \tag{3}$$

The distance between two adjacent samples is given by q in the conversion domain.

b) Dimension Reduction using PCA

The main objective of PCA is to reduce a complex dataset to show the concealed information by eliminating less in- formative bands. The algorithm has used PCA since it is a standard tool for dimensionality reduction not only for the remote sensing technology but for other fields as well. PCA is mathematically defined as an orthogonal linear transformation that transforms the data in to a new coordinate system such that the greatest variance by some projection of the data comes to lie on the first coordinate (called the first principal component), the second greatest variance on the second coordinate, and so on. PCA represents the data in a new coordinate system in which basis vectors follow modes of greatest variance in the data.

Let a data matrix L, consist of observations J and I variables. The formula for the PCA will be given as follows:

$$P = Q'L \tag{4}$$

Where average of sample vectors constructs the principal components P. The principal components containing the highest information will be at the top. In this way they are arranged in order. The covariance matrix c is used to gives the following equation:

$$Q = FD^{-\frac{1}{2}} \tag{5}$$

Where D is the diagonal matrix obtained from eigen values of c. The eigen vectors of ‘c’ forms a matrix F. If there is [IXJ] matrix H, whose j^{th} column is $L_j - \sigma$, then

$$H = [L_1 - \sigma, ..., L_J - \sigma] \tag{6}$$

Since, σ is the mean vector and c is the covariance matrix, the following equations can be written as:

$$\sigma = \left(\frac{1}{J}\right)(L_1 + ... + L_J) \tag{7}$$

$$c = \frac{1}{J-1} H H^T \tag{8}$$

For the input data L, the preserved components for the process will be G when dimension reduction is done. In MATLAB, the inbuilt function pca (L, G) is used where L is the matrix and G is the number of preserved components. PCA works in a suitable manner by extracting important information from the shape preserving filters and therefore is successful in accentuating the spectral differences among the classes composed of pixels.

c) Feature Extraction

The difficulties faced are mostly due the reason that the measured data vectors are high-dimensional. It is possible to believe that high-dimensional data adheres measurements of an underlying source which are multiple and cannot be measured directly. Applying PCA on a hyperspectral image dataset can be difficult due to various bands. These bands contain noise and disturbed information which affects the required and important information.

The need to diminish the image noise and save value of feature extraction, the dimension of hyperspectral image Data set is to be altered. A simple band averaging method can be used. The data K with I dimensions is sub grouped into e equal size alongside the spectral dimension. ‘e’ gives the number of bands after the dimensions are reduced, K=K1, K2, K3. . . ., Ke. The benefit of this dimension reduction allows the

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Fig. 4: a) Indian Pine Image; b). PaviaU Image; c). Salinas Image @IEEE Data Fusion Contest

pixels of the reduced data to be in relation with the reflectance of the scene. The average based dimension reduction has proved to be sufficient. When the blurring degree is comparatively large, distinguishable pixels spectrally comes under distinguished objects. Whereas a high degree of smoothness is capable of decreasing the noise and increasing the pixels spectrally in the respective area.

d) Classification using SVM

SVM stands in the category of algorithms which have proved to be highly accurate for not only low dimension dataset but also for high dimensional datasets. In comparison to the hyperspectral image classification, some of the published works are [13-16].

SVMs are successfully applied for solving problems like pattern recognition, regression, etc. They are independent of the dimensions specified by the input datasets. From previous research works, it has been shown that higher the dimensionality of the space, lower will be the volume ratio. Thus, the space tends to get empty due to increase in dimensionality and results in "centrifuge effect". Thus, when SVM plays potentially defining distinguishable functions on the basis of large number of samples, the results are accurate. Hyperspectral data allows SVM to distinguish between multiple classes.

The datasets with high dimensionality are handled by SVM when there is a good speed of training and reduction in training sets by sequential sort out vectors which are to be annotated [17]. We have used nonlinear SVM kernel-based method. This method manages to be effective in computation of a high dimensionality feature space b(i). A kernel function can be given by eq (9)

$$K[b_i.b] = \varphi(b_i).\varphi(b) \quad (9)$$

It helps in avoiding the computation of inner products simplifying the results of dual problem. Kernel function can be taken different also.

$$K(b_i, b) = [b_i.b + 1]^b \quad (10)$$

The classification using SVM has been executed in MAT-LAB version2016 using LIBSVM library following radial basis function kernel. All the codes have been implemented in a system with 2.50 GHz CPU and 8 GB RAM. SVM parameter have been resolved by a fivefold cross validation. Later, to make the comparisons for overall accuracy and class accuracy have been calculated.

III. Discussion on Datasets

The algorithm was first applied to the Indian Pines image dataset which has been acquired by Airborne Visible Imaging Spectrometer (AVIRIS) in June 1992. Its dimensions are 145 x 145 with 224 spectral bands. Some of the bands at the lower levels did not give any relevant information and also affected the accuracy. They were affected by water and atmospheric absorption so were removed. 24 low SNR were discarded leaving with 200 bands. It can be inferred that the reference image contain 16 different classes mostly included type of crops.

The dataset provided by Airborne Visible Imaging Spectrometer was available with the first band of the hyper spectral image and their false composites. The different vegetation was segregated into classes as provided by the AVIRS and is shown in Fig5, Fig6, and Fig7. The other two datasets are given further in this section and were also provided with their false composites and vegetation classes. The classification into vegetation classes like Oats, Wheat, Woods, etc., makes it useful for the agriculture sector and weather sector to predict crops with their area. Weather prediction plays an important role here. All the datasets were processed in MATLAB 2016 in 8GB RAM; Windows 10; intel processor.

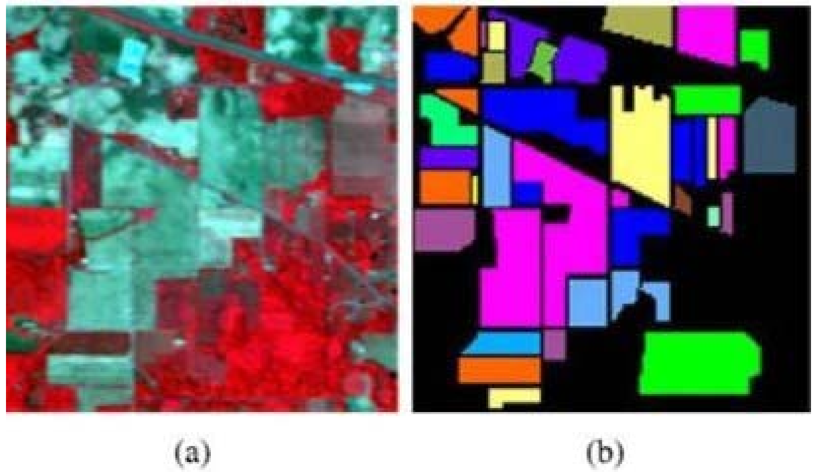

Fig. 5: Indian Pine Dataset:a). Three band color composite; b). Ground Data

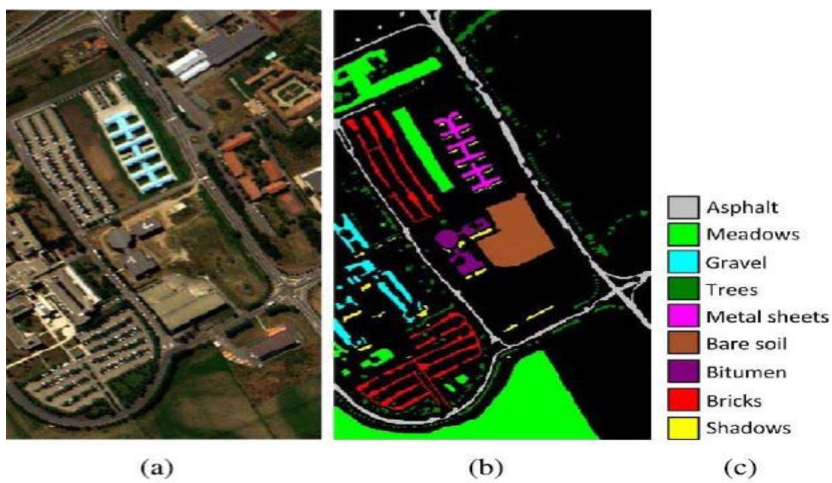

Fig. 6: Pavia U dataset:a). Three band color composite; b). Ground Data

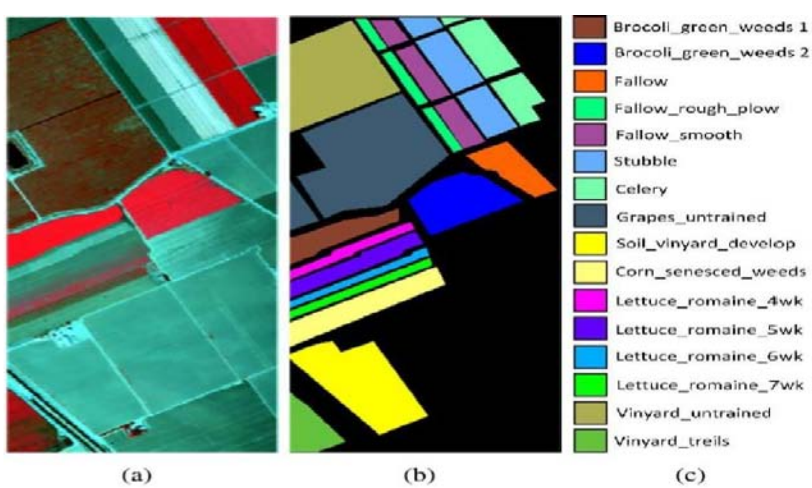

Fig. 7: Salinas Dataset:a). Three band color composite; b). Ground Data

The second dataset is Salinas image, captured by AVIRIs in Valley over agricultural areas, California. Similar to the first dataset, 20 bands were discarded leaving with 204 bands. The dimensions of the dataset are 512 x 217. The third dataset is Pavia U having dimensions 610 $\times$ 340 and 115 spectral bands. This dataset was acquired by reflective optics system imaging spectrometer (ROSIS-03) optical sensor over an urban area around University of Pavia, Italy. 12 irrelevant bands were discarded leaving with 103 bands. It has 16 classes, most of which are man-made building.

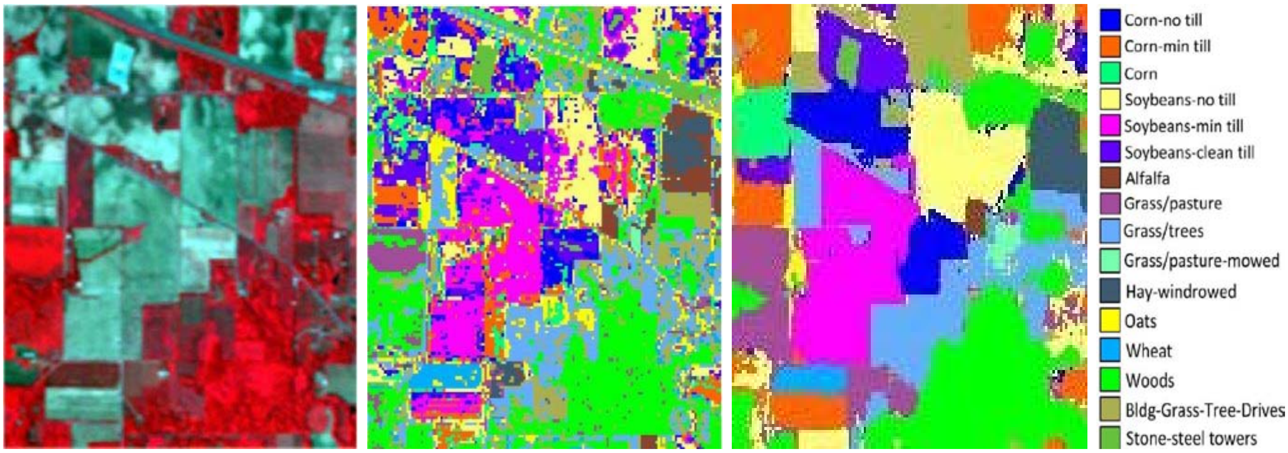

Fig. 8: a). False composite image of Indian Pine dataset, b) Classified Image after SVM algorithm, c) Classified Image after our algorithm

IV. Results and Discussion

The algorithm was first applied on Indian Pine dataset. From Table1, it can be seen that the results acquired by our algorithm are better than doing classification by SVM alone on a hyperspectral image. The accuracy improved by contributing 1% of the ground truth data into training samples. Table1 shows the comparison by calculating accuracy of classification per class and later by calculating overall accuracy. Table2 also shows the calculated Kappa coefficient and class accuracy. The false color composition of the image is also compared with the color composite classification of the image.

Table 1: Classification Performance of Indian Pine Dataset

Class Name	SVM accuracy per class	Our algorithm accuracy
Alfalfa	26.12	95.52
Corn N	45.87	74.95
Corn M	42.69	72.11
Corn	25.33	75.78
Grass M	56.34	89.65
Grass T	76.87	92.43
Grass P	26.12	81.30
Hay W	92.45	97.98
Oats	9.32	86.86
Soybean N	40.53	69.71
Soybean M	60.77	90.67
soybean C	26.18	87.42
wheat	76.08	99.02
wood	85.62	94.63
buildings	22.76	94.32
stone	80.55	92.79

Table 2: Comparison of Accuracy of Classification Performance

Parameters	SVM algorithm	Our Algorithm
overall accuracy	52.17	86.28
class accuracy	51.22	87.03
Kappa coefficient	45.56	84.51

The algorithm was applied on two more datasets, i.e., Salinas and PaviaU hyperspectral Image dataset. The results are shown in the figure. All the parameters were also calculated for these datasets. The accuracy was our algorithm was high than the application of SVM alone. This verifies that Shape preserving filter with PCA is effective for SVM technique for the classification of the hyperspectral images.

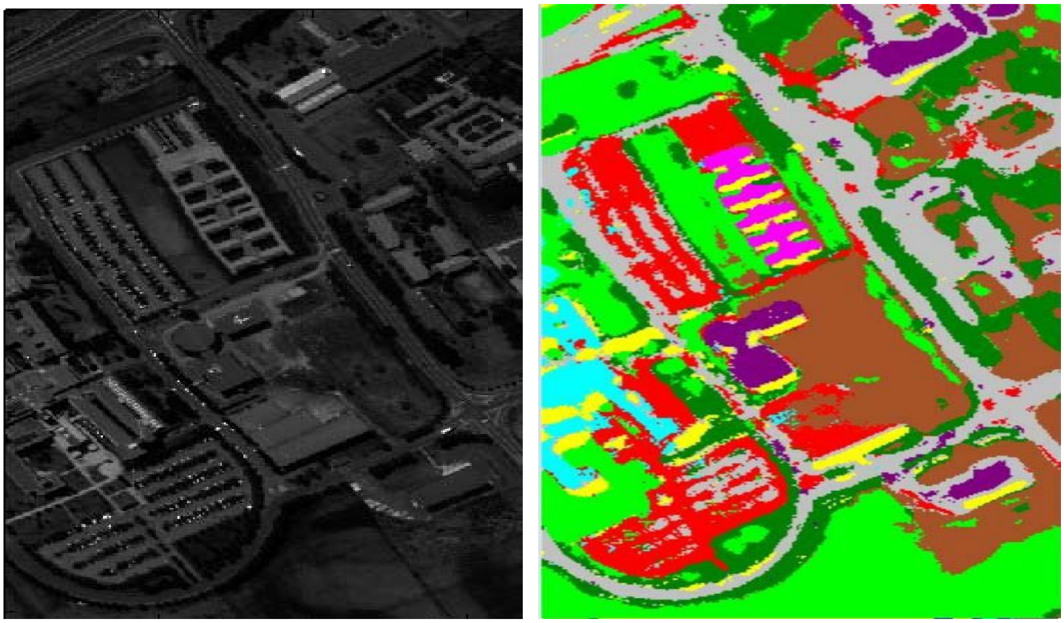

Fig. 9: a) PaviaU hyperspectral Image, b). classified image after applying our algorithm

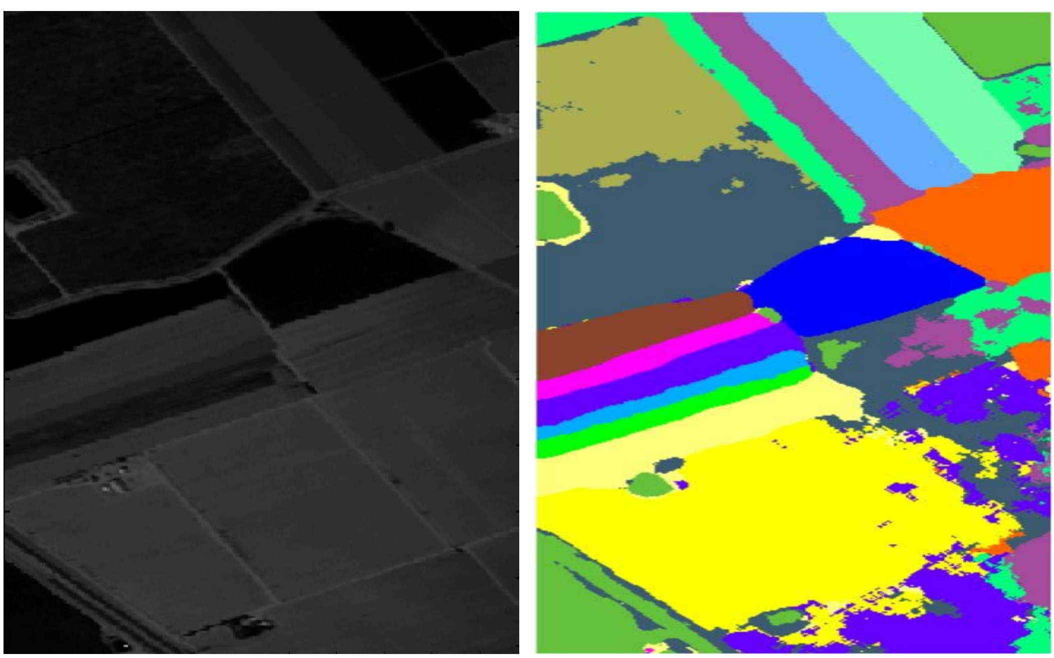

Fig. 10: a) Salinas hyperspectral Image, b). classified image after applying our algorithm

V. Conclusion

The motivation for this work was to built an efficient classification algorithm to differentiate between classes in a hyperspectral images. Hyperspectral images are proficient in giving various applications which are used to predict different prameters related to earth, be it the vegetation or the weather. Classification of hyperspectral image helps in structured planning of crops as well. In this paper, an algorithm has been proposed by adding a shape preserving filter with the dimension reduction technique to make the SVM classification more accurate.

The benefit of PCA is that, it coelesce with the shape preserving filter effectively and helps in distinguishing the various classes in an image. This makes the algorithm more accurate. The accuracy obtained by applying Support Vector Machine is less than the algorithm with the PCA- shape presrving filter methodology. This algorithm is helpful for various applications produced through the classification of a hyperspectral image. Land use classification can be enhanced and analysis of crop field will be done appropriately. The detection of illegal agriculture which exists on large scale can be acquired too. The future work of this research is to improve the drawback of individually selecting the parameters of the filter which results in decrement of prime ability to apply in some of the practical needs.

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The Fast Integration of a Rotated Rectangle Applied to the Rotated Haar-like Features for Rotated Objects Detection

By Mohamed Oualla, Khalid Ounachad & Abdelalim Sadiq
Moulay Ismail University

Abstract- The Integral Image technique, used by Viola and Jones, is generally used to calculate the integral of a rectangular filter in an input picture. This filter is a rectilinear rectangle. We propose a method to integrate a rotated one by any angle of rotation inside an image based on the Bresenham algorithm of drawing a segment. We use some pixels – called key points - that forms the four segments of a rotated rectangle, to calculate its Integral Image. Our method focuses on three essential tasks; the first is to determine the rule for drawing a segment (SDR), the second is to identify all the key points of the rectangle r, and the third is to calculate the integral image. The speed of this method depends on the size and angle of rotation of the rectangle. To demonstrate the efficiency of our idea, we applied it to the rotated Haar-like features that we proposed in a later work [12], which had as objectives the improvement of the Viola and Jones algorithm to detect the rotated faces in a given image. We performed tests on more widespread databases of images, which showed that the application of this technique to rotated Haar-Like features improves the performance of object detectors, in general, and faces in particular.

Keywords: *haar-like features, integral image, face detection, object detection, viola & jones algorithm, adaboost.*

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THEFASTINTEGRATIONOFAROTATEDRECTANGLEAPPLIEDTOTHEROTATEDHAARLIKEFEATURESFORROTATEDOBJECTSDETECTION

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The Fast Integration of a Rotated Rectangle Applied to the Rotated Haar-like Features for Rotated Objects Detection

Mohamed Oualla [α], Khalid Ounachad [σ] & Abdelalim Sadiq [ρ]

Abstract- The Integral Image technique, used by Viola and Jones, is generally used to calculate the integral of a rectangular filter in an input picture. This filter is a rectilinear rectangle. We propose a method to integrate a rotated one by any angle of rotation inside an image based on the Bresenham algorithm of drawing a segment. We use some pixels – called key points - that forms the four segments of a rotated rectangle, to calculate its Integral Image. Our method focuses on three essential tasks; the first is to determine the rule for drawing a segment (SDR), the second is to identify all the key points of the rectangle r, and the third is to calculate the integral image. The speed of this method depends on the size and angle of rotation of the rectangle. To demonstrate the efficiency of our idea, we applied it to the rotated Haar-like features that we proposed in a later work [12], which had as objectives the improvement of the Viola and Jones algorithm to detect the rotated faces in a given image. We performed tests on more widespread databases of images, which showed that the application of this technique to rotated Haar-Like features improves the performance of object detectors, in general, and faces in particular.

Keywords: haar-like features, integral image, face detection, object detection, viola & jones algorithm, adaboost.

I. Introduction

Adaboost learning algorithm, proposed by [1], and adapted by Viola and Jones for object detection [2][3], is one of the most widely used algorithms in detection. This algorithm, based on Haar-like features (Fig. 2), achieves a high detection rate and we use it widely in face and pedestrian detection [4] [5] [6].

Haar-like feature classifiers trained by Adaboost algorithm are often incapable of finding rotated objects (Fig. 1). Many experts have proposed several solutions to fill this problem; Viola and Jones [2] [3] [4] used rotated positive examples during training, but this approach may give some inaccurate classifier. Another process adopted by several researchers [5] [7] [9] [10] consists of training several classifiers which specialize in certain angle intervals, this approach provides classifiers with appropriate accuracy and efficiency, but it makes the training computationally more expensive. In [7][8] the image is physically or virtually rotated until the edges of the Haar-Like feature are aligned vertically or horizontally, this approach makes the detection computationally more expensive and also a loss of information when a set of pixels will be outside the region of interest.

Fig. 1: Face detection with the latest method [12]; The algorithm is unable to detect a few rotated faces.

In [12], we gave a solution allowing, firstly, to define, dynamically, a set of rotated Haar-Like Features by more than 50 angles formally expressed by $arctang$ $(A\ /\ B)$ such that A and B are two integers. And secondly, to calculate, approximatively, the rotated integral image of these rectangles to preserve the two advantages (speed and simplicity) for which Viola and Jones invented this technique for the first time. This method has shown a disadvantage, a little annoying, which consists of a false alarm rate, which is relatively high.

In this paper, we propose a method that calculates the real Integral Image of a rotated rectangle based on the set of pixels, called key-points, forming each of its four segments.

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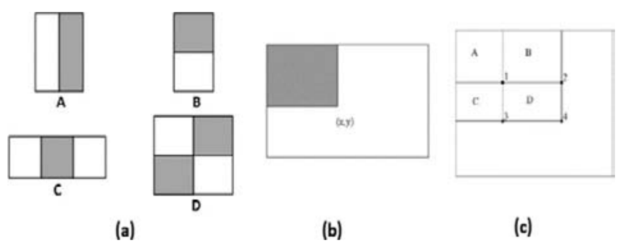


Fig. 2: (a) Haar-Like basic features, used by Viola-Jones in [2]. (b) Integral Image (c) Calculation of the sum of the rectangle D with the Integral Image.

Indeed, we determine these points by adapting the algorithm for drawing a segment [13].

We organize this paper as follows: Section II presents some work done in the literature. In section III we will propose our technique concerning the quickly integration of a rotated rectangle. Section IV explores the results obtained by our two experiments carried out for the case of face detection. In section V, we will give a summary of our work, some conclusions, and perspectives.

II. Related Work

The technique of the Integral Image, strongly associated with the famous algorithm of Viola and Jones [2], is a technique that goes back to the year 1984 when Crow [16] introduced it, for the first time, in computer graphics. Its use in computer vision began in 2001 when Viola and Jones used it to calculate the integral of the rectangular filters called HaarLike features, shown in Fig.2 (a), considered as one of the pillars of their real-time face detection algorithm. Therefore, most researchers have widely used and developed this technique to solve the problems related to the detection of objects, including faces detection [2][7], pedestrian detection [4][6], etc.

Let i be an image of dimension $M \times N$, $i(x, y)$ is the intensity of the pixel (x, y) of the image i. The *Integral Image* is another image ii such that for each pixel (x, y): (see Fig. 2(b)).

$$ii(x,y) = \sum_{\substack{x' \leq x \\ y' \leq y}} i(x',y') \quad (1)$$

Therefore, the integration of each axis-aligned (parallel to the axes of the image coordinate system) rectangle $R = [(x, y), w, h]$ is calculated only in four references: (see Fig. 2(c))

$$ii(R) = ii(x + w, y + h) - ii(x, y + h) - ii(x + w, y) + ii(x, y) \quad (2)$$

As (x, y) is the upper left corner of R, w and h represent, respectively, its width and height. In the rest of this article, this type of rectangle is called a *normal rectangle*.

This technique was then the subject of several improvements, in order to detect rotated objects in an image. Indeed, several works have chosen to feed the original set of *HaarLike features*, initially proposed by Viola and Jones (Fig.2 (a)), by others which are rotated by a variety of angles and offering an ease of calculating their integration. In particular, Lienhart et al. [5] who introduced a 45° tilted integral image. Then, Barczak et al. [7] and Du et al. [8] retained the same technique of Viola and Jones to incorporate rotated features by 26.57° and 63.5°. Then Barczak and Mossom [9] tried to generalize this technique for angles having a tangent in the form of a rational number $1/n$ or $n/1$. Another work is that of Ramirez et al. [10], who introduced the asymmetric Haar Features. Pham et al. [14] have developed a technique called Polygonal integration to divide a polygon into a set of axis-aligned rectangles (*normal rectangles*), then determine its integration according to those of these rectangles. Doretto et al. [15] gave an extension of formula 1 to compute the integral of a domain $D \subset \mathbb{R}^n$, which consists of a finite unification of axis-aligned rectangles.

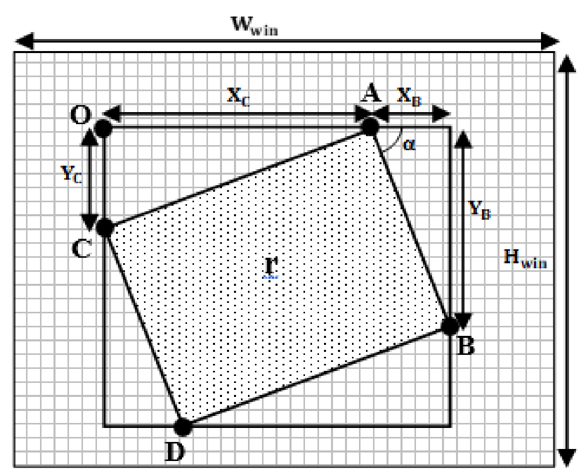


Fig. 3: Representation of a rotated rectangle.

III. Fast Integration of the Rotated Haar-Like

a) Rotated Haar-Like features

A rotated Haar-Like feature is a rectangle rotated by a given angle. The rotated Haar-like features are based on the normal ones presented in [2]. In a scan window named Win - with $Hwin$ as height and $Wwin$ as width - a rotated rectangle is defined by its vertex A (xA, yA), its rotation angle α and its rectangle encapsulating $R[o(xA - xC, yA), w = XC + XB, h = YB + YC]$ as shown in Fig. 3.

Formally, a rotated rectangle is defined by a six-element vector as shown by the following formula:

$$r_A^t = (A, X_B, Y_B, X_C, Y_C, \alpha) \in Win \times (\mathbb{N}^*)^4 \times \mathbb{R}^*$$

$$such\ as\ n_\alpha = \frac{Y_B}{X_B} = \frac{X_C}{Y_C} \tag{3}$$

$$and\ \alpha = arctan\ (n_\alpha)\ /n_\alpha\ \in \mathbb{Q}^*$$

$$and\ Y_B + Y_C + y_A < H_{win}, \qquad X_B + x_A < W_{win}$$

The set of rotated rectangles $\mathcal{R}$ is divided into two categories $\mathcal{R}a$ and $\mathcal{R}b$. These two categories are defined by formulas 4 and 5.

$$\mathcal{R}a = \{r \in \mathcal{R} |\ (yB\ \geq yc\ \ ET\ xA\ \geq xD)\ OU\ (yB\ \leq yc\ ET\ xA \leq xD)\} \tag{4}$$

$$\mathcal{R}b = \{r \in \mathcal{R} |\ (yB\ > yc\ \ ET\ xA\ < xD)\ OU\ (yB\ < yc\ ET\ xA > xD)\} \tag{5}$$

Knowing that B, C and D are other vertices of the rotated rectangle r, as shown in Fig. 3.

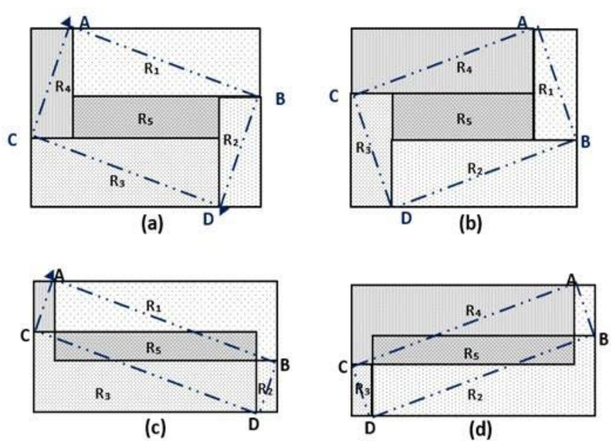


Fig. 4: Representation of a rotated rectangle of the category $\mathcal{R}a$ by (a) and (b) and $\mathcal{R}b$ by (c) and (d).

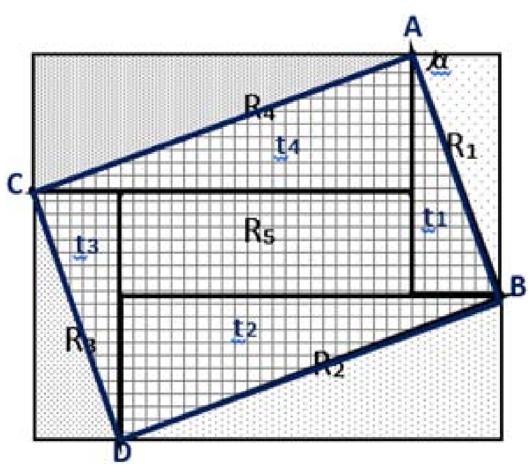


Fig. 5: A rotated rectangle divided into triangles.

b) The integration of a rotated rectangle

The principle of our method consists in dividing the rectangle that encapsulates r into five *normal* rectangles called Ri, as shown in Fig. 4 and 5. The result of the intersection of r with the rectangles Ri is the right triangle called ti . We illustrated this definition in Fig. 5. The following equation gives the identification of these triangles: $ti = r \cap Ri$ for $i \in \{1,2,3,4\}$.

Knowing that the integral of a rotated rectangle is:

$$I(r) = \iint_{(x,y)\in r} i(x,y) \tag{6}$$

such that $i(x, y)$ is the intensity of the pixel (x, y) belonging to the rectangle r. The exploitation of the integral image technique proposed by Viola and Jones [2] leads us to reformulate equation 6 in this form:

$$I(r) = \sum_{i=1}^{4} In(t_i) + S \times I(R_5)\ /\ \begin{cases} S = +1\ if\ r \in \mathcal{R}_a \\ S = -1\ if\ r \in \mathcal{R}_b \end{cases} \tag{7}$$

such that: $I(R5)$ is the *Integral Image* of $R5$ rectangle calculated according to the equation 2. $In(ti)$ is the integration of the triangle ti .

Indeed, we can divide a triangle t into several *normal* rectangles Ri (axis-aligned rectangles) (Fig. 6). The two vertices (Mi, Ni) of each rectangle Ri crossed by the hypotenuse of the triangle t are named *key points*. The set of these *key points*, $\mathcal{PC}$, are found by applying the Segment Drawing Rule (SDR) [13]. In fact, $\mathcal{PC} = \mathcal{M} \cup \mathcal{N}$ such that:

$$\mathcal{M} = \mathcal{M}t1 \cup \mathcal{M}t2 \cup \mathcal{M}t3 \cup \mathcal{M}t4$$

$$\mathcal{N} = \mathcal{N}t1\ \cup \mathcal{N}t2\ \cup \mathcal{N}t3\ \cup \mathcal{N}t4$$

Knowing that $\mathcal{M}ti$ and $\mathcal{N}ti$ are, respectively, the set of key points Mi and Ni of the triangle ti.

Mathematically speaking, let $f: \mathcal{R} \rightarrow \mathcal{PC}^n$ be a function that determines the vector $vp = (P0, \ldots, Pn)$ of the key points, for each rectangle r of R, therefore: $f(r) = vp = (P0, \ldots, Pn)$. And $g: \mathcal{PC}^n \rightarrow \mathbb{R}$ a function that computes the *Integral Image* from a vector of points. In other words, $g(vp) = I(r)$. Indeed, we define the function I as a function composed of f and g: $I(r) = fog(r)$.

Therefore, the method proposed in this article, to calculate the *Integral Image* of a rectangle, is based on three essential tasks:

- Determine the rule for drawing a segment (SDR);
- Determine all the key points (Mi, Ni) of the rectangle r;
- Calculate the integral image of r according to its key points.

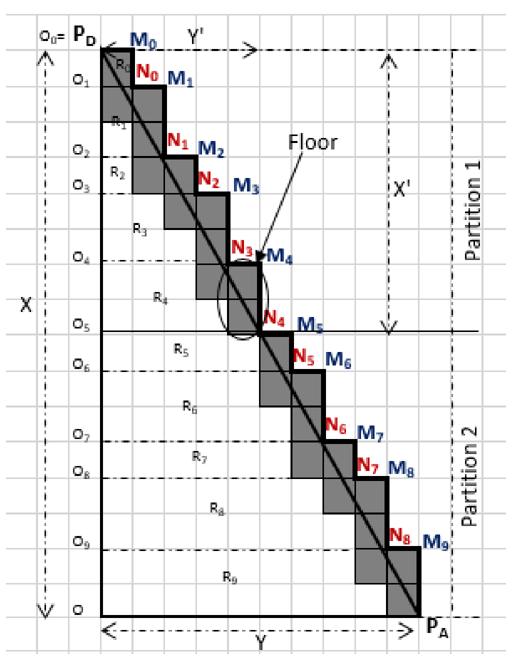
c) Triangle integration

The major problem of the computation part of the integral of a right triangle t is that each slope of its hypotenuse presents different difficulties. Is very difficult to integrate a line with an irrational slope because at the level of each pixel intersected by the line, the partition model is always different. For our case, the slope of the hypotenuse of the triangle t is rational. Specifically, a line with a rational slope produces a finite number of pixel partition models.

Consider, for example, a positive slope n of a line L, when this line crosses a set of pixels, the model of partitions of the pixels is repeated at each n pixels intersected by the line L [14]. This repetition is the key of our solution proposed in this article. More generally, let $d = n/m$ $(n, m \in Z \; and \; m \geq 0)$ be a rational slope, the integer vector $vd = (m, n) \, / \, gcd \, (|\, n \,|, |\, m \,|)$ represents a 2D interval such as the partition model is periodic. Otherwise, the partition model at any pixel (x, y) is the same at $(x, y) + vd$. To determine the pixels traversed by a line L, we used the Bresenham algorithm [13], which makes it possible to define the Segment Drawing Rule (SDR).

Segment Drawing Rule (SDR): Based on the Bresenham algorithm [13], which allows determining all the pixels forming a segment, we have defined the rule allowing to go through all the pixels forming the hypotenuse of a iangle t (Fig. 6 (a)). This rule $RSDR$ is a vector formally defined as follows: $RSDR = (n1, n2, \ldots, ne)$ such that e represents the number of floors which is equal to $min(Y', X')$ and ni that of pixels for the ith floor; Fig. 6 (b) gives an example of these values. A floor is a set of ni pixels aligned either vertically $(if \; \alpha < 45°)$ or horizontally $(if \; \alpha > 45°)$. The transition from one floor to another is done by moving a pixel to the right for sides $[AB]$ and $[CD]$ and left for $[AC]$ and $[BD]$. A particular case is that of $\alpha = 45°$, the number of pixels for each floor is always equal to 1, and the displacement can be done in both directions.

Indeed, the Segment Drawing Rule (SDR) is the result of the function s: $\mathfrak{S} \rightarrow \mathbb{N}^e$ which takes in parameter a segment S and returns a vector.



(a)

(X, Y)	(16,10)
$N = \gcd(\|X\|, \|Y\|)$	2
$(X', Y') = (X, Y) / N$	(8,5)
$e = min(X', Y')$	5
$R_{SDR} = (n_1, n_2, \ldots, n_e)$	$R_{SDR} = (2{,}3{,}2{,}3{,}2)$
k	10
d	$vertical - right$

(b)

Fig. 6: (a) Rule for drawing a segment, (b) Example of values for $X = 16$, $Y = 10$.

$RSDR = (n1, n2, \ldots, ne)$. S is the set of segments of a polygon; for our case, we are talking about a rectangle with four segments. Each segment is formally defined as follows: $S = (PD, PA, X', Y', N, k, d)$, such that:

- PD and PA are, respectively, the starting point and the arrival point of the segment S;
- $N = \gcd(|X|, |Y|)$ is the number of partitions or repetitions of $RSDR$;
- $(X', Y') = (X, Y) / N$;
- $k = min(X, Y) = min(X', Y') * N = e * N$: the number of floors composing the hypotenuse of the triangle;
- d: Represents the direction of the path to follow, to browse all the pixels:

if α<45° then d∈{vertical-right,vertical-left}

if α>45° then d∈{horizontal-right,horizontal-left}

Algorithm 1 shows the definition of the segment drawing rule (SDR) for both segments $[AB]$ and $[CD]$ with a direction $d = Vertical - Right$.

The authors of [14] have shown that the number of pixels, denoted np, traversed by the hypotenuse of the right triangle t for each partition is $np = |\, X' | + |\, Y' \,| - 1$, indeed, we easily deduce that the total number of pixels traversed by the hypotenuse of t is: np

$\times\ N$. Therefore, to determine the SDR, algorithm 1 traverses $(np + e) \times N$ pixels.

Integral image of a right triangle: As mentioned above, the principle of our method is based on the division of a triangle into k normal rectangles Ri. A normal rectangle Ri is defined by the following quadruple: (see Fig. 6 (a)) $Ri = [OiMiNiOi{+}1]\ for\ t1$, such us :

- $t1$ is the triangle with the hypotenuse as segment $[AB]$, shown in Fig. 5;
- k: Number of floors;
- $i = 0,1, \dots, k-1$;

Algorithm 1 Get SDR

Require

- P_D: *Starting point* $(A\ or\ C)$
- $(X', Y') = (X, Y)\ /\ \gcd(|X|, |Y|)\ and\ (X, Y) = (X_B, Y_B)\ see\ Figure\ 2$
- $e = min(X', Y')$ number of floors
- $n_i = umber\ of\ pixels\ on\ the\ i^{th}\ floor$

Ensure: $SDR\ for\ segment\ [AB]\ and\ [CD]$

Initialisation:

```
p(x_p, y_p) = P_D + 1
Do:
  For i = 1 to e − 1 do
    c = x_p, n_i = 0
    While c ≥ 0 do
      x_p = c
      if p in segment (AB or CD)
      and p inside rectangle then
        − increment n_i
        − increment c
      Else
        x_p = c − 1
        y_p = y_p + 1
        Break;
    End While
  End For
Return SDR
```

- $Nk{-}1 = PA\ and\ O0 = PD$;
- $Ok = O$.

Therefore, the *Integral Image* of a triangle t will be the sum of those of all rectangles Ri, formally:

$$In(t) = \sum_0^{k-1} Im(R_i) /\ k\text{: number of rectangles } R_i. \quad (8)$$

Indeed, the Integral Image of a normal rectangle Ri, $Im(R\boldsymbol{i})$, according to formula 2 is:

$$Im(\boldsymbol{R_i}) = ii(N_i) - ii(O_{i+1}) - ii(M_i) + ii(O_i) \quad (9)$$

Such as the function ii represents the Integral Image of a given pixel.

Therefore, from equation 8 and 9, we deduce the formula to calculate the Integral Image of a triangle t (case of triangle $t1$):

$$In(t) = \sum_0^{k-1} Im(\boldsymbol{R_i}) = ii(P_D) + ii(P_A) - ii(O) + \sum_0^{k-2} ii(N_i) - \sum_0^{k-1} ii(M_i) \quad (10)$$

Knowing that for $t1$: $PD = A\ et\ PA = B$.

According to this principle, we deduce the formulas for calculating the integral image of all types of triangles of the rotated rectangle r: (Fig. 5)

$$In(t_1) = ii(A) + ii(B) - ii(O) - \sum_0^{k-1} ii(M_i) + \sum_0^{k-2} ii(N_i) \quad (11)$$

$$In(t_2) = ii(O) - \sum_0^{k-1} ii(M_i) + \sum_0^{k-2} ii(N_i) \quad (12)$$

$$In(t_3) = -ii(O) + \sum_0^{k-1} ii(M_i) - \sum_0^{k-2} ii(N_i) \quad (13)$$

$$In(t_4) = -ii(A) - ii(C) + ii(O) + \sum_0^{k-1} ii(M_i) - \sum_0^{k-2} ii(N_i) \quad (14)$$

d) Rotated Rectangle Integration

In the end and according to equation 7, formula 15 shows the Integral Image of a rotated rectangle. That of the rectangle of the medium $R5$ is easily found via the equation 2.

$$I(r) = ii(B) - ii(C)) - \sum_0^{k-1} ii(M_{1i}) + \sum_0^{k-2} ii(N_{1i}) - \sum_0^{l-1} ii(M_{2i}) + \sum_0^{l-2} ii(N_{2i}) + \sum_0^{k-1} ii(M_{3i}) - \sum_0^{k-2} ii(N_{3i}) + \sum_0^{l-1} ii(M_{4i}) - \sum_0^{l-2} ii(N_{4i}) \quad (15)$$

Knowing that k is the number of floors of the hypotenuses of triangles $t1$ and $t2$ and l that of triangles $t2$ and $t4$. So, the total number of key points Pi of a rotated rectangle r, adding the two points B and C, is $n = 4\ (k + l) - 2$.

In general, the *Integral Image* of a rotated rectangle r is:

$$I(r) = \sum_0^{n-1} \rho_i * ii(P_i) / \rho_i \in \{+1, -1\} \quad (16)$$

Such as ρi is the parity corresponding to the pixel Pi. Fig. 7 shows the variation of the sign ρi according to the type of the triangle and the key point ($+1$, for B, and -1 for C)

Algorithm 2 illustrates the process proposed to find these points for the two segments $[AB]$ and $[CD]$ with the direction of the path $d = Vertical - Right$.

Indeed, to compute the *Integral Image* of a rotated rectangle, we need 4 $(k + 1) - 2$ access to the memory, which means that the associated algorithm has a linear complexity O(n). In practice, the worst-case complexity varies between 40 and 74 operations for only 12% of cases.

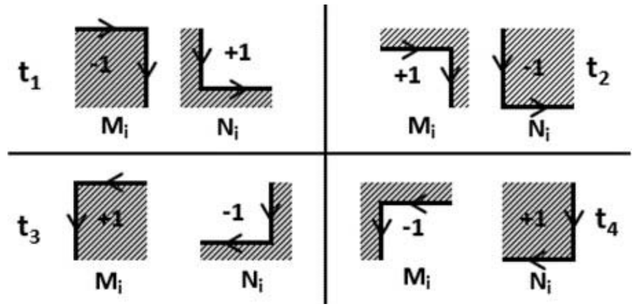


Fig. 7: The variation of the sign ρi according to the type of the triangle and the key point (M or N)

Algorithm 2 Get key points

Require

– $S = (P_D, P_A, X', Y', N, k, d)$ *such as* $P_D =$ A or C and $P_A =$ B or D

– $R_{SDR} = (n_1, n_2, \ldots, n_e)$

– $d = Vertical - Right$

Ensure: *Key points for segment* $[AB]$*and* $[CD]$

Initialisation:

$$M_0(x_{M_0}, y_{M_0}) = \begin{cases} x_{M_0} = x_{P_D} + 1 \\ y_{M_0} = y_{P_D} \end{cases}$$

Do:

For $i = 1$ ***to*** $k - 1$ ***do***

$x_{M_i} = x_{M_{i-1}} + 1$

$c = i \bmod e$

if $c <> 0$ ***then***

$y_{M_i} = y_{M_{i-1}} + n_{c-1} - 1$

Else

$y_{M_i} = y_{M_{i-1}} + n_{e-1}$

$x_{N_{i-1}} = x_{M_{i-1}}$

$y_{N_{i-1}} = y_{M_i}$

End For

Return *key points*

The complexity in the best case varies between 6 and 20 operations for more than 45% of cases, and 23 on average for all cases.

IV. Experiences

During the learning phase, we adopted the use of two of the most known and most available databases in our field, which are: UMIST Face Database [17] and CMU-PIE Face Database [18]. The base of faces UMIST consists of 564 images - cut and trimmed - of 20 people (mixed race, kind, and appearance) [17]. In this database we represent each person's frontal profile by a multitude of images illustrating a range of poses from different angles; their number is about 19 up to 36 for each person. These images are sampled, in our experience, up to a resolution of 20 × 20. Their number is 6900 images of faces. The CMU-PIE database contains 41,368 images obtained from 68 people. These images were taken in the CMU 3D room using a set of 13 high-quality color cameras synchronized with 21 flashes. The resulting RGB color images are 640 × 486 in size. These images are sampled, in our experiment, up to a resolution of 18 × 20. And for the training of our detector, we used 9996 images of faces. For the test phase, we used the standard MIT + CMU base which contains 117 images with 511 faces.

The result of our work is the creation of two detectors UMIST-Detector and PIE-Detector from the process of learning using the two image bases, respectively, UMIST and PIE CMU described above.

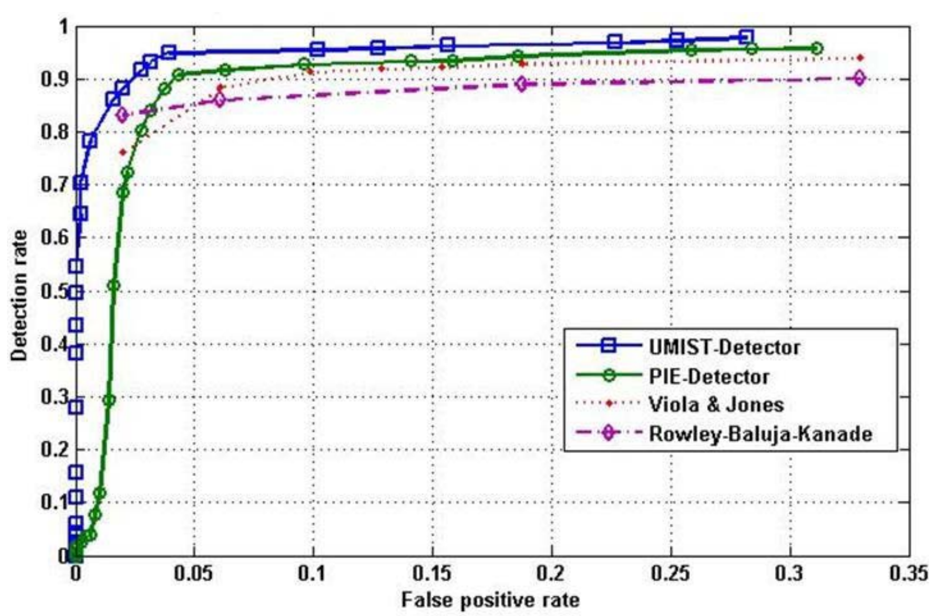


Fig. 8: The ROC curve of UMIST-Detector, PIE-Detector, and other detectors using the MIT-CMU test base.

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The learning phase uses more than 300,000 features (or weak classifiers) divided into two types: normal and rotated. The storage of this large number of features took on a large amount of memory. The result of this phase is a detector composed of a group of features selected by the AdaBoost algorithm. For each feature selected, it takes about 3 to 4 hours - sometimes more - calculating time using an HP Notebook PC with a 2.6 GHz frame rate and 4 GB of memory. This slowness of learning was considered a major drawback of the Viola & Jones method.

Table 1: Number of normal and rotated Haar-Like features selected by AdaBoost for each Data Base

	UMIST	CMU-PIE	VIOLA & JONES
Normal	4103	4075	4297
Rotated	6424	4393	0
TOTAL	10527	8468	4297

Our program was run for 21 days for the first experience and 15 days for the second. The first detector consists of 10527 features distributed over 53 stages, and the second detector contains 8468 features spread over 46 stages.

The Viola-Jones detector contains 4297 features distributed over 32 stages, as is presented in the article of its authors [2][3]. The difference in the number of weak classifiers of our detectors and that of Viola and Jones is because we use, at most of the original features, those rotated by different angles. Table I shows the numbers of normal and rotated features selected by AdaBoost for each experiment, compared by the number obtained by Viola and Jones. Indeed, this added value has allowed us to achieve good results. These results clearly show that our detectors have correct detection rates greater than or nearly equal to those reported by Viola-Jones. UMIST-Detector has a detection accuracy of up to 97.8%, and this amounts to the fact that the images of the UMIST database are better pre-processed and standardized at the level of illumination, rotation of faces, different human races, etc. With PIE-Detector the detection rate cannot exceed the 95.9% threshold. To have performance tests comparable to those performed by Viola & Jones and Rowly [2][3][11], we used the MIT-CMU test database, which consists of 117 images and 511 faces. Viola and Jones used 130 images and 507 faces. A difference that we neglected because most of the images were the same or have undergone some slight modifications. Fig. 8 illustrates these results as a ROC.

The results are generally better, especially those obtained by Viola and Jones. Our two detectors have lower false alarm rates than the other methods; 28% for the first experience and 31% for the second. By using a 2.3 GHz core i3 and a 4 GB memory capacity, our detectors can scan an image of 252 × 426 pixels in about 0.9 seconds with a scaling factor of 1.2. what makes them a little bit slow compared to that of Viola and Jones (0.7 seconds to scan an image of 384 × 288), and this is mainly due to the large number of weak classifiers used by our method. The average speed to determine all the key points for each rotated feature does not exceed 62.4 μs.

V. Conclusion

In this work, we have proposed a simple, and effective method to integrate a rectangle rotated by any angle of rotation. The principle of this technique is to find specific pixels (key points) for each segment of the rectangle, then calculate the sum of its pixels according to these points. To find these points, we adopted the Bresenham algorithm for drawing a segment. This technique applied to the Viola and Jones algorithm with rotated HaarLike features added to the core set has proven efficiency and a high detection rate for detecting rotated faces in an image. In fact, we performed two experiments using, for the training phase, two image databases known in the literature, notably UMIST and CMU- PIE, and the MIT-CMU database for the test phase. Our perspective is to apply this technique for real-time detection and also for face and emotion recognition.

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The Optimum Encryption Method for Image Compressed by AES

By Marwah Kamil Hussein
University of Basrah

Abstract- In this paper, the idea of partial encoding has been proposed to use for secure encryption of only a portion of compressed data. Only 10% -25% of the output is encrypted from the Quad tree compression algorithm. As a result, the encryption and decryption time has been reduced considerably. Thus, in the compression stage, the Quad tree compression algorithm is used while in the encoding stage, the Advanced Encryption Standard (AES) algorithm is applied. The proposed partial coding system is fast and safe and does not reduce the compression performance of the underlying specific algorithm.

Keywords: quad tree compression, image processing, compression, encoding, decoding, partial encryption, AES.

GJCST-F Classification: I.4.2

THEOPTIMUMENCRYPTIONMETHODFORIMAGECOMPRESSEDBYAES

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I. Introduction

The use of image and video applications such as the World Wide Web and video conferencing has increased dramatically in recent years. When communication bandwidth or storage is limited, data has been often compressed. Especially when a wireless network is used, low bit-rate compression algorithms are needed because of the limited bandwidth. The processing time for encryption and decryption is a major bottleneck in real-time image and video communication and processing. Moreover, we must also take into account the processing time required for compression and decompression.

We propose a novel approach called partial encryption to reduce encryption and decryption time in image communication and processing. In this approach, only part of the compressed data is encrypted. Partial encryption allows the encryption and decryption time to been significantly reduced without affecting the compression performance of the underlying compression algorithm [1].

The aim of the algorithm proposed here is to combine image compression with encryption. Many researchers have examined the possibility of combining compression and encryption. In 1997, Li X., KnipeJ., Cheng H. [2] proposed two separate algorithms to compress and encrypt images. In the first, a Quad tree-based algorithm has been used to decompose the image in the spatial domain. In the second, a wavelet transform has been used to decompose the image in the transform domain and a modification of the SPIHT algorithm. A partial encryption method in this work takes advantage of the tree structure and simplifies, or even eliminates, the need for secret- key encryption. In 1997, Tang L.[3] proposed the idea of incorporating cryptographic techniques (random algorithms) with digital image processing techniques (image compression algorithms) to achieve compression (decompression) and encryption (decryption) in one step. In 1998, Cheng H.[4] proposed an alternative solution, called partial encryption, in which a secure encryption algorithm has been used to encrypt only part of the compressed data. Partial encryption is applied to quad tree image compression algorithm in this work.

In the present work, only part of the compressed image is encrypted. Some compression algorithms have been important parts that provides a significant amount of information about the original data; partial encryption approach encrypts only it, as illustrated in Figure (1). A significant reduction in encryption and decryption time has been achieved when the relative size of the important part is small.

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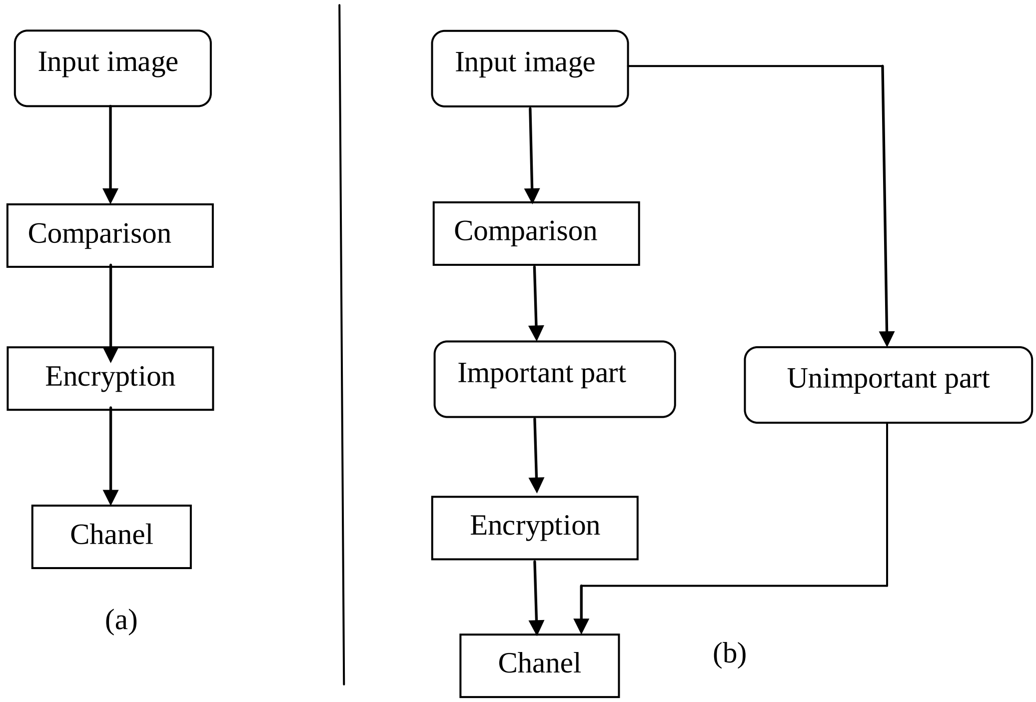

Figure 1: Comparison of (a) the traditional approach to secure image (b) The proposed approach.

II. Basic Principles

a) *Quad tree Compression Algorithm*

Quad tree compression partitions the visual data into a structural part (the Quad tree structure) and color information (the leave values). The Quad tree structure shows the location and size of each homogeneous region; the color information represents the intensity of the corresponding region. The generation of the quad tree follows the splitting strategy well known from the area of image segmentation [5].

A quad tree is a rooted tree in which every node has zero or four children, whereas a 4-arry tree is a rooted tree in which every node has at most four children. Nodes with children have been called internal nodes, whereas those without any children are called leaf nodes. For each node in a tree, we define its level to be the number of edges in the shortest path from the node to the root. The height of the tree is known to be the maximum of the levels of its nodes. Thus, a node at a low level is close to the root.

The quad tree decomposition provides outlines of objects in the original image, as illustrated in Figure (2). In lossless compression, the algorithm starts with a tree with one node. If the image is homogeneous, the root node has been made a leaf, and the gray level describing the image is attached to the leaf. Otherwise, the image has been partitioned into four quadrants, and four corresponding children have been added to the root of the tree. The algorithm then recursively examines each quadrant using each of the four children as the root of a new subtree. The lossy version is similar to the lossless counterpart, but the test for homogeneity of a square block has been replaced by a test for similarity. The similarity of the pixels in a block can been measured by the variance of the pixel values, texture information, and other kinds of statistics.

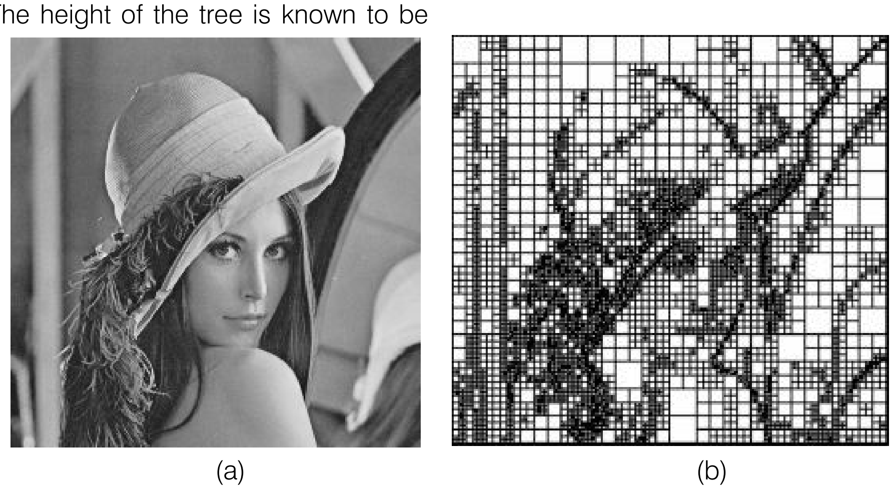

Figure 2: Quad tree decomposition of an image (a) Original image. (b) Quad tree decomposition.

b) Huffman Coding

In computer science and information theory, Huffman coding is an entropy encoding algorithm used for lossless data compression. The term refers to the use of a variable-length code table for encoding a source symbol (such as a character in a file) where the variable-length code table has been derived in a particular way based on the estimated probability of occurrence for each possible value of the source symbol. It was developed by David A. Huffman while he was a Ph.D. student at MIT and published in the 1952 paper "A Method for the Construction of Minimum-Redundancy Codes"[6].

Huffman coding is a type of variable length entropy coding where each symbol corresponds to a unique binary string of varying length. Huffman coding is uniquely decodable. In other words, when the symbols are encoded by concatenating the binary strings, this concatenated binary string can be decoded uniquely when reading sequentially in the same order that it was written[7].

c) Advanced Encryption Standard (AES) Cipher

The AES cipher described by Rijndael (also called Rijndael encryption algorithm)[8], it is a block cipher that converts clear text data blocks of 128, 192, or 256 bits into cipher text blocks of the same length. The AES cipher uses a key of selectable length (128, 192, or 256 bits). This encryption algorithm has been organized as a set of iterations called round transformations. In each round, a data block has been transformed a series of operations. The total number of rounds depends on the largest of round r and key length k and equals 10, 12, and 14 for lengths of 128, 192, and 256 bits, respectively. All-round transformations are identical, apart from the final one. The AES algorithm takes the cipher key and transforms a key expansion routine to generate a key schedule. For number of round=10 and key length=128bits, the key expansion generates total of 44 words. The resulting key schedule consists of a linear array of 4-byte words, denoted by [wi], with i in the range $0 \leq i < 44$.

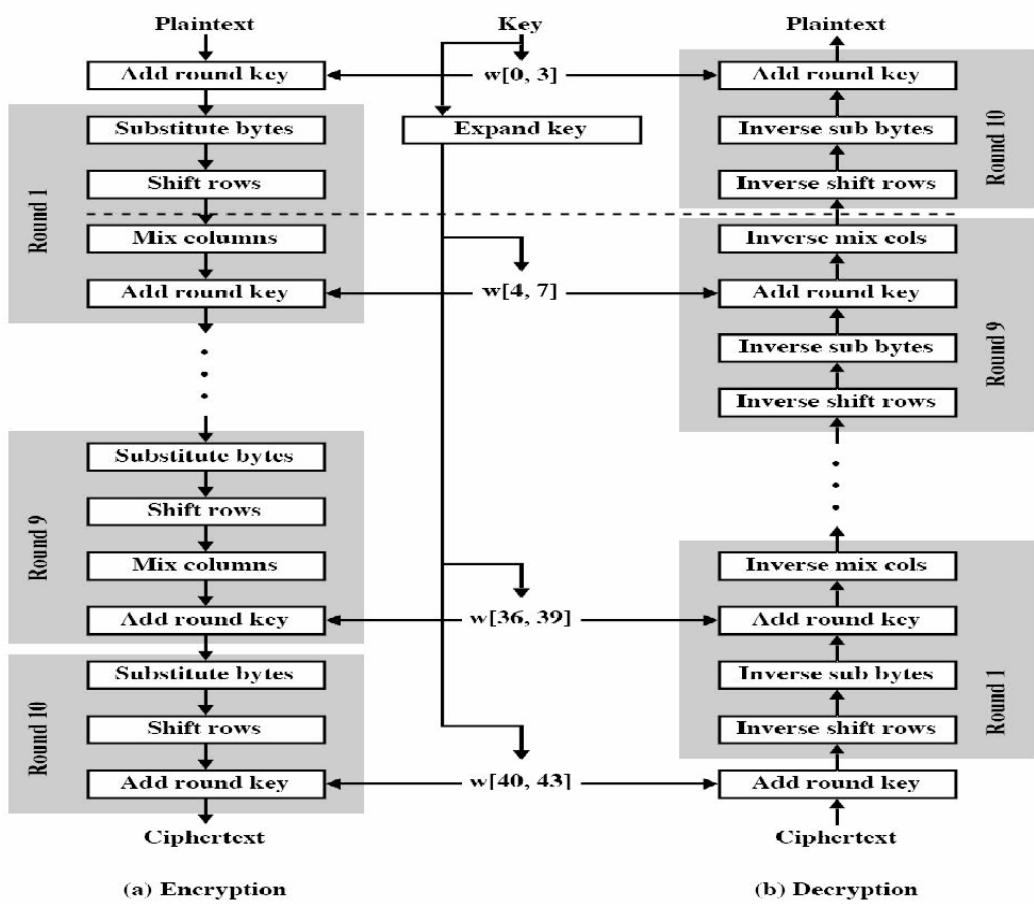

Figure 3: AES Encryption and Decryption

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In this scheme, we propose a method for partial encryption (PE) the compressed image. The proposed method consists of Quad tree compression, encryption of important part, then coding the resultant image by using a Huffman coding algorithm. The encryption step in this algorithm can been performed by using an advanced encryption standard algorithm. During the compression step, the Quad tree image compression is used, which can achieve a reasonably good compression rate, Quad tree compression algorithms are computationally simple and outperform JPEG at low bit rates.

In this scheme, only the important part (Quad tree structure) is encrypted, whereas the remaining parts (unimportant parts) are transmitted without encryption. The Quad tree structure has been encrypted with AES.

Quad tree–AES–PE-Algorithm:

1. Encryption key selection.
2. Threshold value selection.
3. Decomposition (compression) the image, here Quad tree compression is applied.
4. Partial encryption, here AES cipher is used.
5. Entropy coding, here the Huffman coding is adopted.

III. Experimental Results

In this section, several of experiments that are used to examine our proposed Quad tree based image encryption algorithm will been presented. The algorithms were programmed in MATLAB version 6.5 on a Pentium IV PC (2.00 GHz) using color boys image and grayscale boys image of (256×256) pixels.

To evaluate each of the proposed partial encryption schemes, five aspects are examined [9]:

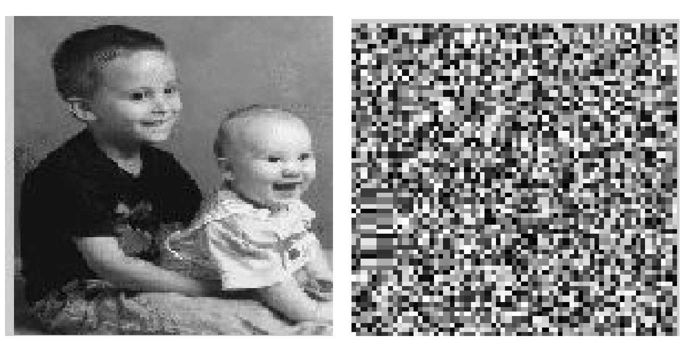
1. Security. Security in this work means confidentiality and robustness against attacks to break the images. It is that the goal is not 100% security, but analgorithm is adopted, such as AES cipher that makes them difficult to cryptanalyze.
2. Speed. Less data to encrypt means less CPU time required for encryption. So, general partial encryption algorithms are used to reduce encryption and decryption time.
3. Compression Performance. The compression performance of the selected compression method has been used to reduce the bandwidth required for data transmission. The proposed encryption scheme does not reduce the compression performance of the underlying selected compression method. Peak signal-to-noise ratio (PSNR) measures are estimates of the quality of a reconstructed image compared to an original image. Typical PSNR values ranges 20 and 40 decibels (dB) [10].
4. Keyspace Analysis. A good image encryption algorithm should be sensitive to cipher key, and the keyspace should be large enough to make brute-force attack infeasible.
5. Histograms of Encrypted Images. Select several 256 gray-level images with a size of 256×256 that have different contents to calculate their histograms. One can see that the histogram of the cipher-image is significantly uniform and from that of the original image.

In this work, several experiments on the proposed partial encryption scheme have been done. Different cases were considered.

In these experiments, three different threshold values have been chosen, which are 0.3, 0.5, and 0.7 in lossy compression. In Table (1), the first column gives the threshold value. The second column gives CR. The third column gives the PSNR of the reconstructed image with the original image for each test image. Lastly, the fourth column gives the time of the operations. The encryption key is "2b 7e 15 16 28 ae d2 a6 abf7 15 88 09 cf 4f 3c". The size of the key spaces is 2^{128}. Only part of the output from the image compression algorithm is encrypted.

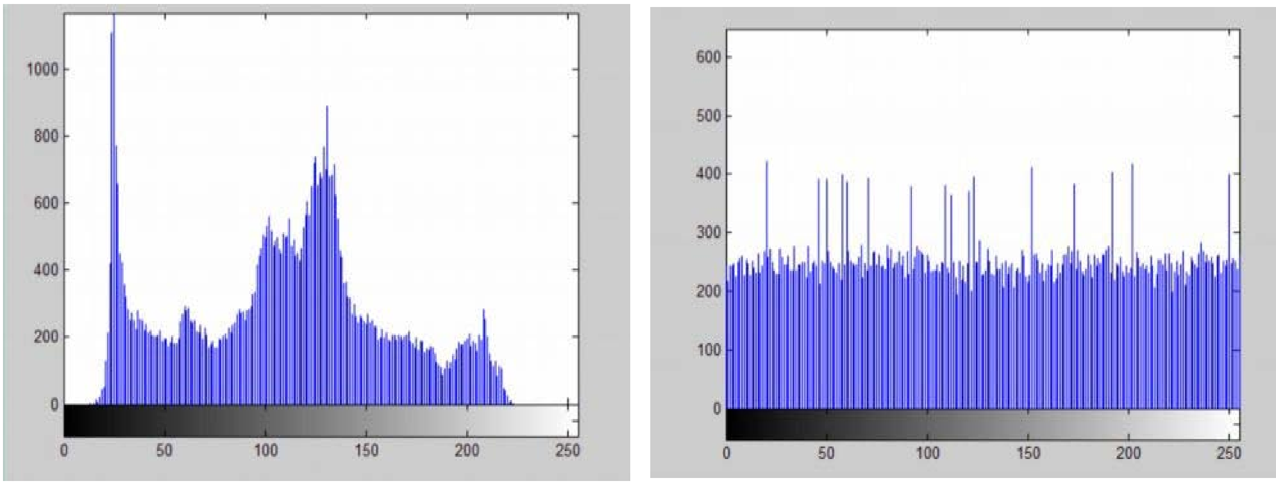
Experiment 1

In this experiment, the AES encryption scheme has been considered only. Figure (4) shows the result obtained for the grayscale boys' images. Figure (5) shows the histograms of the original grayscale boy's image and the cipher-image.



(a) (b)

Figure 4: Results of experiment 1 using the AES encryption scheme: a) Original grayscale boys' image b) Image resulting from encryption.



(a) (b)

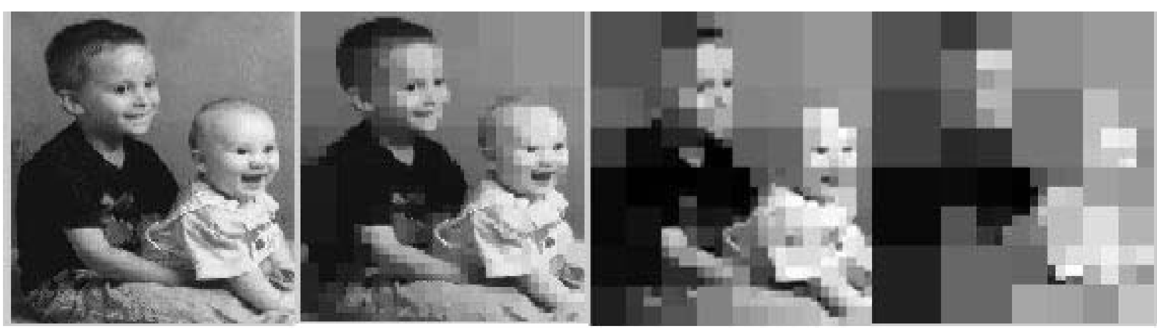
Figure 5: Histogram of experiment 1 using AES (a) The original grayscale boys' image. (b) The cipher-image.

Experiment 2

In this method, different threshold values (0.3, 0.5, and 0.7) of grayscale images (lossy compression) have been chosen. The results in this method have been present in Table (1). Figure (6) shows the results obtained for grayscale boys' image.

Table 1: Resulting in experiment 2.

Threshold value	CR	PSNR (dB)	Time (sec)
0.3	0.0198	27.1229	16.9070
0.5	0.0041	21.6693	10.4840
0.7	0.0005	18.5871	8.7660



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

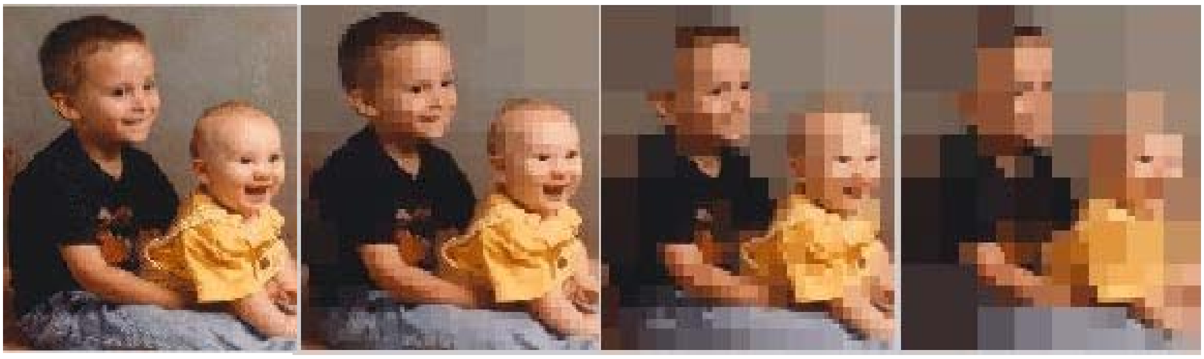
Figure 6: Results of experiment 2: (a) Original grayscale boys' image. (b) Reconstructed image at threshold =0.3. (c) Reconstructed image at threshold =0.5. (d) Reconstructed image at threshold =0.7.

Experiment 3

In this scheme, different threshold values (0.3, 0.5, and 0.7) of color images (lossy compression) have been chosen. The results of this method have been present in Table (2). Figure (7) shows the results obtained for the color boys' image.

Table 2: Resulting in experiment 3.

Threshold value	CR	PSNR (dB)	Time (sec)
0.3	0.0086	28.0000	20.8280
0.5	0.0025	22.6112	12.3750
0.7	0.0006	20.0000	9.4690



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

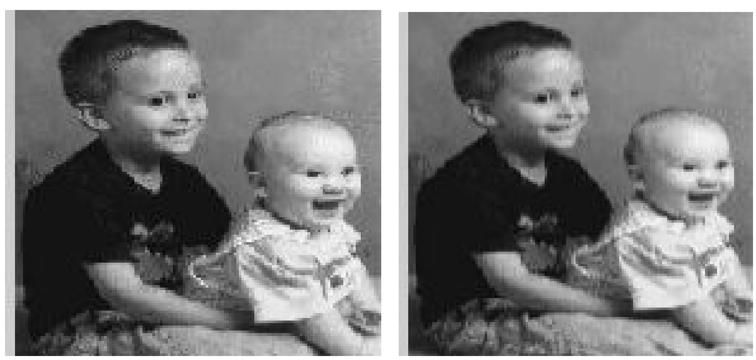
Figure 7: Results of experiment 3: (a) Original color boys' image. (b) Reconstructed image at threshold =0.3. (c) Reconstructed image at threshold =0.3. (d) Reconstructed image at threshold =0.5.

Experiment 4

In this experiment, the threshold value equal to zero of grayscale images (lossless compression) has been chosen. The results of this method have been present in Table (3). Figure (8) shows the results obtained for grayscale boys' image.

Table 3: Resulting in Experiment 4.

Threshold value	CR	PSNR (dB)	Time (sec)
0	0.3196	infinity	353.0940



(a) (b)

Figure 8: Results of experiment 4: (a) Original grayscale boys' image. (b) Reconstructed image.

Experiment 5

In this experiment, the threshold value equal to zero of color images (lossless compression) has been chosen. The results of this method have been present in Table (4). Figure (9) shows the results obtained for the color boys' image.

Table 4: Resulting in experiment 5.

Threshold value	CR	PSNR (dB)	Time (sec)
0	0.1071	infinity	556.7190

(a) (b)

Figure 9: Results of experiment 4: (a) Original color boys' image. (b) Reconstructed image.

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IV. Conclusion

In all experiments, the attacker cannot obtain the original image unless he knows the encryption key. So, the proposed method has good security since the key space is very large to make brute-force attack infeasible. Out of the results of experiments (lossy compression), one can notice that as the threshold value increase, the CR will increase (low compression). Figure (10) shows the CR versus the threshold value for the color boys' image.

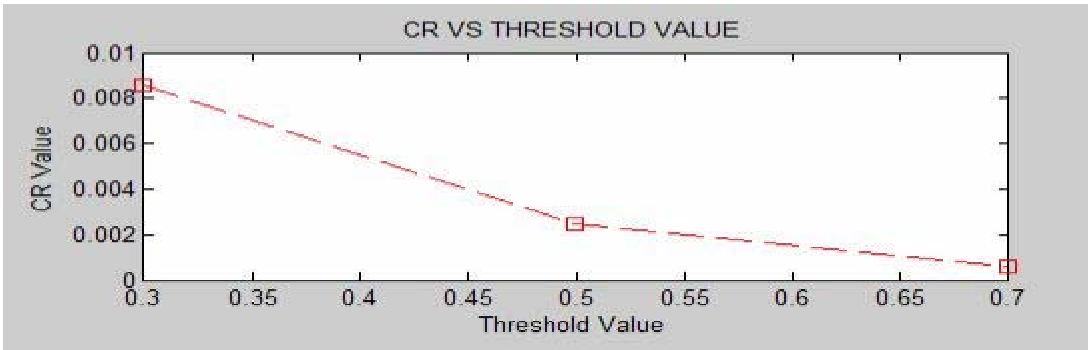

Figure 10: CR versus threshold for color boys' image.

Out of experiments, we conclude that as the threshold value is increased, both the PSNR and the execution time are decreased. Figures (11 and 12) show the PSNR and the execution time versus the threshold value for the color boys' image, respectively.

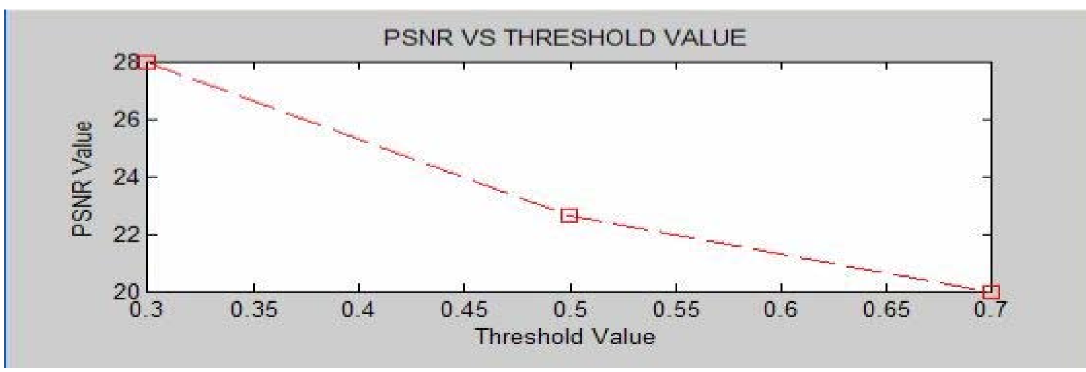

Figure 11: PSNR versus threshold for color boys image.

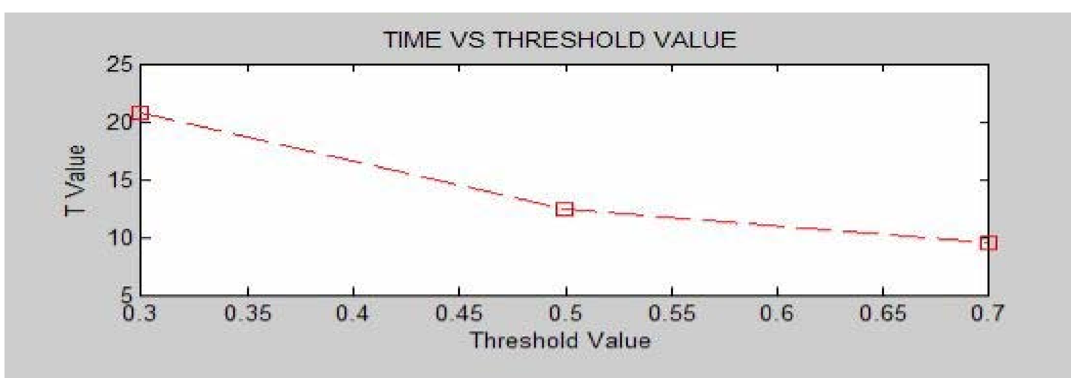

Figure 12: Time versus threshold for color boys image.

From histograms, one can see that the histogram of the cipher-image is significantly different from that of the original image. By this difference between the two histograms, the positions and the values of the pixels of original image have been rearranged with the user key. As a result, the cipher-image can reach properties of confusion to protect the confidential image data from unauthorized access.

It can been noticed that the execution time required to encrypt the amount of image data (the important) is shorter compared to that of the full image. So partial encryption reduces the CPU time considerably. This time can been further reduced by using an efficient program code and a faster computer.

Also, the execution time lossy compression is less than lossless compression. The PSNR value of lossless compression equal to infinity because of the reconstructed image after compression is numerically identical to the original image on a pixel-by-pixel basis, as shown in Tables (3 and 4). The CR value of lossy compression is less than lossless compression, the reconstructed image contains degradation relative to the original image, because redundant information has been discarded during compression. As a result, much higher compression is achievable, and according to what we will see below, no visible loss has been perceived (visually lossless), as shown in Tables (1 and 3).

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Object Detection and Tracking using Watershed Segmentation and KLT Tracker

By Tunirani Nayak & Nilamani Bhoi
Veer Surendra Sai University of Technology

Abstract- In this paper, a moving object is extracted from a video using video object detection algorithm based on spatial and temporal segmentation. The technique begins with temporal segmentation in which edge map is extracted using edge operator. The initial binary mask is obtained by using morphological operation applied on initial edge map. The next phase is spatial segmentation where gradient image is obtained by multi-scale morphological operator. The modified gradient image is obtained by the operator applied over the current frame. At last, moving object is extracted by precisely and accurately by watershed segmentation which is performed on the modified gradient image. Again, morphological operation is applied on the output to get final binary mask. This binary mask is then complemented to yield the contour line of the video object. Using the binary mask, the video object is extracted from the video frames. After detection of video object, the object tracking is performed using Kanade–Lucas–Tomasi (KLT) feature tracker.

Keywords: *video object segmentation, morphological operator, watershed algorithm, KLT tracker.*

GJCST-F Classification: *I.4.8*

OBJECTDETECTIONANDTRACKINGUSINGWATERSHEDSEGMENTATIONANDKLTTRACKER

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Object Detection and Tracking using Watershed Segmentation and KLT Tracker

Tunirani Nayak [α] & Nilamani Bhoi [σ]

Abstract- In this paper, a moving object is extracted from a video using video object detection algorithm based on spatial and temporal segmentation. The technique begins with temporal segmentation in which edge map is extracted using edge operator. The initial binary mask is obtained by using morphological operation applied on initial edge map. The next phase is spatial segmentation where gradient image is obtained by multi-scale morphological operator. The modified gradient image is obtained by the operator applied over the current frame. At last, moving object is extracted by precisely and accurately by watershed segmentation which is performed on the modified gradient image. Again, morphological operation is applied on the output to get final binary mask. This binary mask is then complemented to yield the contour line of the video object. Using the binary mask, the video object is extracted from the video frames. After detection of video object, the object tracking is performed using Kanade–Lucas–Tomasi (KLT) feature tracker.

Keywords: video object segmentation, morphological operator, watershed algorithm, KLT tracker.

I. Introduction

Video object segmentation describes to take out of the objects moving from the camera's order. Segmentation is the process of dividing information fragments into essential elements that are defined as part. In terms of the still images, the segmentation means to split the image into a random number of areas that represent the main part of the image. The given video, word segmentation is used to describe the number of different processes for the division of videos into sections that have meaning into different granulations. This video can be temporarily disassociated to a scene or shots, and a background.

Spatial segmentation of pictures incorporates regional-based and boundary-based strategies. The region-based approach depends on the nearby highlights such as intensity, surface and position. In other words, a temporary segmental video segment is expected to separate the video into a component picture called scenes and shots.

In other words, a temporary segmental video segment is expected to separate the video into a component picture called scenes and shots. This shot is characterized as frame that obtained without intrusion by a camera. Temporal division to shots is done by distinguishing the move from one to the next.

There are number of object detection techniques and algorithm based on video segmentation has proposed by many researchers. In [3] Neri, A, Colonnese, S, Russo, G, Talone, P, jointly presented a paper in which the method used for segmentation is of low computational complexity. This paper aimed at separating the moving objects from the background in video grouping.In [4] Renjie Li, Songyu Yu, Xiaokang Yang, proposed a paper which addresses an productive spatio-temporal division plot to extricate moving objects from video arrangements. The temporal segmentation yields a temporal mask that demonstrates moving regions and inactive region for each frame. In [5] Chinchkhede, D.W.; Uke, N. J, presented a paper based on the process for image segmentation in video sequence based on Expectation Maximization (EM) is used, which is a mixture of Gaussian classification model. In [6] K Ganesan, S Jalla, presented a paper in which a comparative study of video object extraction based on efficient edge detection techniques. In [7] Gao Hai, Siu Wan2Chi, Hou Chao2Huan presented a new progressed image segmentation scheme in which an unsupervised image-segmentation algorithm based on morphological tools has been presented. In [11] L. Vincent and P. Soille introduced powerful algorithm for computing watersheds in digital gray-scale images. Here a overview of watersheds is discussed then immersion simulation process is applied. In [12] Thomas Sikora implemented a video standard verification model to develop the algorithm. Here description of content-based scalability and content-based bit stream access and manipulation are given. In [16] Nishu Singla implemented a paper which presents a modern calculation for identifying moving objects from a inactive background scene based on frame difference. In [18] Arindrajit Seal, Arunava Das, Prasad Sen, described that a grey-level picture may be visualized as a topographic alleviation, where the grey-level of a pixel is thought as its stature within the relief.

The paper is organised as follows: session I we discussed about the proposed method. Temporal segmentation and spatial segmentation are discussed in session II. At last experimental result, discussion and conclusion is presented in session III.

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II. Proposed Method

Here the purpose of the paper is that the process of the video segmentation begins with the difference between the image between the preceding frame and the current frame. Because of the different picture, the frame contains all the information about changes between the frame and the noise. Working with differences is followed by the extraction of video frames in folders that are used more to play and read video frames. The edge of the image, which differs in the frame, is determined by the edge detection operators. The Canny operator has the ability to get high accuracy when detecting edges and constraining the false edges. Within the same way the edge of the current frame is detected by the edge operator. Then morphological operations are processed on the edge of difference image, resulting in the temporal mask of the image difference. Background noise has been extracted from the MATLAB image processing function. Here we use multi-scale morphological gradient on the current framework for watershed conversion. Then the paper reached the desired results i.e. contour of the video object followed by extracted video object.

After object detection or moving object extraction, then we can track the object by using tracking algorithm. Here we used Kanade–Lucas–Tomasi (KLT) Tracker. It works well suited for tracking objects in which it does not change shape and exhibit visual texture.

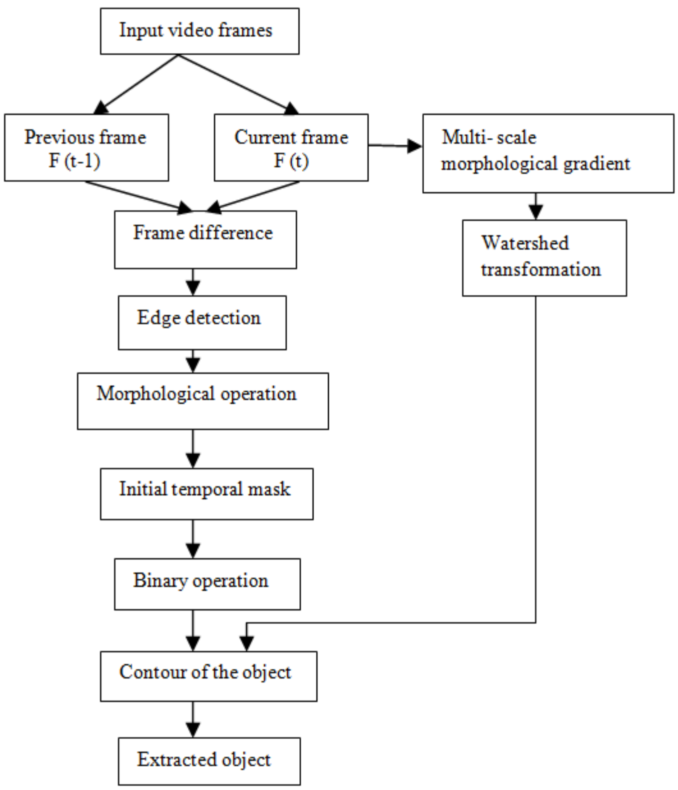


Fig.1: Block diagram of object detection

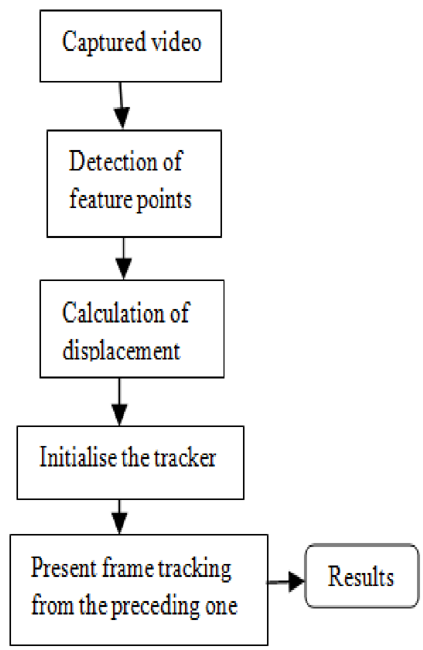


Fig. 2: Block diagram of KLT tracker

III. Methodology

Different methods used for object detection are described below:

a) Object Segmentation

Object segmentation is one of the methods in which we can successfully segment the object and detect the moving object. It is performed by using temporal and spatial segmentation.

i. *Temporal Segmentation*

The initial step or method of video segmentation is temporal segmentation. The objective is to detect the object from back ground. The object may be moving or stationary based on the video taken while recording. Here we have taken moving object video database. From the block diagram, temporal segmentation can proceed by using the following methods.

a. *Frame Difference*

Here we have started our work by extracting number of frames from the video and stored in a folder which is further used for our work. Then we have chosen a particular frame i.e. f (t) which is the current frame and its previous frame i.e. f (t-1). After converting these original images into their respective gray images we have to subtract one frame from another.

b. *Edge detection of moving object*

Edge location may be an essential apparatus for image segmentation. Most strategies are applied to image fragmentation based on changes in local intensity. The boundary between two regions with different gray properties is called as edge of an image. We get the edge map image by using canny operator as follows:

$$\text{Edge} = canny(f_{t-1} - f_t) \quad (1)$$

Canny approach is based on three goals:

1. Low error rate- here no false response is found responses should be there. The edge detected must be close to the actual edge.
2. The edges must be well localized i.e., the distance between the edges marked by the detector should be as close as possible to the centre of the real edge.
3. Single point response- Only one point should come back from the detector for the real edge, which means the number of peaks around the edges should be minimal.

c. *Morphological Process*

When images are processed for enhancement and while performing some operations like thresholding, more is the chance for distortion of the image due to noise. As a result, imperfections exist in the structure of the image. The primary goal of morphological operation is to remove this imperfection that mainly affects the shape and texture of image. Dilation and erosion are two primary operations of morphological processing.

The dilation operation expands an object both horizontally and vertically. Hence number of structuring elements of different shape and size are applied over the object. The dilation of an object A (set) striking by structuring element B is characterized as;

$$A \oplus B = \{z \mid (\hat{B})_z \cap A \neq \emptyset \quad (2)$$

On the off chance that the set B is symmetric about its origin and changes with z. so B̂ and A have at least one common component. At that point it can be characterized as;

$$A \oplus B = \{z \mid [(\hat{B})_z \cap A] \subseteq A\} \quad (3)$$

The erosion operation is just the reverse of dilation operation. The erosion operation shrinks the object. The erosion can be characterized as;

$$A \Theta \mathrm{B} = \{z \mid (B)_z \subseteq A\} \quad (4)$$

The erosion of an object A by structuring element B can also be defined as

$$A \Theta \mathrm{B} = \{z \mid (B)_z \cap A^c = \emptyset\} \quad (5)$$

As described above dilation and erosion morphological methods are used to find out the initial binary mask of the object. In order to eliminate the background noise, 'bwareaopen' Matlab function is used here to remove all the connected components that have less than a certain number of pixels. The structuring element is of type disk-shaped for proper detection.

ii. *Spatial Segmentation*

We only get a rough part through the temporary breakdown due to the complex traffic information. Spatial segmentation is required to achieve the precise boundary of the object. Watershed is one of the fast segmentation algorithms of the mathematical morphology. A neighborhood least compares to the valley, while the most extreme compares to the top. The water surface will be filled slowly from the minimum base. As water level will rise, hence water level of other regions also increases. On the off chance that the location where the assembly was built was a dam that avoided this merger, at that point the geography is partitioned into distinctive regions, known as the catchment basins. At the conclusion of each least submersion strategy, it is totally encompassed by the dams - close the range where the building, called the watershed. So, it introduced catchment basins and edge lines due to watershed segmentation. Watershed algorithms are ordinarily executed on the gradient. The normal temporary operator generates minimal local results on broken or abnormal errors. To mitigate this problem, due to the fact that the morphological gradient of the image has increased more in scale, compared to the resulting gradient image, by the spatial template of the image, the gradient of the morphological structure by a symmetric structural element is less depending on the direction of the edges. Multi-scale morphological algorithms are connected to the current frame, the video object and the foreground marker, and this background is utilized to control watershed segmentation in arrange to attain way better spatial distribution. The watershed change is broadly utilized in numerous zones of picture handling, counting parts of therapeutic imaging, due to a few of the benefits given below.

a. *Multi-scale morphological gradient*

The input gray scale object is denoted as f, the structuring element is B and $\oplus$, Θ are the dilation and erosion morphological operations, then with the standard operator with a single dimensional morphological gradient is characterized as $G(f) = (f \oplus \mathrm{B}) - (f \Theta \mathrm{B})$. Its execution depends on the estimate of the structuring component, in the event that the sort B is huge, it'll lead to an overlap between the edges, which can lead to a greatest gradient that does not coordinate an edge. In any case, if the structuring element is as well small, with a incline, it produce ramp edges having low output values with high spatial resolution gradient operator. The multi-scale morphological gradient operator is defined as below;

$$MG(f) = \frac{1}{3} \times \sum_{i=1}^{3}[(f \oplus B_i) - (f \Theta B_i) \Theta B_i - 1] \quad (6)$$

Bi is the disk-shaped structuring component of ith groups, and its span 2*i* +1, 0 ≤*i*≤ 3. The multi-scale morphological gradient has preferred to apply individually for both large and small structuring components. It is safe to clamours and intelligently edges due to the normal operation utilized within the calculation. It makes strides the obscured edge and decreases the number of neighbourhood minima that cannot be performed.

b. *Binary Operation*

Here in this paper we have used sobel and canny edge detection techniques on different video sequence. Then using morphological operations using matlab we got the initial binary mask of the object. After getting the multi-scale gradient image, it is needed to apply watershed transformation to reduce the over segmentation. By multiplying the initial binary mask with the original frame resulting the extracted video object. Then the paper reached the desired results i.e. contour of the video object followed by extracted video object.

b) Object tracking

In computer vision, the motion of an object is tracked by one of the methods called optical flow. In this method, the velocity vectors for points in a series of images or frames calculated and it approximate positions of points in next image sequence. One of the challenges of computer vision is calculating optical flow or motion velocity. Hence next it describes an object tracking technique called KLT (Kanade-Lucas-Tomasi) feature tracker.

i. *Kanade–Lucas–Tomasi (KLT) Tracker*

One of the feature-tracking algorithm is Kanade-Lucas-Tomasi(KLT) , which tracks a set of points. There are many applications of KLT such as camera motion estimation, video stabilization and object tracking. It works well suited for tracking objects in which it does not change shape and exhibit visual texture.

Kanade-Lucas-Tomasi method derives and calculates the difference between two frames of the video sequence. The object tracking is based on the criteria of Sum of Squared Difference (SSD) which is applied to find the feature point whose objective is to minimize the following energy function using window:

$$E_t(dx,dy) = \sum [I(x+dx, y+dy, t+dt) - I(x,y,t)]^2 \quad (7)$$

The KLT algorithm can be of two main phases, (1) detection phase (2) tracking phase. In the detection phase, first step is searching for the salient feature points and next these feature points are added to the already existing ones. In the tracking phase, the motion vector is calculated for each corresponding feature point.

a. *Feature Point Detection*

In this method for a given object we have to detect new feature points and add these feature points to the already existing one. Basically, the feature points pixels neighborhood are highly structured. Hence it is more reliable and accurate to track feature points. So, the structure matrix G can be defined as:

$$G = \sum_{x \in W(p)} \nabla I(x). \nabla I(x) \quad (8)$$

Its eigen values λ1, λ2 is always≥ 0 because the matrix is positive semi-definite represent the neighbourhood region. Based on the values of λ1 and λ2, W is defined. If λ1= λ2=0, W is completely homogenous. If λ1 > 0, λ2 = 0 then W indicates an edge and λ1 > 0, λ2 > 0 indicates a corner. Strong corners that have higher λ1, λ2 values are extracted by KLT tracer.

b. *Feature Point Tracking*

In this tracking phase, let I and J are denoted as the current frame and next frame respectively in the given video sequence. Our objective is to calculate the motion vector v for each corresponding feature point p in frame I, so that its tracked position in frame J is p + v. Hence the SSD error function is calculated as

$$\varepsilon(v) = \sum_{x \in W(p)} (J(x+v) - I(x))^2 \quad (9)$$

The above equation defines or measures the deviation of intensity of frame between a neighbourhood of the feature point position in I and its potential position in J and should be zero in the ideal case. In order to better estimate for v1, take the first derivative of ε(v) and set it to zero and approximating J(x + v) by its first order Taylor expansion around v = 0 . It is an iterative method; hence by using no of iteration, we obtain the better result for v.

Here, a particular threshold value is set. The condition is that the feature point is removed from consideration if the quality of a tracked feature point decreases below a predefined threshold. Hence new features are introduced in the same window for compensation. The feature point with the minimum criteria should be retained if its SSD is below a certain threshold.

IV. Result and Discussion

The proposed technique used for video segmentation is executed in MATLAB program of version R2018. We have taken four standard video database called hall_monitor, Claire and daria_walk. These databases are well suited for object detection. Initially we have taken hall_monitor database for segmentation is illustrated in Figure 3. Fig 3 (a) is the current frame 46. Fig 3 (b) is the subtracted image from current frame with previous frame, 46 and 47. The subtracted output carries the less information about the object. By using the canny operator, we got the edge map as shown in fig 3(c). Here still some edge information's are missing. Fig 3 (d) gives the initial temporal mask by using some morphological operation like dilation and erosion. In order to avoid over segmentation then we found watershed transform on the gradient image of the current frame as shown in fig 3(e). To properly extract the object with exact boundary, a contour of the object is found out after executing binary operation on the initial binary mask as shown in fig 3 (f). Here we got the exact contour. The moving object is extracted as appeared in Fig 3 (g) after applying some post processing operation. The proposed algorithm ia also applied over Claire, daria_walk and momson database as shown in Figure 4, 5 and 6 respectively. Still some background information is available in the extracted video object. In Claire video sequence, some background information are available in the head portion. In daria_walk sequence the path walk of the human being is perfectly identified .But still some background parts are detected with object. In momson sequence the object is perfectly detected.

a) b) c) d) e)

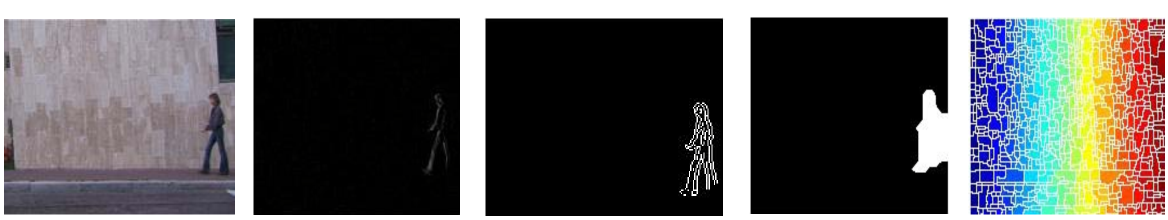
f) g)

Fig. 3: Object detection result of hall_monitor image (a) original frame-46, (b) Frame difference image 46, 47, (c) edge mask, (d) binary mask, (e) watershed segmentation output, (f) contour of the object, (g) final output.

a) b) c) d) e)

f) g)

Fig. 4: Object detection result of Claire image (a) original frame-1, (b) Frame difference image 1,2, (c) edge mask, (d) binary mask, (e) watershed segmentation output, (f) contour of object, (g) Extracted moving object.



a) b) c) d) e)

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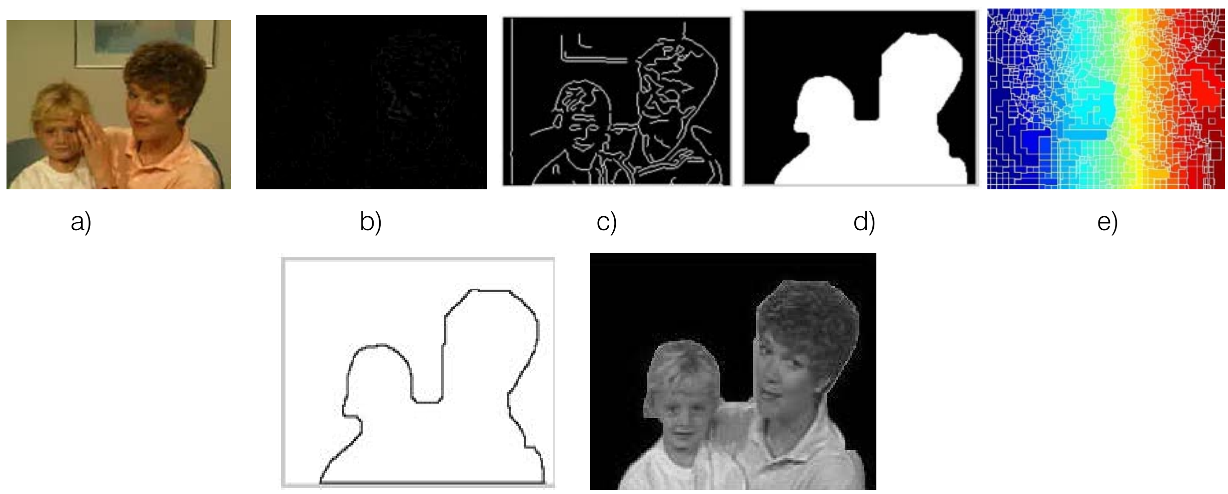
f) g)

Fig. 5: Object detection result of daria_walk image (a) original frame-46, (b) Frame difference image 46, 47, c) edge mask, (d) binary mask, (e) watershed segmentation output, (f) contour of the object, (g) final output.



a) b) c) d) e)

f) g)

Fig. 6: Object detection result of momson image (a) original frame-33,(b) Frame difference image 33,34 (c) edge mask, (d) binary mask, (e) watershed segmentation output, (f) contour of object, (g) Extracted moving object.

By using TP, FP, TN, FN statistics, different evaluation metrics are calculated as follows.

$$FPR = \frac{\text{number of FP}}{(\text{number of FP} + \text{number of TN})}$$

$$TPR = \frac{number\ of\ TP}{number\ of\ TP + number\ of\ FN}$$

$$\text{Accuracy(Ac)} = \frac{\text{number of TP} + \text{number of TN}}{(\text{number of (TP + TN + FP + FN)}}$$

Table 1: Performance measures (FPR, TPR, Ac) of Hall_monitor, Claire, Momson Image Sequence

Sl. No.	Image Sequence	FPR	TPR	Ac
1	Hall monitor(46)	0.0054	0.9443	0.9927
2	Claire(1)	0.0123	0.0326	0.9818
3	Momson(33)	0.0241	0.9914	0.9829

The performance of the object detection method can be quantified by using FPR, TPR, Ac. We have taken the ground truth image of the respective video sequence for better comparison of the detection result with the binary mask. Among all the video sequence hall_monitor sequence gives good accuracy.

Here we have taken daria_walk video sequence. The KLT tracker is used to track the motion of the human, who is walking on the street. Here the object is moving and the background is stationary. The figure shows 1, 10, 50 and 80th frame of the video sequence.

Fig. 7: Object tracking result a) Frame No.1, (b) Frame No.10, (c) Frame No.50, (d) Frame No.80.

V. Conclusion

This paper inquires the segmenting algorithm for a video based on the temporal and spatial data. Amid the temporal segmentation stage, Canny is utilized to discover the edge of the difference between the two adjoining frames. Initial binary segmentation mask is obtained by the morphological process. The erosion operation is chosen so as to work on a temporal mask for partial division to quote the foreground and background substrates for watershed calculation. Within the spatial division stage, a multi-scale morphological gradient operator with a high capacity in commotion concealment is applied to the current image frame to pick up gradient images. At long last, the watershed division is done on a modified gradient image. It is slightest influenced by commotion and lighting changes. It overcomes the method of over-segmentation and partitioning algorithm, maintained a strategic distance from the present-day handle of joining this region to diminish computer complexity. The proposed procedure incorporates numerous parameters such as high and low levels within the canny operator and the measure of the structuring components that are characterized within the test. In order to exactly extract the moving object from stationary background historical information is required. One of the challenging tasks is how to extract the moving object if the background is also moving.

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2. Authors must accept the privacy policy, terms, and conditions of Global Journals.
3. Ensure corresponding author's email address and postal address are accurate and reachable.
4. Manuscript to be submitted must include keywords, an abstract, a paper title, co-author(s') names and details (email address, name, phone number, and institution), figures and illustrations in vector format including appropriate captions, tables, including titles and footnotes, a conclusion, results, acknowledgments and references.
5. Authors should submit paper in a ZIP archive if any supplementary files are required along with the paper.
6. Proper permissions must be acquired for the use of any copyrighted material.
7. Manuscript submitted *must not have been submitted or published elsewhere* and all authors must be aware of the submission.

Declaration of Conflicts of Interest

It is required for authors to declare all financial, institutional, and personal relationships with other individuals and organizations that could influence (bias) their research.

Policy on Plagiarism

Plagiarism is not acceptable in Global Journals submissions at all.

Plagiarized content will not be considered for publication. We reserve the right to inform authors' institutions about plagiarism detected either before or after publication. If plagiarism is identified, we will follow COPE guidelines:

Authors are solely responsible for all the plagiarism that is found. The author must not fabricate, falsify or plagiarize existing research data. The following, if copied, will be considered plagiarism:

- Words (language)
- Ideas
- Findings
- Writings
- Diagrams
- Graphs
- Illustrations
- Lectures

- Printed material
- Graphic representations
- Computer programs
- Electronic material
- Any other original work

Authorship Policies

Global Journals follows the definition of authorship set up by the Open Association of Research Society, USA. According to its guidelines, authorship criteria must be based on:

1. Substantial contributions to the conception and acquisition of data, analysis, and interpretation of findings.
2. Drafting the paper and revising it critically regarding important academic content.
3. Final approval of the version of the paper to be published.

Changes in Authorship

The corresponding author should mention the name and complete details of all co-authors during submission and in manuscript. We support addition, rearrangement, manipulation, and deletions in authors list till the early view publication of the journal. We expect that corresponding author will notify all co-authors of submission. We follow COPE guidelines for changes in authorship.

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Appealing Decisions

Unless specified in the notification, the Editorial Board's decision on publication of the paper is final and cannot be appealed before making the major change in the manuscript.

Acknowledgments

Contributors to the research other than authors credited should be mentioned in Acknowledgments. The source of funding for the research can be included. Suppliers of resources may be mentioned along with their addresses.

Declaration of funding sources

Global Journals is in partnership with various universities, laboratories, and other institutions worldwide in the research domain. Authors are requested to disclose their source of funding during every stage of their research, such as making analysis, performing laboratory operations, computing data, and using institutional resources, from writing an article to its submission. This will also help authors to get reimbursements by requesting an open access publication letter from Global Journals and submitting to the respective funding source.

Preparing your Manuscript

Authors can submit papers and articles in an acceptable file format: MS Word (doc, docx), LaTeX (.tex, .zip or .rar including all of your files), Adobe PDF (.pdf), rich text format (.rtf), simple text document (.txt), Open Document Text (.odt), and Apple Pages (.pages). Our professional layout editors will format the entire paper according to our official guidelines. This is one of the highlights of publishing with Global Journals—authors should not be concerned about the formatting of their paper. Global Journals accepts articles and manuscripts in every major language, be it Spanish, Chinese, Japanese, Portuguese, Russian, French, German, Dutch, Italian, Greek, or any other national language, but the title, subtitle, and abstract should be in English. This will facilitate indexing and the pre-peer review process.

The following is the official style and template developed for publication of a research paper. Authors are not required to follow this style during the submission of the paper. It is just for reference purposes.

Manuscript Style Instruction (Optional)

- Microsoft Word Document Setting Instructions.
- Font type of all text should be Swis721 Lt BT.
- Page size: 8.27" x 11'", left margin: 0.65, right margin: 0.65, bottom margin: 0.75.
- Paper title should be in one column of font size 24.
- Author name in font size of 11 in one column.
- Abstract: font size 9 with the word "Abstract" in bold italics.
- Main text: font size 10 with two justified columns.
- Two columns with equal column width of 3.38 and spacing of 0.2.
- First character must be three lines drop-capped.
- The paragraph before spacing of 1 pt and after of 0 pt.
- Line spacing of 1 pt.
- Large images must be in one column.
- The names of first main headings (Heading 1) must be in Roman font, capital letters, and font size of 10.
- The names of second main headings (Heading 2) must not include numbers and must be in italics with a font size of 10.

Structure and Format of Manuscript

The recommended size of an original research paper is under 15,000 words and review papers under 7,000 words. Research articles should be less than 10,000 words. Research papers are usually longer than review papers. Review papers are reports of significant research (typically less than 7,000 words, including tables, figures, and references)

A research paper must include:

a) A title which should be relevant to the theme of the paper.
b) A summary, known as an abstract (less than 150 words), containing the major results and conclusions.
c) Up to 10 keywords that precisely identify the paper's subject, purpose, and focus.
d) An introduction, giving fundamental background objectives.
e) Resources and techniques with sufficient complete experimental details (wherever possible by reference) to permit repetition, sources of information must be given, and numerical methods must be specified by reference.
f) Results which should be presented concisely by well-designed tables and figures.
g) Suitable statistical data should also be given.
h) All data must have been gathered with attention to numerical detail in the planning stage.

Design has been recognized to be essential to experiments for a considerable time, and the editor has decided that any paper that appears not to have adequate numerical treatments of the data will be returned unrefereed.

i) Discussion should cover implications and consequences and not just recapitulate the results; conclusions should also be summarized.
j) There should be brief acknowledgments.
k) There ought to be references in the conventional format. Global Journals recommends APA format.

Authors should carefully consider the preparation of papers to ensure that they communicate effectively. Papers are much more likely to be accepted if they are carefully designed and laid out, contain few or no errors, are summarizing, and follow instructions. They will also be published with much fewer delays than those that require much technical and editorial correction.

The Editorial Board reserves the right to make literary corrections and suggestions to improve brevity.

Format Structure

It is necessary that authors take care in submitting a manuscript that is written in simple language and adheres to published guidelines.

All manuscripts submitted to Global Journals should include:

Title

The title page must carry an informative title that reflects the content, a running title (less than 45 characters together with spaces), names of the authors and co-authors, and the place(s) where the work was carried out.

Author details

The full postal address of any related author(s) must be specified.

Abstract

The abstract is the foundation of the research paper. It should be clear and concise and must contain the objective of the paper and inferences drawn. It is advised to not include big mathematical equations or complicated jargon.

Many researchers searching for information online will use search engines such as Google, Yahoo or others. By optimizing your paper for search engines, you will amplify the chance of someone finding it. In turn, this will make it more likely to be viewed and cited in further works. Global Journals has compiled these guidelines to facilitate you to maximize the web-friendliness of the most public part of your paper.

Keywords

A major lynchpin of research work for the writing of research papers is the keyword search, which one will employ to find both library and internet resources. Up to eleven keywords or very brief phrases have to be given to help data retrieval, mining, and indexing.

One must be persistent and creative in using keywords. An effective keyword search requires a strategy: planning of a list of possible keywords and phrases to try.

Choice of the main keywords is the first tool of writing a research paper. Research paper writing is an art. Keyword search should be as strategic as possible.

One should start brainstorming lists of potential keywords before even beginning searching. Think about the most important concepts related to research work. Ask, "What words would a source have to include to be truly valuable in a research paper?" Then consider synonyms for the important words.

It may take the discovery of only one important paper to steer in the right keyword direction because, in most databases, the keywords under which a research paper is abstracted are listed with the paper.

Numerical Methods

Numerical methods used should be transparent and, where appropriate, supported by references.

Abbreviations

Authors must list all the abbreviations used in the paper at the end of the paper or in a separate table before using them.

Formulas and equations

Authors are advised to submit any mathematical equation using either MathJax, KaTeX, or LaTeX, or in a very high-quality image.

Tables, Figures, and Figure Legends

Tables: Tables should be cautiously designed, uncrowned, and include only essential data. Each must have an Arabic number, e.g., Table 4, a self-explanatory caption, and be on a separate sheet. Authors must submit tables in an editable format and not as images. References to these tables (if any) must be mentioned accurately.

Figures

Figures are supposed to be submitted as separate files. Always include a citation in the text for each figure using Arabic numbers, e.g., Fig. 4. Artwork must be submitted online in vector electronic form or by emailing it.

Preparation of Eletronic Figures for Publication

Although low-quality images are sufficient for review purposes, print publication requires high-quality images to prevent the final product being blurred or fuzzy. Submit (possibly by e-mail) EPS (line art) or TIFF (halftone/ photographs) files only. MS PowerPoint and Word Graphics are unsuitable for printed pictures. Avoid using pixel-oriented software. Scans (TIFF only) should have a resolution of at least 350 dpi (halftone) or 700 to 1100 dpi (line drawings). Please give the data for figures in black and white or submit a Color Work Agreement form. EPS files must be saved with fonts embedded (and with a TIFF preview, if possible).

For scanned images, the scanning resolution at final image size ought to be as follows to ensure good reproduction: line art: >650 dpi; halftones (including gel photographs): >350 dpi; figures containing both halftone and line images: >650 dpi.

Color charges: Authors are advised to pay the full cost for the reproduction of their color artwork. Hence, please note that if there is color artwork in your manuscript when it is accepted for publication, we would require you to complete and return a Color Work Agreement form before your paper can be published. Also, you can email your editor to remove the color fee after acceptance of the paper.

Tips for writing a good quality Computer Science Research Paper

Techniques for writing a good quality computer science research paper:

1. Choosing the topic: In most cases, the topic is selected by the interests of the author, but it can also be suggested by the guides. You can have several topics, and then judge which you are most comfortable with. This may be done by asking several questions of yourself, like "Will I be able to carry out a search in this area? Will I find all necessary resources to accomplish the search? Will I be able to find all information in this field area?" If the answer to this type of question is "yes," then you ought to choose that topic. In most cases, you may have to conduct surveys and visit several places. Also, you might have to do a lot of work to find all the rises and falls of the various data on that subject. Sometimes, detailed information plays a vital role, instead of short information. Evaluators are human: The first thing to remember is that evaluators are also human beings. They are not only meant for rejecting a paper. They are here to evaluate your paper. So present your best aspect.

2. Think like evaluators: If you are in confusion or getting demotivated because your paper may not be accepted by the evaluators, then think, and try to evaluate your paper like an evaluator. Try to understand what an evaluator wants in your research paper, and you will automatically have your answer. Make blueprints of paper: The outline is the plan or framework that will help you to arrange your thoughts. It will make your paper logical. But remember that all points of your outline must be related to the topic you have chosen.

3. Ask your guides: If you are having any difficulty with your research, then do not hesitate to share your difficulty with your guide (if you have one). They will surely help you out and resolve your doubts. If you can't clarify what exactly you require for your work, then ask your supervisor to help you with an alternative. He or she might also provide you with a list of essential readings.

4. Use of computer is recommended: As you are doing research in the field of computer science then this point is quite obvious. Use right software: Always use good quality software packages. If you are not capable of judging good software, then you can lose the quality of your paper unknowingly. There are various programs available to help you which you can get through the internet.

5. Use the internet for help: An excellent start for your paper is using Google. It is a wondrous search engine, where you can have your doubts resolved. You may also read some answers for the frequent question of how to write your research paper or find a model research paper. You can download books from the internet. If you have all the required books, place importance on reading, selecting, and analyzing the specified information. Then sketch out your research paper. Use big pictures: You may use encyclopedias like Wikipedia to get pictures with the best resolution. At Global Journals, you should strictly follow here.

6. Bookmarks are useful: When you read any book or magazine, you generally use bookmarks, right? It is a good habit which helps to not lose your continuity. You should always use bookmarks while searching on the internet also, which will make your search easier.

7. Revise what you wrote: When you write anything, always read it, summarize it, and then finalize it.

8. Make every effort: Make every effort to mention what you are going to write in your paper. That means always have a good start. Try to mention everything in the introduction—what is the need for a particular research paper. Polish your work with good writing skills and always give an evaluator what he wants. Make backups: When you are going to do any important thing like making a research paper, you should always have backup copies of it either on your computer or on paper. This protects you from losing any portion of your important data.

9. Produce good diagrams of your own: Always try to include good charts or diagrams in your paper to improve quality. Using several unnecessary diagrams will degrade the quality of your paper by creating a hodgepodge. So always try to include diagrams which were made by you to improve the readability of your paper. Use of direct quotes: When you do research relevant to literature, history, or current affairs, then use of quotes becomes essential, but if the study is relevant to science, use of quotes is not preferable.

10.Use proper verb tense: Use proper verb tenses in your paper. Use past tense to present those events that have happened. Use present tense to indicate events that are going on. Use future tense to indicate events that will happen in the future. Use of wrong tenses will confuse the evaluator. Avoid sentences that are incomplete.

11. Pick a good study spot: Always try to pick a spot for your research which is quiet. Not every spot is good for studying.

12. Know what you know: Always try to know what you know by making objectives, otherwise you will be confused and unable to achieve your target.

13. Use good grammar: Always use good grammar and words that will have a positive impact on the evaluator; use of good vocabulary does not mean using tough words which the evaluator has to find in a dictionary. Do not fragment sentences. Eliminate one-word sentences. Do not ever use a big word when a smaller one would suffice.

Verbs have to be in agreement with their subjects. In a research paper, do not start sentences with conjunctions or finish them with prepositions. When writing formally, it is advisable to never split an infinitive because someone will (wrongly) complain. Avoid clichés like a disease. Always shun irritating alliteration. Use language which is simple and straightforward. Put together a neat summary.

14. Arrangement of information: Each section of the main body should start with an opening sentence, and there should be a changeover at the end of the section. Give only valid and powerful arguments for your topic. You may also maintain your arguments with records.

15. Never start at the last minute: Always allow enough time for research work. Leaving everything to the last minute will degrade your paper and spoil your work.

16. Multitasking in research is not good: Doing several things at the same time is a bad habit in the case of research activity. Research is an area where everything has a particular time slot. Divide your research work into parts, and do a particular part in a particular time slot.

17. Never copy others' work: Never copy others' work and give it your name because if the evaluator has seen it anywhere, you will be in trouble. Take proper rest and food: No matter how many hours you spend on your research activity, if you are not taking care of your health, then all your efforts will have been in vain. For quality research, take proper rest and food.

18. Go to seminars: Attend seminars if the topic is relevant to your research area. Utilize all your resources.

19. Refresh your mind after intervals: Try to give your mind a rest by listening to soft music or sleeping in intervals. This will also improve your memory. Acquire colleagues: Always try to acquire colleagues. No matter how sharp you are, if you acquire colleagues, they can give you ideas which will be helpful to your research.

20. Think technically: Always think technically. If anything happens, search for its reasons, benefits, and demerits. Think and then print: When you go to print your paper, check that tables are not split, headings are not detached from their descriptions, and page sequence is maintained.

21. Adding unnecessary information: Do not add unnecessary information like "I have used MS Excel to draw graphs." Irrelevant and inappropriate material is superfluous. Foreign terminology and phrases are not apropos. One should never take a broad view. Analogy is like feathers on a snake. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Never oversimplify: When adding material to your research paper, never go for oversimplification; this will definitely irritate the evaluator. Be specific. Never use rhythmic redundancies. Contractions shouldn't be used in a research paper. Comparisons are as terrible as clichés. Give up ampersands, abbreviations, and so on. Remove commas that are not necessary. Parenthetical words should be between brackets or commas. Understatement is always the best way to put forward earth-shaking thoughts. Give a detailed literary review.

22. Report concluded results: Use concluded results. From raw data, filter the results, and then conclude your studies based on measurements and observations taken. An appropriate number of decimal places should be used. Parenthetical remarks are prohibited here. Proofread carefully at the final stage. At the end, give an outline to your arguments. Spot perspectives of further study of the subject. Justify your conclusion at the bottom sufficiently, which will probably include examples.

23. Upon conclusion: Once you have concluded your research, the next most important step is to present your findings. Presentation is extremely important as it is the definite medium though which your research is going to be in print for the rest of the crowd. Care should be taken to categorize your thoughts well and present them in a logical and neat manner. A good quality research paper format is essential because it serves to highlight your research paper and bring to light all necessary aspects of your research.

Informal Guidelines of Research Paper Writing

Key points to remember:

- Submit all work in its final form.
- Write your paper in the form which is presented in the guidelines using the template.
- Please note the criteria peer reviewers will use for grading the final paper.

Final points:

One purpose of organizing a research paper is to let people interpret your efforts selectively. The journal requires the following sections, submitted in the order listed, with each section starting on a new page:

The introduction: This will be compiled from reference matter and reflect the design processes or outline of basis that directed you to make a study. As you carry out the process of study, the method and process section will be constructed like that. The results segment will show related statistics in nearly sequential order and direct reviewers to similar intellectual paths throughout the data that you gathered to carry out your study.

The discussion section:

This will provide understanding of the data and projections as to the implications of the results. The use of good quality references throughout the paper will give the effort trustworthiness by representing an alertness to prior workings.

Writing a research paper is not an easy job, no matter how trouble-free the actual research or concept. Practice, excellent preparation, and controlled record-keeping are the only means to make straightforward progression.

General style:

Specific editorial column necessities for compliance of a manuscript will always take over from directions in these general guidelines.

To make a paper clear: Adhere to recommended page limits.

Mistakes to avoid:

- Insertion of a title at the foot of a page with subsequent text on the next page.
- Separating a table, chart, or figure—confine each to a single page.
- Submitting a manuscript with pages out of sequence.
- In every section of your document, use standard writing style, including articles ("a" and "the").
- Keep paying attention to the topic of the paper.
- Use paragraphs to split each significant point (excluding the abstract).
- Align the primary line of each section.
- Present your points in sound order.
- Use present tense to report well-accepted matters.
- Use past tense to describe specific results.
- Do not use familiar wording; don't address the reviewer directly. Don't use slang or superlatives.
- Avoid use of extra pictures—include only those figures essential to presenting results.

Title page:

Choose a revealing title. It should be short and include the name(s) and address(es) of all authors. It should not have acronyms or abbreviations or exceed two printed lines.

Abstract: This summary should be two hundred words or less. It should clearly and briefly explain the key findings reported in the manuscript and must have precise statistics. It should not have acronyms or abbreviations. It should be logical in itself. Do not cite references at this point.

An abstract is a brief, distinct paragraph summary of finished work or work in development. In a minute or less, a reviewer can be taught the foundation behind the study, common approaches to the problem, relevant results, and significant conclusions or new questions.

Write your summary when your paper is completed because how can you write the summary of anything which is not yet written? Wealth of terminology is very essential in abstract. Use comprehensive sentences, and do not sacrifice readability for brevity; you can maintain it succinctly by phrasing sentences so that they provide more than a lone rationale. The author can at this moment go straight to shortening the outcome. Sum up the study with the subsequent elements in any summary. Try to limit the initial two items to no more than one line each.

Reason for writing the article—theory, overall issue, purpose.

- Fundamental goal.
- To-the-point depiction of the research.
- Consequences, including definite statistics—if the consequences are quantitative in nature, account for this; results of any numerical analysis should be reported. Significant conclusions or questions that emerge from the research.

Approach:

- o Single section and succinct.
- o An outline of the job done is always written in past tense.
- o Concentrate on shortening results—limit background information to a verdict or two.
- o Exact spelling, clarity of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else.

Introduction:

The introduction should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable of comprehending and calculating the purpose of your study without having to refer to other works. The basis for the study should be offered. Give the most important references, but avoid making a comprehensive appraisal of the topic. Describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will give no attention to your results. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here.

The following approach can create a valuable beginning:

- o Explain the value (significance) of the study.
- o Defend the model—why did you employ this particular system or method? What is its compensation? Remark upon its appropriateness from an abstract point of view as well as pointing out sensible reasons for using it.
- o Present a justification. State your particular theory(-ies) or aim(s), and describe the logic that led you to choose them.
- o Briefly explain the study's tentative purpose and how it meets the declared objectives.

Approach:

Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done. Sort out your thoughts; manufacture one key point for every section. If you make the four points listed above, you will need at least four paragraphs. Present surrounding information only when it is necessary to support a situation. The reviewer does not desire to read everything you know about a topic. Shape the theory specifically—do not take a broad view.

As always, give awareness to spelling, simplicity, and correctness of sentences and phrases.

Procedures (methods and materials):

This part is supposed to be the easiest to carve if you have good skills. A soundly written procedures segment allows a capable scientist to replicate your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order, but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt to give the least amount of information that would permit another capable scientist to replicate your outcome, but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section.

When a technique is used that has been well-described in another section, mention the specific item describing the way, but draw the basic principle while stating the situation. The purpose is to show all particular resources and broad procedures so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step-by-step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

Materials may be reported in part of a section or else they may be recognized along with your measures.

Methods:

- o Report the method and not the particulars of each process that engaged the same methodology.
- o Describe the method entirely.
- o To be succinct, present methods under headings dedicated to specific dealings or groups of measures.
- o Simplify—detail how procedures were completed, not how they were performed on a particular day.
- o If well-known procedures were used, account for the procedure by name, possibly with a reference, and that's all.

Approach:

It is embarrassing to use vigorous voice when documenting methods without using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result, when writing up the methods, most authors use third person passive voice.

Use standard style in this and every other part of the paper—avoid familiar lists, and use full sentences.

What to keep away from:

- o Resources and methods are not a set of information.
- o Skip all descriptive information and surroundings—save it for the argument.
- o Leave out information that is immaterial to a third party.

Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part as entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Use statistics and tables, if suitable, to present consequences most efficiently.

You must clearly differentiate material which would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matters should not be submitted at all except if requested by the instructor.

Content:

- Sum up your conclusions in text and demonstrate them, if suitable, with figures and tables.
- In the manuscript, explain each of your consequences, and point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation of an exacting study.
- Explain results of control experiments and give remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or manuscript.

What to stay away from:

- Do not discuss or infer your outcome, report surrounding information, or try to explain anything.
- Do not include raw data or intermediate calculations in a research manuscript.
- Do not present similar data more than once.
- A manuscript should complement any figures or tables, not duplicate information.
- Never confuse figures with tables—there is a difference.

Approach:

As always, use past tense when you submit your results, and put the whole thing in a reasonable order.

Put figures and tables, appropriately numbered, in order at the end of the report.

If you desire, you may place your figures and tables properly within the text of your results section.

Figures and tables:

If you put figures and tables at the end of some details, make certain that they are visibly distinguished from any attached appendix materials, such as raw facts. Whatever the position, each table must be titled, numbered one after the other, and include a heading. All figures and tables must be divided from the text.

Discussion:

The discussion is expected to be the trickiest segment to write. A lot of papers submitted to the journal are discarded based on problems with the discussion. There is no rule for how long an argument should be.

Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implications of the study. The purpose here is to offer an understanding of your results and support all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of results should be fully described.

Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact, you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved the prospect, and let it drop at that. Make a decision as to whether each premise is supported or discarded or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."

Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work.

- You may propose future guidelines, such as how an experiment might be personalized to accomplish a new idea.
- Give details of all of your remarks as much as possible, focusing on mechanisms.
- Make a decision as to whether the tentative design sufficiently addressed the theory and whether or not it was correctly restricted. Try to present substitute explanations if they are sensible alternatives.
- One piece of research will not counter an overall question, so maintain the large picture in mind. Where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

When you refer to information, differentiate data generated by your own studies from other available information. Present work done by specific persons (including you) in past tense.

Describe generally acknowledged facts and main beliefs in present tense.

The Administration Rules

Administration Rules to Be Strictly Followed before Submitting Your Research Paper to Global Journals Inc.

Please read the following rules and regulations carefully before submitting your research paper to Global Journals Inc. to avoid rejection.

Segment draft and final research paper: You have to strictly follow the template of a research paper, failing which your paper may get rejected. You are expected to write each part of the paper wholly on your own. The peer reviewers need to identify your own perspective of the concepts in your own terms. Please do not extract straight from any other source, and do not rephrase someone else's analysis. Do not allow anyone else to proofread your manuscript.

Written material: You may discuss this with your guides and key sources. Do not copy anyone else's paper, even if this is only imitation, otherwise it will be rejected on the grounds of plagiarism, which is illegal. Various methods to avoid plagiarism are strictly applied by us to every paper, and, if found guilty, you may be blacklisted, which could affect your career adversely. To guard yourself and others from possible illegal use, please do not permit anyone to use or even read your paper and file.

Criterion for Grading a Research Paper (Compilation) by Global Journals Inc. (US)

Please note that following table is only a Grading of "Paper Compilation" and not on "Performed/Stated Research" whose grading solely depends on Individual Assigned Peer Reviewer and Editorial Board Member. These can be available only on request and after decision of Paper. This report will be the property of Global Journals Inc. (US).

Topics	Grades		
	A-B	**C-D**	**E-F**
Abstract	Clear and concise with appropriate content, Correct format. 200 words or below	Unclear summary and no specific data, Incorrect form Above 200 words	No specific data with ambiguous information Above 250 words
Introduction	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

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