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VOLUME 13

ISSUE 5

VERSION 1.0



GLOBAL JOURNAL OF COMPUTER SCIENCE AND TECHNOLOGY: F  
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VOLUME 13 ISSUE 5 (VER. 1.0)

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## Image Mosaicing with Invariant Features Detection using SIFT

By Jagjit Singh

*Lovely Professional University, India*

*Abstract* - There are situations where it is not possible to capture larger views with the given imaging media such as still cameras or video recording machines in a single stretch because of their inherent limitations. So to avoid such conditions a term Image Mosaicing comes into play. This Paper presents a complete system for mosaicing a group of still images with some amount of overlapping between every two successive images. Mainly the idea is to wrap up the overlapping areas within the group of images. Detection for the common area is done using common features by the help of feature extraction from the images. In this paper technique used for the feature extraction is SIFT which is used to extract invariant features which are stable in nature. Invariant features are those features of an image which does not change even after the scaling, rotation, or zooming, change in illumination of the image is done. Multiple level filtering and downsampling are the key factors of the SIFT. So the steps involved are feature detection, matching of stable features, wrapping up of features around those feature locations. Mosaicing part consists of two major part and those are transformation matrix and bilinear interpolation. Mosaiced images are full length images which consist of all the group images.

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# Image Mosaicing with Invariant Features Detection using SIFT

Jagjit Singh

**Abstract** - There are situations where it is not possible to capture larger views with the given imaging media such as still cameras or video recording machines in a single stretch because of their inherent limitations. So to avoid such conditions a term Image Mosaicing comes into play. This Paper presents a complete system for mosaicing a group of still images with some amount of overlapping between every two successive images. Mainly the idea is to wrap up the overlapping areas within the group of images. Detection for the common area is done using common features by the help of feature extraction from the images. In this paper technique used for the feature extraction is SIFT which is used to extract invariant features which are stable in nature. Invariant features are those features of an image which does not change even after the scaling, rotation, or zooming, change in illumination of the image is done. Multiple level filtering and downsampling are the key factors of the SIFT. So the steps involved are feature detection, matching of stable features, wrapping up of features around those feature locations. Mosaicing part consists of two major part and those are transformation matrix and bilinear interpolation. Mosaiced images are full length images which consist of all the group images.

## I. INTRODUCTION

The basis of the image mosaicing technique is to find the common part in the two images which are going to be mosaiced. Different techniques are available but every technique contains some or the other flaw in it. So after the literature review, the technique best suitable for common invariant feature extraction is SIFT (Scale Invariant Feature Technique). Scale Invariant Feature Transform is an approach for extracting distinctive invariant features from images, and it has been successfully applied to many computer vision problems (e.g. face recognition and object detection) [1]. The features are invariant to image scaling, translation, and rotation, and partially invariant to illumination changes. This approach transforms an image into a large collection of local feature vectors, each of which is invariant to image translation, scaling, and rotation, and partially invariant to illumination changes. The scale-invariant features are efficiently identified by using a staged filtering approach. [2] The first stage identifies key locations in scale space by looking for locations that are maxima or minima of a difference-of-Gaussian function. Each point is used to generate a feature vector that describes the local image

region sampled relative to its scale-space coordinate frame. The features achieve partial invariance to local variations, by blurring image gradient locations.

To achieve rotation invariance and a high level of efficiency, we have chosen to select key locations at maxima and minima of a difference of Gaussian function applied in scale space. This can be computed very efficiently by building an image pyramid with resampling between each level.

To generate the next pyramid level, we resample the already smoothed image B using bilinear interpolation with a pixel spacing of 1.5 in each direction. While it may seem more natural to resample with a relative scale of, the only constraint is that sampling be frequent enough to detect peaks. The 1.5 spacing means that each new sample will be a constant linear combination of 4 adjacent pixels. This is efficient to compute and minimizes aliasing artefacts that would arise from changing the resampling coefficients. [2]

Maxima and minima of this scale-space function are determined by comparing each pixel in the pyramid to its neighbors. First, a pixel is compared to its 8 neighbors at the same level of the pyramid. If it is a maxima or minima at this level, then the closest pixel location is calculated at the next lowest level of the pyramid, taking account of the 1.5 times resampling. If the pixel remains higher (or lower) than this closest pixel and its 8 neighbors, then the test is repeated for the level above.

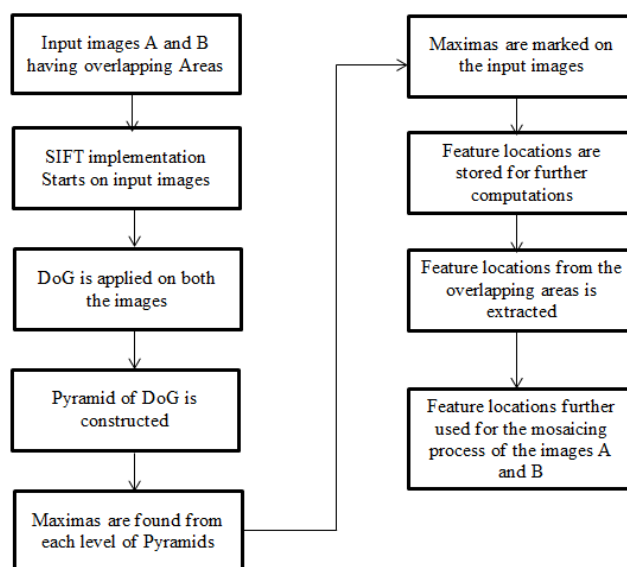


Figure 1 : Basic Implementation of SIFT and Mosaicing

## II. RESEARCH METHODOLOGY

Steps involved in the image mosaicing using SIFT is as follow. Below represents the all the basic steps involved with the help of the basic flow charts.

### a) Difference of Gaussian (DoG)

Difference of Gaussians is a feature enhancement algorithm that involves the subtraction of one blurred version of an original image from another, less blurred version of the original. In the simple case of grayscale images, the blurred images are obtained by convolving the original grayscale images with Gaussian kernels having differing standard deviations. Blurring an image using a Gaussian kernel suppresses only high-frequency spatial information. Subtracting one image from the other preserves spatial information that lies between the ranges of frequencies that are preserved in the two blurred images. Thus, the difference of Gaussians is a band-pass filter that discards all but a handful of spatial frequencies. Following flow chart further gives the detail description of the major steps involved in the DoG.

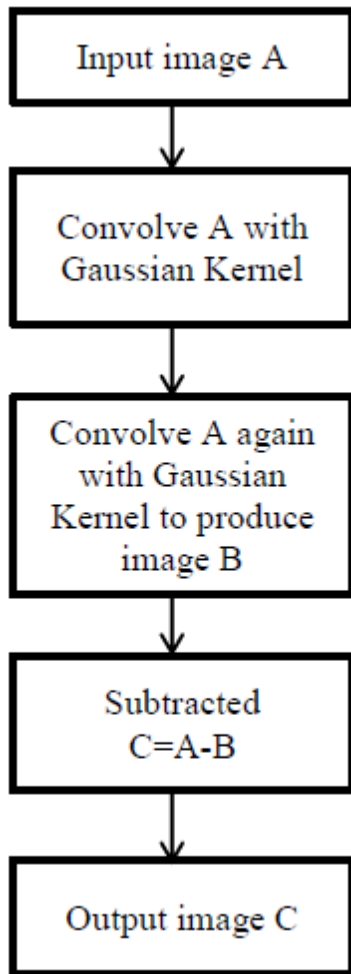


Figure 2 : Flow chart for DoG

### b) Pyramid of DoG

Pyramid or pyramid representation is a type of multi-scale signal representation developed by the computer vision, image processing and signal processing communities, in which an image is subject to repeated smoothing and subsampling. The Difference of Gaussian pyramid is generated from a single input image. The output is a pyramid of several images, each being a unique difference of Gaussian. To generate the pyramid, the input image is repeatedly blurred; the difference between consecutive blur amounts is then output as one Octave of the pyramid. One of the blurred images is down sampled by a factor of two in each direction, and the process occurs again with output in a different size.[3]. In Pyramid of DoG one of the important factors is the Downsampling of the image as to create the next level of the pyramid. In this algorithm the method used for the Downsampling of the images is the Bilinear Interpolation.

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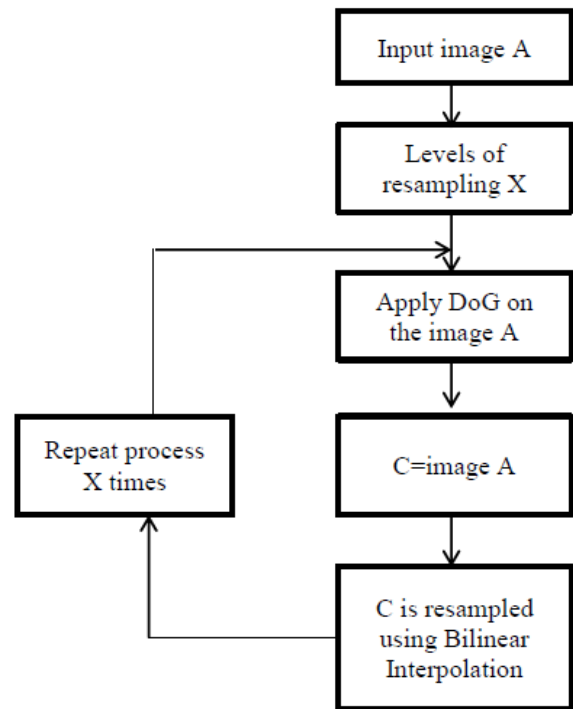


Figure 3 : Flow chart of Pyramid of DoG

### c) Bilinear Interpolation

Interpolation is a method of constructing new data points within the range of a discrete set of known data points. Bilinear interpolation is an extension of linear interpolation for interpolating functions of two variables. In this project Bilinear Interpolation is used to Downsample the images. It is mainly a combination of

the bilinear interpolation and the Nearest Neighbour Image Scaling approach. Nearest neighbour is the simplest and fastest implementation of image scaling technique. The principle in image scaling is to have a reference image and using this image as the base to construct a new scaled image. The constructed image will be smaller, larger, or equal in size depending on the scaling ratio. When enlarging an image, we are actually introducing empty spaces in the original base picture. From the image in figure, a n image with dimension ( $w1 = 4, h1 = 4$ ) is to be enlarged to ( $w2 = 8, h2 = 8$ ). The black pixels represent empty spaces where interpolation is needed, and the complete picture is the result of nearest neighbor interpolation. Scaling algorithm is to find appropriate spot to put the empty spaces inside the original image, and to fill all those spaces with livelier colors. For the nearest neighbor technique, the empty spaces will be replaced with the nearest neighboring pixel, hence the name. This results in a sharp but jaggy image, and if the enlarge scale is two; it would seem each pixel has doubled in size. Shrinking, in the other hand involves reduction of pixels and it means lost of irrecoverable information. In this case scaling algorithm is to find the right pixels to throw away.



Figure 4 : Example for bilinear implementation showing the basic process

d) *Maximas Finding*

Maximas in the given pyramid of DoG are determined by comparing each pixel in the pyramid to its neighbors. First, a pixel is compared to its 8 neighbors at the same level of the pyramid. If it is a maxima or minima at this level, then the closest pixel location is calculated at the next lowest level of the pyramid, taking account of the 1.5 times resampling.[3] If the pixel remains higher (or lower) than this closest pixel and its 8 neighbors, then the test is repeated for the level above. Since most pixels will be eliminated within a few comparisons, the cost of this detection is small and much lower than that of building the pyramid.

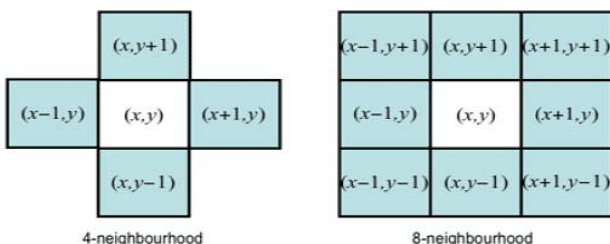


Figure 5 : Figure showing the neighbourhood of a pixel

In this algorithm the maximas are found by simply first comparing the intensity value of a pixel by 8-pixels around that pixel. Neighboring pixels are North, South, West, East, North-east, North-west, South-East, South-West. In the next step the maximas which are extracted from the first scale space are then compared by the maximas extracted from the one level below the scale space. Likewise the maximas are extracted from all the images which are included in the pyramid of DoG.

i. *Mosaicing*

Image mosaics are collection of overlapping images together with coordinate transformations that relate the different image coordinate systems. By applying the appropriate transformations via a warping operation and merging the overlapping regions of warped images, it is possible to construct a single image covering the 25 entire visible area of the scene. This merged single image is the motivation for the term-mosaic. Image mosaicing can be done in a variety of ways. There are many algorithms to do image mosaicing. The algorithm does require effective corner matching. Usually, the algorithms differ in the Image registration process.

After observing the problem domain that is the specifications of the area on which we are working, as simulation of these basic fundamentals is essential for thorough understanding of the algorithm [4]. We chose transformation and Bilinear Interpolation in estimating the missing values.

In case of the image mosaicing, the images specified need not to be necessary that they are aligned as per the images provided. For this fact the proper transformation is performed on each and every image to make it properly aligned as per the first image.

Mainly in dealing with this kind of implementation of algorithm, a common vector is found out. So that the multiplication of that vector with the image aligns it perfectly. Image warping is vector technique used in these algorithms.

III. RESULTS AND CONCLUSIONS

SIFT implementation is carried out on the test image Test-1.



Figure 6 : Test-1

First step in the SIFT is the DoG of the given Image. On applying the DoG the results are as follow.



Figure 7 : Implementation of DoG

Now the next step in SIFT is the creation of the Pyramid of DoG. Following are the desired output when Pyramid is created from the test image.

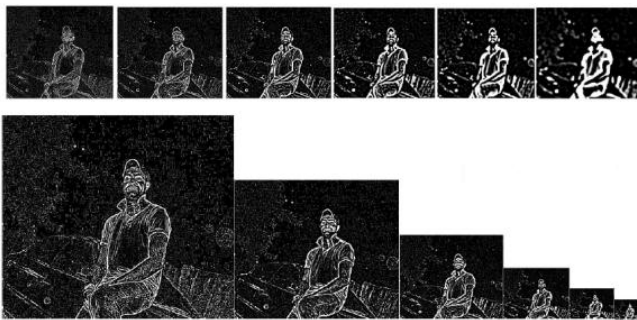


Figure 8 : Pyramid of DoG on the Test image-1

Above are all the desired output that we get after downsampling and then implementing DoG after every Downsampling. The results are quite good and stable for most of the images.

Now the Maxima finding comes after the implementation of the DoG and the Pyramid of the DoG. The outputs are as follow for the maxima finding. First maximas are found within the same space scale and then compaired by the maximas of the one level above it and then with the one level down, so at the end we are left with the maximum number maximas which are quite stable.

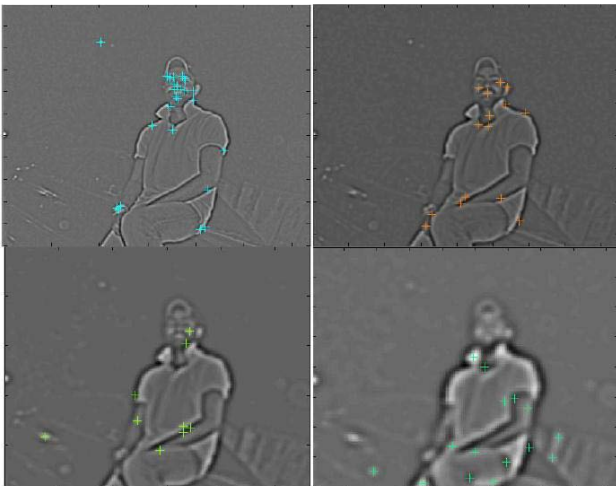


Figure 9 : Maxima finding on the different space scale

After this the marking on the test image is as follow.



Figure 10 : Maxima marking on the original image (Test-1)

Mosaicing part contains the manual detection of the feature locations which are common between the groups of images and then wrapping of the images is done across that point. A new image is generated which is a stich of the two images. The output are as follow.

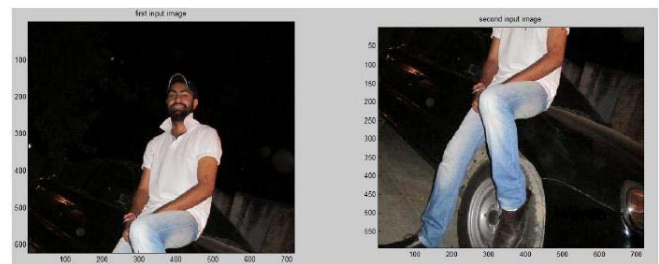


Figure 11 : Images which are going to be mosaiced

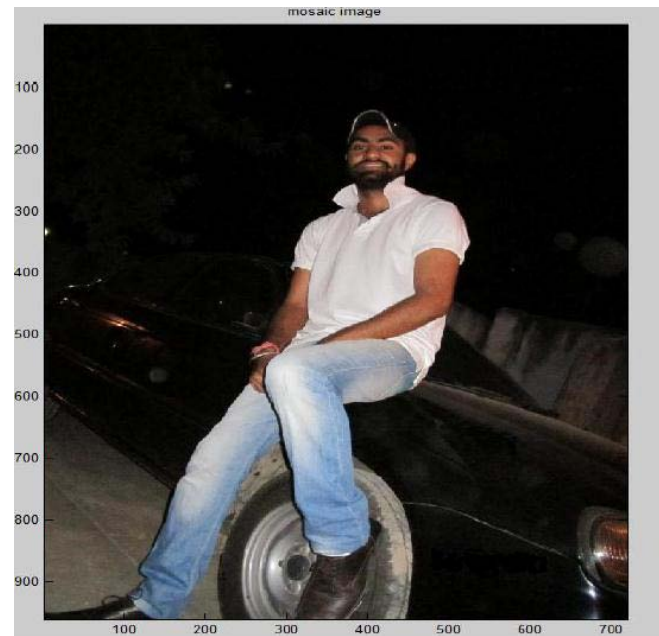


Figure 12 : Resulting image after the mosaicing process (Mosaiced Image)

Above is the final image mosaiced after the whole process of sift and image wrapping.

#### IV. CONCLUSION

We presented the implementation of SIFT algorithm for the feature detection for the given image. First the Difference of Gaussian for the test image is found and then pyramid of Difference of Gaussian is created for the desired levels of scale space. DoG is applied and then the Downsampling is done. As we downsample the DoG image, we get more prominent and less no of features which further helps in less computation and saves time also. Our main aim of using SIFT was that SIFT features are invariant and after implementation we can find that most of the features detected even after the change in the angle and illumination of camera are same if compared with the same image under normal conditions. Maximas that we get for a particular image are constant and invariant to image scaling, translation, and rotation, and partially invariant to illumination changes. The feature locations are picked up from the overlapping areas manually and used for further processing. Mosaicing part which we implemented uses transformation matrix made from the feature locations that are picked up and then inverse mapping is done to create a mosaic with the help of the bilinear interpolation. The mosaics which we are getting are quite good in quality. Illumination and angle of camera does some time affects the mosaic of the images but still the results are worth computing.

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## Mixed Pixel Resolution by Evolutionary Algorithm: A Survey

By Mittu Mittal & Gagandeep Kaur

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**Abstract** - Now a day's Remote Sensing is a mature research area. Remote sensing is defined as a technique for acquiring the information about an object without making physical contact with that image via remote sensors. But the major problem of remotely sensed images is mixed pixel which always degrades the image quality. Mixed pixels are usually the biggest reason for degrading the success in image classification and object recognition. Another major problem is the decomposition of mixed pixels precisely and effectively. Remote sensing data is widely used for the classification of types of features such as vegetation, water body etc but the problem occurs in tagging appropriate class to mixed pixels. In this paper we attempted to present an approach for resolving the mixed pixels by using optimization algorithm i.e. Biogeography based optimization. The main idea is to tag the mixed pixel to a particular class by finding the best suitable class for it using the BBO parameters i.e. Migration and Mutation.

**Keywords** : *remote sensing, mixed pixel, biogeography based optimization, migration, mutation, evolutionary algorithms.*

**GJCST-F Classification**: 1.4.6



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**Keywords** : remote sensing, mixed pixel, biogeography based optimization, migration, mutation, evolutionary algorithms.

## I. INTRODUCTION TO REMOTE SENSING

Remote sensing is the practice of deriving information about the earth's land and water surfaces using images acquired from an overhead perspective, using electromagnetic radiation in one or more regions of the electromagnetic spectrum, reflected or emitted from the earth's surface. This definition certainly does not cover all areas (e.g. meteorological or terrestrial remote sensing), it does serve well as a description of remote sensing. Remote sensing makes use of electromagnetic radiation. The strongest and best-known source of electromagnetic radiation is our sun, which emits radiation over the entire electromagnetic spectrum see fig 1. Besides this natural source of illumination, which is used for passive remote sensing, it is also possible to use an artificial source of electromagnetic radiation, in which case we speak of active remote sensing.

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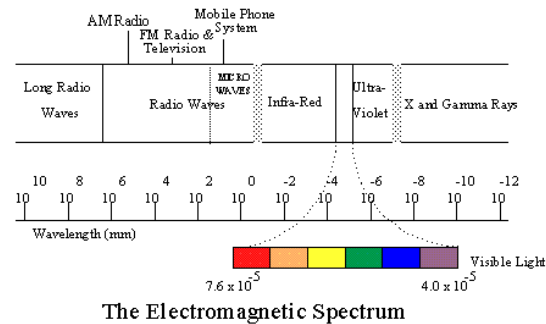


Figure 1 : Principal divisions of the electromagnetic spectrum

Remote sensing map takes pixel as a measurement unit in the ground detection. Since the limited precision of satellite remote sensing detection, sometimes there are several kinds of ground objects in the range of one pixel, which is named mixed pixel. On the contrary, the pixel that consists of one kind of ground object is described as typical pixel. Generally the spectrum features of different ground objects are different. The spectrum of mixed pixels is a mixture of poly-type spectrum of ground objects according to some proportion. The existence of mixed pixel is one of the main factors that affect classifying precision in image recognition. Especially it affects the classification and recognition of linear ground objects and petty ground objects. A lot of mixed pixels are bound to appear at the edge of ground objects. The key to resolve the problem is to find out the Proportion of different objects.

There are various methods for the decomposition of mixed pixel as follows:

1. Linear discriminate analysis
2. Probabilistic, geometric-optical
3. Stochastic geometric
4. Fuzzy
5. Artificial Neural Network models
6. Evolutionary algorithms

All of the above mentioned methods are traditional. But evolutionary algorithms are new approach for resolving mixed pixel problem of remote sensing images.

## II. BIOGEOGRAPHY BASED OPTIMIZATION

Biogeography is the study of the distribution of biodiversity spatially and temporally. Over real ecological changes, it is also tied to the concepts of species. Immigration is the introduction of new people into a habitat or population. It is a biological concept and is important in population ecology. A habitat (which is Latin for "it inhabits") is an ecological or environmental area that is inhabited by a particular species of animal, plant or other type of organism. It is the natural environment in which an organism lives, or the physical environment that surrounds (influences and is utilized by) a species population. Biogeography unfolds the geographical distribution of biological organisms. Their interest was primarily focused on the distribution of species among neighboring islands. The application of biogeography to engineering is similar to what has occurred in the past few decades with genetic algorithms (GAs), neural networks, fuzzy logic, particle swarm optimization (PSO), and other areas of computer intelligence. The term "island" here is used descriptively rather than literally. That is, an island is any habitat that is geographically isolated from other habitats. We therefore use the more generic term "habitat" in this paper (rather than "island"). Geographical areas that are well suited as residences for biological species are said to have a high habitat suitability index (HSI). Features that correlate with HSI include such factors as rainfall, diversity of vegetation, diversity of topographic features, land area, and temperature. The variables that characterize habitability are called suitability index Variables (SIVs). SIVs can be considered the independent variables of the habitat, and HSI can be considered the dependent variable. Habitats with a high HSI have many species that emigrate to nearby habitats, simply by virtue of the large number of species that they host. We call this approach to problem solving biogeography-based optimization (BBO).

### a) Mixed Pixel Problem

The importance and impact of spatial resolution is also witnessed by the mixed pixel 'problem'. Mixed pixels, sometimes known as 'mixels', occur where the image pixels are not homogenous, or 'pure'. Instead a pixel contains a measure of the energy reflected or emitted from several different materials or land surface objects and the sensor records a composite of these responses (Fig 2).

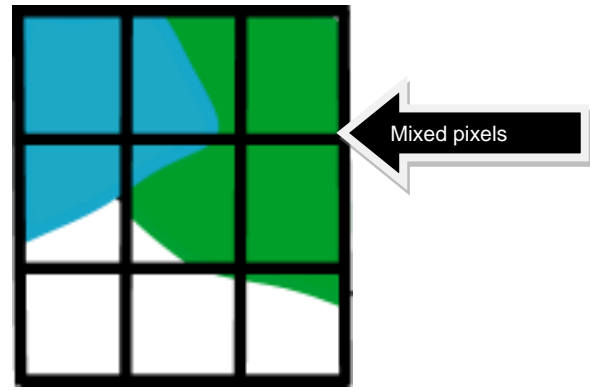


Figure 2 : The mixed pixel problem. Many of the pixels in this 9 cell grid contain more than one class

In many cases this spectral mixing can make it very difficult for the image analyst to identify the different sub-pixel fractional components that serve to make up the landscape under observation. Under these circumstances the analyst may wish to employ a finer resolution data set, in order that a greater number of 'pure' pixels may be recorded. Even with very fine resolution, however, there is still the issue of edge pixels, where pixels can show the boundaries between different land surface properties. Land surface features do not follow the arbitrary confines of the pixel and therefore even very fine spatial resolution data of the order of a few meters' will still experience some degree of confusion and spectral missing.

As you can imagine, mixed pixels can cause great difficulties in the stages of image analysis and interpretation. One of the common tasks in this process is image classification. Classification is widely used as it allows users to easily discriminate information from images presented as a series of categories (classes) rather than raw digital number (DN) values. Images are classified on the basis of their spectral properties. Each pixel of remote sensing image contains the information from multifarious ground objects due to the difference from the resolution of remote sensing image, called **Mixed pixel**.

There are three main causes for mixing pixels in any remotely sensed image which are listed below:-

- Mixed caused by the presence of small, sub pixel targets within the area it represents( Fig 3).



Figure 3 : Mixed Pixel

- Mixing as a result of the pixel straddling the boundary of discrete thematic classes (Fig 4).



Figure 4 : Mixed Pixel

- Mixing due to gradual transition observed between continuous thematic classes.

To resolve these problems we proposed a new methodology using BBO algorithm which is described in next section.

### III. METHODOLOGY

*INPUT* : Data set of pure and mixed pixels

- Read an image and identify the data set of pure and mixed pixels.
- Clustering is done on the basis of color intensity, texture etc.
- Initially choose a set of pure pixels and calculate the best pixel value using G.A.
- Now calculate HSI of each of the Habitat.
- Take one class of mixed pixel and transfer each of corresponding mixed pixel to both the Habitats to which it belongs i.e. Immigration & Emigration.
- Recalculate the HSI of those two Habitats. If recalculated HIS (A) < HIS (B) then absorb the mixed pixel in feature A otherwise in feature B.
- Repeat till all the mixed pixels of class taken are resolved.

*OUTPUT* : All mixed pixels are classified

### IV. DISTINCTIVE FEATURES OF BBO

- First, Biogeography-Based Optimization is a type of evolutionary algorithm. As its name implies, Biogeography is the study of the migration, speciation, and extinction of species. This clearly distinguishes it from reproductive strategies such as GAs and evolutionary strategies.
- BBO also clearly differs from ACO, because ACO generates a new set of solutions with each iteration. BBO, on the other hand, maintains its set of solutions from one iteration to the next, relying on migration to probabilistically adapt those solutions.
- In BBO the original population is not discarded after each generation. It is rather modified by migration.

- Another distinctive feature is that, for each generation, BBO uses the fitness of each solution to determine its immigration and emigration rate.
- BBO is easier to implement and there are fewer parameters to adjust.
- BBO has a more effective memory capability than GA.

### V. CONCLUSION & FUTURE SCOPE

Mixed pixel resolution is a big problem in any remotely sensed imaging. Thus our method can resolve greater number of mixed pixels problem in effective way and also helpful in providing great accuracy in output images. Future work could focus on combining BBO with other EAs like PSO, ABC etc to resolve the problem of mixed pixel resolution.

### VI. ACKNOWLEDGEMENT

This study was supported by the Department of computer science & Engineering of RIMT Institutes Near Floating Restaurant, Sirhind Side, Mandi Gobindgarh-147301, and Punjab, India.

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# Character Segmentation for Telugu Image Document using Multiple Histogram Projections

By N. Anupama, Ch. Rupa & Prof. E. Sreenivasa Reddy

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*Abstract* - TEXT line segmentation is one of the major component of document image analysis. Text line segmentation is necessary to detect all text regions in the document image. In this paper we propose an algorithm based on multiple histogram projections using morphological operators to extract features of the image. Horizontal projection is performed on the text image, and then line segments are identified by the peaks in the horizontal projection. Threshold is applied to divide the text image into segments. False lines are eliminated using another threshold. Vertical histogram projections are used for the line segments and decomposed into words using threshold and further decomposed to characters. This approach provides best performance based on the experimental results such as Detection rate DR (98%) and Recognition Accuracy RA (98%).

*Keywords* : optical character recognition, segmentation, histogram projection, telugu scripts.

*GJCST-F Classification*: 1.4.6



CHARACTER SEGMENTATION FOR TELUGU IMAGE DOCUMENT USING MULTIPLE HISTOGRAM PROJECTIONS

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RESEARCH | DIVERSITY | ETHICS

# Character Segmentation for Telugu Image Document using Multiple Histogram Projections

N. Anupama<sup>α</sup>, Ch. Rupa<sup>σ</sup> & Prof. E. Sreenivasa Reddy<sup>ρ</sup>

**Abstract** - TEXT line segmentation is one of the major component of document image analysis. Text line segmentation is necessary to detect all text regions in the document image. In this paper we propose an algorithm based on multiple histogram projections using morphological operators to extract features of the image. Horizontal projection is performed on the text image, and then line segments are identified by the peaks in the horizontal projection. Threshold is applied to divide the text image into segments. False lines are eliminated using another threshold. Vertical histogram projections are used for the line segments and decomposed into words using threshold and further decomposed to characters. This approach provides best performance based on the experimental results such as Detection rate DR (98%) and Recognition Accuracy RA (98%).

**Keywords** : optical character recognition, segmentation, histogram projection, telugu scripts.

## I. INTRODUCTION

Text line segmentation is an essential pre-processing stage for recognition in many Optical Character Recognition (OCR) systems. Segmentation of text line is a vital step because inaccurately segmented text lines result in errors during recognition stage. Segmentation of the handwritten document is still one of the most concerned challenging problems. Several techniques for text line segmentation are reported in the literature for segmenting Indian script documents. These methods include projection profile (white space analysis) [1], voronoi and docstrum [2], graph cut, connected components based. Segmentation is not accurate with these methods. Jawahar [3] proposed the graph cut method that requires a priori information about the script structure to cut. Rajasekharan proposed a method based on projection method for Kannada script document segmentation [4]. As a conventional technique for text line segmentation, global horizontal projection analysis of black pixels has been utilized in [5, 6, 7, 8]. Partial or piece-wise horizontal projection analysis of black pixels as modified global projection technique is employed by many researchers to segment text pages of different languages [9, 10, 11]. In piecewise horizontal projection technique text-page image is decomposed into vertical strips. The positions of potential piece-wise separating

lines are obtained for each strip using partial horizontal projection on each stripe. The potential separating lines are then connected to achieve complete separating lines for all respective text lines located in the text page image.

In this paper a robust method for segmentation of documents into lines and words and the proposed method is based on the modified histogram as the Telugu script is very complex. For accurate line segmentation Foreground and background information is also used. This method take cares of eliminating false lines and recovering the loss of text in overlapped text lines.

The rest of the paper is organized as follows: In Section 2, we discussed the properties of Telugu scripts considered here. Proposed approach is discussed in Section 3. Experimental results in Section 4. Finally the paper is concluded in section 5.

## II. CHARACTERISTICS OF TELUGU SCRIPT

Telugu is the most popular South Indian spoken script based language. The Telugu character set contains 16 vowels, 36 consonants, vowel (mastras) and consonant modifiers (vaththus). These characters are combined to represent several frequently used syllables (estimated between 5000 and 10000) in the language [12, 13, 14]. We refer to these basic orthographic units as glyphs (single connected component representation). These characters will have variable size. (i.e. width and height). In Latin based scripts most of the characters have same size except few characters. Segmentation of such characters is difficult when compared with Latin based scripts like English. The figure 1 shows sample Telugu simple and compound character images.

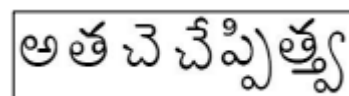


Figure 1 : Examples for simple and compound characters

## III. PROPOSED APPROACH

Here we propose a new technique which automatically identify and segment the text line regions of handwritten documents. Figure 2 shows the basic steps in our proposed algorithm.

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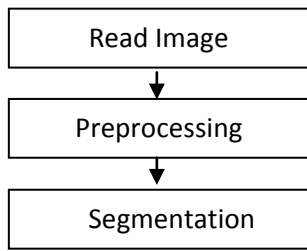


Figure 2 : Shows the basic steps in segmentation algorithm

a) Pre Processing

The raw data is subjected to a number of preliminary processing steps to make it usable in the stages of character analysis.

Pre-processing aims to produce data that are easy for segmentation accurately. The main objectives of pre-processing include:

- Binarization
- Noise reduction
- Skeletonization/Normalization
- Skew correction.

We have used binary image for our work and to convert the original grey-level document images into binary image, we have applied the algorithm due to Otsu [15]. Then noise removed, skew corrected output image from the pre-processing phase is given as input to the Segmentation stage. For Noise removal we use morphological operators. Figure 3 shows steps in Noise removal.

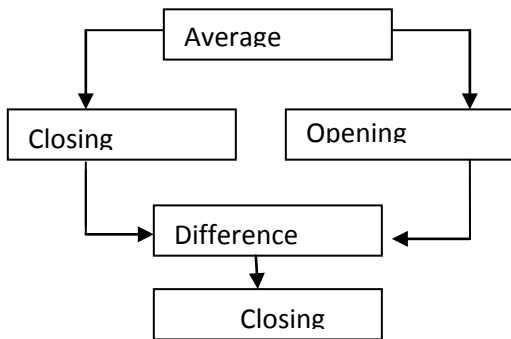


Figure 3 : Steps in Noise Removal

$$E(I(x,y)) = \frac{1}{mn} \sum_{i=-\frac{m}{2}}^{\frac{m}{2}} \sum_{j=-\frac{n}{2}}^{\frac{n}{2}} I(x+i,y+j) S(i,j) \quad (1)$$

$$I(x,y).S = (I(x,y) \oplus S) \odot S \quad (2)$$

$$I(x,y) \circ S = (I(x,y) \odot S) \oplus S \quad (3)$$

$$D(x,y) = I1(x,y) - I2(x,y) \quad (4)$$

$$T(I(x,y)) = \begin{cases} 255, & \text{if } I(x,y) > T \\ 0 & \text{otherwise} \end{cases} \quad (5)$$

In Equations 1-5

$I(x, y)$  denotes the gray level value of the pixel located at position  $(x, y)$ .

$S$  is the structural element of size  $m \times n$  where  $m$  and  $n$  are odd values larger than zero. Here we use a structuring element of  $3 \times 3$  in mathematical morphological context. Closing operation is performed to turn the border of the resulting image more compact and closer. Normalization provides a tremendous reduction in data size, thinning extracts the shape information of the characters. The document then has to be skew corrected which is the input for Segmentation.

b) Segmentation

Once the pre-processing is completed then the histogram projections in  $y$  direction are obtained in order to perform Line segmentation and then  $x$  histogram projections for words and character segmentation.

$$Profile(y) = \sum f(x,y)$$

i. Line segmentation

It is the process of identifying lines in a given image.

Steps for the line Segmentation is as follows

1. Scan the preprocessed image horizontally and find the number of ON pixels in each row.
2. Plot the histogram in  $y$  direction for the ON pixel count for the image.
3. Scan the histogram projection to find first ON pixel count with zero and remember that  $y$  coordinate as  $y1$ .
4. Continue scanning the histogram projection then we would find lots of ON pixel counts to be non zero since the characters would have started.
5. Finally we get the first ON pixel count as zero and remember that  $y$  coordinate as  $y2$ .
6. Scan the image from  $y1$  to  $y2$  rows for the segmented line.
7. Clear  $y1$  and  $y2$ .
8. Repeat the above steps till the end of the histogram.

ii. Word Segmentation

As each word is separated with a distance, we use that concept for word segmentation. Scan the segmented line image vertically for word segmentation. Steps for the line Segmentation is as follows:

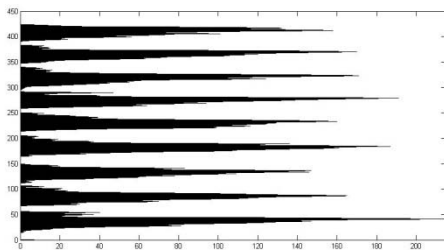
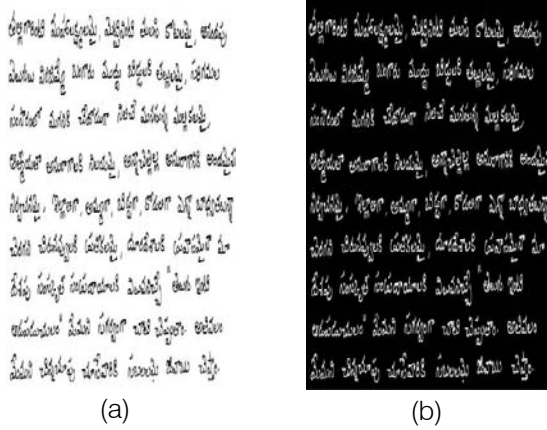
1. Scan the segmented line image vertically and find the number of ON pixels in each column.
2. Plot the histogram in  $x$  direction for the ON pixel count for the image.
3. Scan the histogram projection to find first ON pixel count with zero and remember that  $x$  coordinate as  $x1$ .



4. Continue scanning the histogram projection then we would find lots of ON pixel counts to be non zero since the characters would have started.
5. Finally we get the first ON pixel count as zero and remember that x coordinate as x2.
6. Scan the image from x1 to x2 columns and get the segment word.
7. Clear x1 and x2.
8. Repeat the above steps till the end of the vertical histogram.

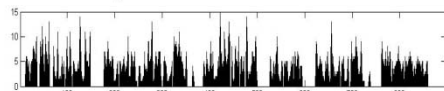
iii. *Character Segmentation*

Repeat the same algorithm defined in 3.2.2 for segmenting the word into characters. In step 1 give the input the segmented word image and in step 3 use a character separating distance ( as 2) based on the histogram. After completing step 8 we will be having the segmented characters.

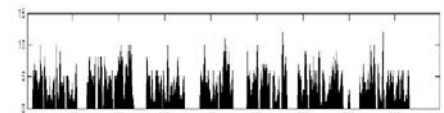


(c)

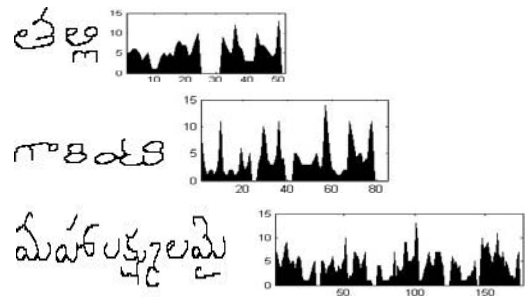
అల్లగాలిది మహావక్త్రులమై, మెచ్చినది తులసి కొబలమై, అనందపు



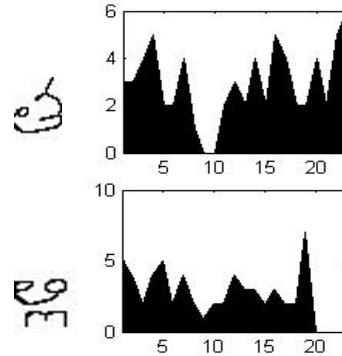
వెలుగులు విరబిష్ణు బంగారు మొద్దు బోధలకి అల్లలమై, సరిగమలు



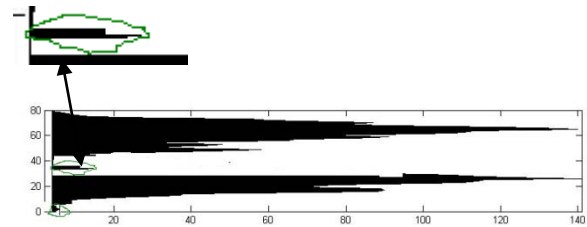
(d)



(e)



(f)



(g)

Figure 4 : Intermediate stages: (a) Input image, (b) Pre processed step, (c) Y histogram projection (d)Text line separation with horizontal histogram projections, (e) x histogram projections for segmented words.(f) X histogram projection for segmented characters. (g)False line

c) *False Line Exclusion*

This procedure tries to exclude possible noises close to the text line regions. Once the possible text line are segmented by removing an offset from the histogram, we calculate the average height of these line regions to exclude false lines that might be detected. Figure 4.g a small peak in the histogram shown in green, if this region has enough height it can be confused with a text line segment by the algorithm. The equation below provides the average height of the lines found in a histogram:

$$\sum (y_{max} - y_{min}) / N_r$$

Where Ymax is the max height of the text line region and Ymin is the beginning of text region and Nr is the total no of line regions.

The lines with height below a pre-determined threshold are removed. The value of this threshold is proportional to the average height of the text lines in the whole image.

d) *False Word Exclusion*

As in 3.3 we will find the average height of the word in x direction and the word not satisfying the determined threshold will be treated as false word.

IV. PERFORMANCE EVALUATION

The performance is evaluated by checking the count of number of matches between the segmented entities with that of entities in the ground truth [16]. A Match Score table is created where the pixels of the segments and the ground truth are coincide. Let *I* be the set of all image points, *G<sub>j</sub>* the set of all points inside the *j* ground truth region, *S<sub>i</sub>* the set of all points inside the *i* segmented region, *T(s)* a function that counts the elements of set *s*. Matching results of the *j* ground truth region and the *i* segment region:

$$\text{Match Score}(i,j) = \frac{T(G_j \cap S_i \cap I)}{T(G_j \cup S_i \cup I)}$$

A one-to-one match is used if the matching score is equal to or above the evaluator's acceptance threshold *T<sub>a</sub>*. If *G* is the count ground-truth elements, *S* is the count of result elements, and *o2o* is the number of one-to-one matches, we calculate the detection rate (*DR*) and recognition accuracy (*RA*) as follows:

$$DR = \frac{o2o}{G}, \quad RA = \frac{o2o}{S}$$

DR and RA is used to extract the performance metric which is

$$PM = \frac{2DR.RA}{DA+RA}$$

V. RESULTS AND DISCUSSION

The algorithm is implemented in MATLAB. The algorithm is tested with several document images. Sample test results are shown in Figure 4. From the experiment the proposed method is fast and reliable to even for handwritten documents which have non overlapped lines. The line segmentation accuracy with DR is 99% and RA is 98% for good quality documents. The limitation of this method is that it resulted in segmentation errors for touching characters.

	M	o2o	DR(%)	RA(%)	PM(%)
Words	4044	3975	98.54	98.29	98.42
Characters	31197	27078	91.12	86.80	88.91

VI. CONCLUSION AND FUTURE WORK

In this experiment, the proposed algorithm is tested with several document images. Even though this algorithm provides robust results it could not accurately segment the overlapped lines. A heuristic algorithm needs to be thought of in case of overlapping lines and words to recover the loss text.

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## Digital Color Image Watermarking using DWTDCT Coefficients in RGB Planes

By K. Chaitanya, E. Sreenivasa Reddy & K. Gangadhara Rao

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**Abstract** - Digital image watermarking is used to identify the authenticity and integrity and to show the identity of its owners. This paper presents a more secure method for copy right protection. In the proposed method, the color image is decomposed into 3 color channels Red, Green and Blue and then DWT and DCT are applied to B channel of the R, G and B channels. The colored Watermark image is decomposed into R, G, B channels and DCT is applied to all the channels separately. R, G, B channels of watermark image are embedded into mid frequency coefficients of B channel already selected. The performance of proposed algorithm is measured by using Mean Square Error, Peak Signal to Noise Ratio, Standardized Correlation and Normalized Correlation. A comparative study of proposed scheme with the existing methods which uses DWT-DCT transforms is carried here and results shown.

**Keywords** : *discrete cosine transform (DCT), discrete wavelet transformation (DWT), normalized correlation (NC), peak signal to noise ratio (PSNR).*

**GJCST-F Classification:** *1.4.0*



DIGITAL COLOR IMAGE WATERMARKING USING DWTDCT COEFFICIENTS IN RGB PLANES

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# Digital Color Image Watermarking using DWT-DCT Coefficients in RGB Planes

K.Chaitanya<sup>α</sup>, E. Sreenivasa Reddy<sup>σ</sup> & K.Gangadhara Rao<sup>ρ</sup>

**Abstract** - Digital image watermarking is used to identify the authenticity and integrity and to show the identity of its owners. This paper presents a more secure method for copy right protection. In the proposed method, the color image is decomposed into 3 color channels Red, Green and Blue and then DWT and DCT are applied to B channel of the R, G and B channels. The colored Watermark image is decomposed into R, G, B channels and DCT is applied to all the channels separately. R, G, B channels of watermark image are embedded into mid frequency coefficients of B channel already selected. The performance of proposed algorithm is measured by using Mean Square Error, Peak Signal to Noise Ratio, Standardized Correlation and Normalized Correlation. A comparative study of proposed scheme with the existing methods which uses DWT-DCT transforms is carried here and results shown.

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## I. INTRODUCTION

Now a days we can transmit any type of information either data(in the form of image) or images(pictures) by using the Internet. The data may also accessible by unauthorized persons while transmit data through ordinary commercial information transmitting channel like Internet. So for providing data security we need advanced authentication methods. One of such authentication method is digital watermarking.

Data hiding techniques can be classified into 2 types: Spatial domain [1] and Transform domain [2 3 4 5]. Transform domain techniques are Discrete Wavelet Transform (DWT) [2, 3, 4], Discrete Cosine Transform (DCT) [5] and Discrete Fourier Transform (DFT). Spatial domain techniques are Least Significant Bit insertion (LSB) etc. In our proposed method we use combination of Discrete Wavelet Transform and Discrete Cosine Transform [6 7] for embedding the watermark images.

In our proposed method we embed the watermark image in the blue channel. Cones are the sensors in the human eye responsible for color vision. Detailed experimental evidence has established that the 6 to 7 million cones in the human eye can be divided into three principal sensing categories, corresponding roughly to red, green and blue. Approximately 65% of all

cones are sensitive to red light, 33% are sensitive to green light, and only 2% are sensitive to blue light. Human eye is less sensitive to blue light, so we embed the image in blue channel.

The performance is measured by the PSNR, SC and NC and also apply different attacks like salt & Pepper, Gaussian Blur, Gaussian Noise, Sharpening& Cropping and analyze the results.

### a) Discrete Wavelet Transform

Discrete Wavelet Transform [24] decomposes an image into 4 multi-resolution sub-bands. Those are LL1, LH1, HL1, HH1. In this LL1 contains the original information and HH1 contains edges and textures. If we embed the watermark information in LL1 and HH1 the image quality is disturbed. So, we cannot embed the watermark information in these two sub-bands. The human visual system is less sensitive to HL1 than LH1. So, we can identify the sub-band HL1 then apply the 2<sup>nd</sup> level DWT to that sub-band and we get LL2, LH2, HL2, HH2 sub-bands and select HL2 for embed the watermark.

### b) Discrete Cosine Transform

The sub-band (HL2) divided into 8×8 blocks. Apply DCT [27] to each block. Each block contains low-frequency, mid-frequency and high-frequency sub-bands. Generally we choose the mid-frequency sub-bands for embedding the watermark image. If we compress the image then high-frequency coefficients are generally removed. The low-frequency sub-bands are the visualized components. So we can't insert in low and high-frequency sub-bands.

## II. PROPOSED METHOD

This method involves the following steps:

1. Decompose the image into 3 color components: red, green and blue.
2. Apply 2 levels DWT to Blue channel and then convert it into frequency components using DCT.
3. For providing security embed the watermark into Blue color component.

### a) Watermark Embedding Algorithm

1. Select any color image as the original image 'OI'. Decompose the image into 3 color components R, G and B.
2. Apply DWT to B channel. Then we get multi-resolution sub-bands LL1, HL1, LH1, and HH1.
3. Apply DWT again to HL1 and we get LL2, HL2, LH2 and HH2. Select the HL2 sub-bands.

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4. Divide the HL2 sub-band into 8x8 size blocks (consider each block as cell).
5. Apply DCT to each cell of HL2 sub-band.
6. Select any color watermark image 'WI'. Obtain the R, G, B channels of WI.
7. Apply DCT to each R, G and B channels separately.
8. Embed one pixel of every R, G and B channels of Watermark image WI into each cell of HL2.
9. Apply IDCT to the each cell of HL2 sub-band.
10. Apply 2 levels IDWT to B channel.
11. Combine the R, G and B channels to get the watermarked image 'WMI'.

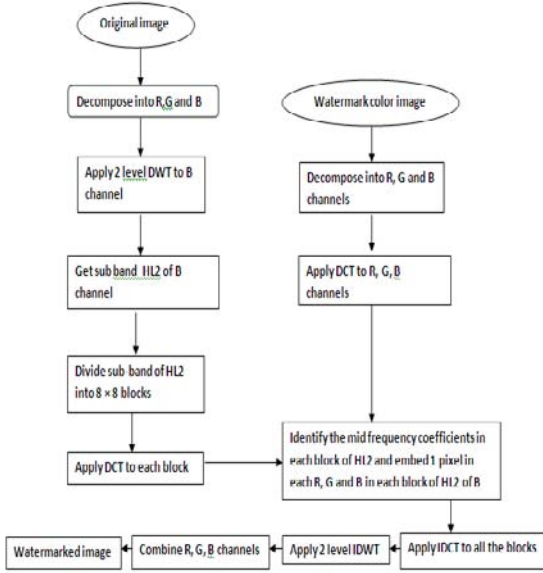


Figure 1 : Watermark Embedding Algorithm

b) Watermark Extraction Algorithm

1. Take the watermarked image 'WMI' and decompose into R, G and B channels.
2. Apply DWT to B channel. Then we get multi-resolution sub-bands LL1, HL1, LH1, and HH1.
3. Apply DWT again to HL1 and we get LL2, HL2, LH2 and HH2. Select the HL2 sub-bands.
4. Divide the HL2 sub-band into 8x8 size blocks (consider each block as cell).
5. Apply DCT to each cell of HL2 sub-band.
6. Extract the first bits of watermark from first cell of B channel and placed in first positions of WR, WG and WB channels. Extract the second bits of watermark from the second cell of B channel and placed in second positions of WR, WG and WB channels.
7. Repeat the previous step until we get all the pixels into the WR, WG and WB channels of 'WI' separately.
8. Apply IDCT to WR, WG and WB channels.
9. Combine WR, WG and WB channels, then we get Extracted color watermark image 'EWI'.

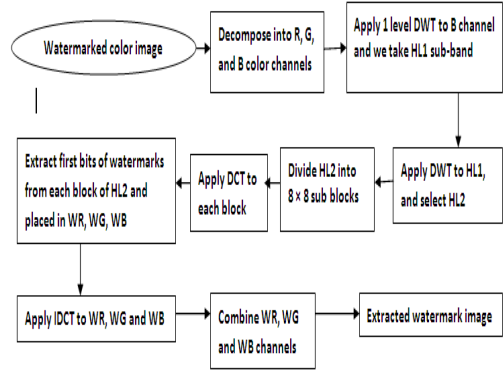


Figure 2 : Watermark Extraction Algorithm

III. PERFORMANCE ANALYSIS

The performance of watermarked image is calculated by the two error matrices Mean Square Error (MSE) and Peak Signal to Noise Ratio (PSNR) between Original Image and Watermarked Image. The quality of Extracted Watermark is calculated by Normalized Correlation (NC) and Standard Correlation (SC) between watermark image and Extracted Watermark image.

The following are the equations for calculating MSE, PSNR, NC and SC.

a) Mean Square Error (MSE)

MSE and PSNR are the two error metrics used to compare watermarked image quality. The MSE represents the cumulative squared error between the watermarked image and the original image, whereas PSNR represents a measure of the peak error. The lower the value of MSE, the lower the error.

To compute the PSNR, the block first calculates the mean-squared error using the following equation:

$$MSE = \frac{\sum_{i=1}^M \sum_{j=1}^N (OI(i,j) - WMI(i,j))^2}{MN}$$

Where M and N are the height and width of the image. OI is the Original Image and WMI is the Water marked Image.

b) Peak Signal to Noise Ratio (PSNR)

$$PSNR = 10 \log_{10} \left[ \frac{R^2}{MSE} \right]$$

In the previous equation, R is the maximum fluctuation in the input image data type. For example, if the input image has a double-precision floating-point data type, then R is 1. If it has an 8-bit unsigned integer data type, R is 255, etc.

c) Normalized Correlation (NC)

$$NC = \frac{\sum_{i=1}^M \sum_{j=1}^N (WI(i,j) \cdot EWI(i,j))}{\sqrt{\sum_{i=1}^M \sum_{j=1}^N (WI(i,j))^2}}$$

Where  $WI [i, j]$  is the original watermark image and  $EWI [i, j]$  is the extracted watermark image . $M$  is the Height and  $N$  is the Width of the image.

d) Standard Correlation (SC)

$$SC = \frac{\sum_{i=1}^M \sum_{j=1}^N (wi(i,j) - w11)(ewi(i,j) - ew11)}{\sqrt{\sum_{i=1}^M \sum_{j=1}^N (wi(i,j) - w11)^2} \sqrt{\sum_{i=1}^M \sum_{j=1}^N (ewi(i,j) - ew11)^2}}$$

Where  $WI [i, j]$  is the original watermark image and  $W11$  is the mean of original watermark image,  $EWI [i, j]$  is the extracted watermark image and  $EW11$  is the mean of the extracted watermark image.

IV. RESULTS

We use 3 color images candle, flower, lotus and leaf of size  $1024 \times 1024$  for testing this method. The watermark image used for embedding is shown in figure4 of size  $32 \times 32$ .The figure 3 shows the results before watermarking and after watermarking of the original color image. Figure 4 shows the results of watermark and extracted watermarking.



Figure 3 : Candle, flower, lotus and leaf images before and after embedding watermark

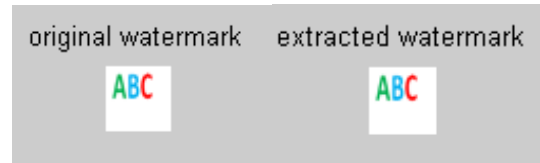


Figure 4 : Original watermark and extracted watermark images

V. ANALYSIS

We analyze the proposed method by calculating the MSE and PSNR between original image and watermarked image, by calculating the NC and SC between Original watermark image and Extracted watermark image. Table1 shows the MSE, PSNR between original and watermarked images for candle, flower, lotus and leaf images. Table2 shows the NC, SC between original watermark and extracted watermarked images for candle, flower, lotus and leaf.

Table 1 : MSE, PSNR between original and watermarked images

Image	MSE	PSNR
Candle	3.5699e <sup>-005</sup>	92.6042
Flower	4.4328e <sup>-005</sup>	91.6640
Lotus	3.5049e <sup>-005</sup>	92.6841
Leaf	3.5678e <sup>-005</sup>	92.6068

Table 2 : NC and SC between original and extracted watermark images candle, flower, lotus and leaf

Image	NC	SC
Candle	1	1
flower	1	1
Lotus	1	1
leaf	1	1

a) Attacks

Salt & Pepper noise with noise density 0.002 is added to the watermarked images, Gaussian blur with disk radius 1, sharpening with parameter 0.5, cropping with 20 percent, Gaussian noise is added with length=2 and theta=4 and the corresponding PSNR of the original and watermarked after attack, NC of the original watermark and extracted watermark after attack.

Table 3 : PSNR of Extracted watermark from watermarked images after attacks

	PSNR(dB)			
	Candle	Flower	Lotus	Leaf
Salt and Pepper	79.6051	79.1953	79.3784	79.7989
Gaussian Blur	89.1485	76.3084	94.6734	88.8786
Sharpening	75.5086	63.5381	79.8306	75.2392
Gaussian Noise	78.2971	78.3414	78.3462	78.0324
Cropping	90.1163	89.0328	90.1372	89.9924



**Table 4** : NC between original watermark and extracted watermark after attacks

	NC			
	Candle	Flower	Lotus	Leaf
Salt and Pepper	1	0.9995	1	1
Gaussian Blur	0.9974	0.9974	0.9974	0.9974
Sharpening	0.9507	0.9507	0.9507	0.9507
Gaussian Noise	0.9998	0.9998	0.9998	0.9998
Cropping	1	1	1	1

**b) Comparison Results**

Table 5 shows the comparison results with the existing transformation methods Bi-Ortho [7], DCT- Coef [21], DWT-DCT based on the NC value between original watermark and extracted watermark if the watermarked image undergoes any attacks.

**Table 5** : Comparison with existing methods

Attack	Bi-Ortho	DCT-Coef	DWT-DCT
Salt and Pepper	0.8518	0.998	0.9995
Gaussian Blur	--	0.998	0.9974
Sharpening	--	0.995	0.9507
Gaussian Noise	0.8575	0.996	0.9998
Cropping	0.8484	0.920	1

**VI. CONCLUSION**

This robust watermarking technique is proposed for increasing the security of data hiding and robustness and quality compared to existing algorithms. For improving the security we use the frequency transformations DWT and DCT applied to the Blue channel of original image and embed the color watermark image.

Our future work is to implement Video watermarking by embed the watermark image in the video instead of image.

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## Classification and Analysis of Morphological Edge Detectors

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*Abstract* - In this paper we critically examine various morphologic edge detectors, the methods they apply, their orientation in detecting the edges accurately and to raise the de-noising capacity. Comparative analysis of these edge detectors reveals the various advantages and disadvantages of one approach over the other.

*Keywords* : edge detector, de-noising capacity, orientation, mathematical morphology, edge accuracy.

*GJCST-F Classification: 1.4.6*



*Strictly as per the compliance and regulations of:*



# Classification and Analysis of Morphological Edge Detectors

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**Abstract** - In this paper we critically examine various morphologic edge detectors, the methods they apply, their orientation in detecting the edges accurately and to raise the de-noising capacity. Comparative analysis of these edge detectors reveals the various advantages and disadvantages of one approach over the other.

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## I. INTRODUCTION

Images when subjected to discontinuities in its physical features such as surface illumination, shadows, geometry and intensity levels causes distortion at its outline called edges. These edges represent vital information which needs to be detected and extracted to construct the original image. This process of detection of the edges and restoring the edges is called as edge detection. In the field of image processing edge detection is a key step in the preprocessing of a computer vision system. Due to this significance impact, edge detection plays a pivotal role, as its results affect the final performance of image processing directly.

Edge detectors employ various operators to perform edge detection. Traditional operators such as spatial differential operators or template matching operators were used widely to detect edges. Differential operators include Sobel edge operator. Template matching operators include Prewitt, Kirsch, Robinson three level and five level edge operators. The performance of these operators degrades with noise. Marr, Hildreth and Canny operators were developed with an inbuilt noise smoothing mechanism to overcome degradation due to noise.

Canny operator, though still exists, lags when compared to the advanced edge detectors using morphological approach.

Mathematical morphology technique is used for the analysis and processing of geometrical structures, based on set theory, lattice theory, topology and random functions. Features such as low noise sensitivity, low cost and easy computation makes morphology theory as most advanced technique in edge detection.

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Initially morphology dealt with binary images with basic operations of *dilation* and *erosion*. Based on these two compound operations *opening* and *closings* are defined. These operations when performed on single structural element becomes very sensitive to noise hence it is applied using multi structural elements.

Mathematical morphology as a significant sub-branch of nonlinear filtering theory has abandoned conventional mathematical modelling and analytical standpoint. It overcame the defect of high sensitivity to noise in traditional edge detection and could probe ideal edges located in the images. Hence the study of various morphology edge detectors gives us an in-depth understanding into the edge detection mechanism.

## II. EDGE DETECTORS

### a) Morphologic Edge Detectors

Morphologic transformations form binary image to gray scale image. The morphological operations, *dilation (enlarges the image)* and *erosion (shrinks the image)*, work with two images, the original image and a template called structuring element. Each structuring element has a particular shape which controls the parameters of the operation. A simple method of performing gray scale edge detection in morphology is to take the difference between an image and its erosion/dilation image generated by a structuring element. Rod shaped with flat top structuring element is popularly used for edge detection.

Dilation and Erosion Residue edge detectors are used in this method to perform edge detection. *Dilation residue edge detector*[1] provides edge strength to the side having low value. *Erosion residue edge detector* provides edge strength to the side having high value. These biased detectors are thus sensitive to noise.

### b) Blur-Minimum Edge Detector

Dilation and Erosion operators are biased when they are applied for edge detection individually as seen above. To develop an unbiased edge operator, dilation and erosion operators are combined. The resultant combined operator is known as *blur-minimum edge detector*[3]. This is a good detector of ramp edge and is less sensitive to noise.

This cannot detect ideal step edges. Emphasizing this defection which can be controlled by pre smoothing with simple mean filter. This increases

the performance of edge detection, as it converts the step edge into ramp edge and reduces the noise in the image.

This detector lacks in localization sensitivity and produces thick edges, likewise edges are discontinuous in nature.

#### c) *Multi-Scale Morphology Edge Detector*

Iterative opening and closing operations are able to filter the noise and make the image smooth. As the size of the noise patterns in the image vary significantly, using one structuring element will not be able to remove the noise effectively.

In multi scale morphologic edge detector, structuring elements of different sizes are used to extract features at different scales. The smaller the size of structuring element, lesser is the noise removing capacity and more the ability to detect fine edges. By using large structuring element, more amount of noise is reduced likewise thickness of edges increases causing smearing of closely spaced edges.

Edge maps, combination of different size structuring elements, helps in reducing the defects encountered by using larger size structuring element. True edge points are extracted from the combined edge map as follows:

1. Obtain edge strength maps using structuring elements of different scale.
2. Combine these edge strength maps.
3. Extract the edge points lying on the ridge of the edge strength surface using non-maximal suppression technique.

This detector performs better than other improved morphological detectors under noisy conditions. It is possible to obtain thin edges or object boundaries with multiscale operator which may not be detected with other morphological methods. This method can detect weak edge points lying next to strong edge points without any sacrifice of quality.

#### d) *Alternative Sequential Filter Edge Detector*

*Alternating Sequential Filter (ASF) edge detector*[4] basically an erosion residue edge detector uses a rod structuring element preceded by noise suppression. In this noise is suppressed by alternating application of opening and closing morphological filters.

This is used to detect weak edge points besides the strong edge point without quality degradation.

This edge detector cannot detect small and quick variations on gray level surface i.e., it is difficult to select a structuring element.

#### e) *Multi-scale morphologic edge detector using edge tracking approach*

Multi-scale morphologic gradient method's deficiency begins when there is a presence of large amount of noise in the image. This leads to the

amount of noise in the image. This leads to the complexity in choosing the structural element. If we consider a small structural element, edges can be preserved whereas the noise cannot be eliminated. When big structural element is considered, though noise is removed, tiny edge characteristics are lost.

The edge of the actual object often possesses extremely high spatial continuity and exhibits good linearity[5]. Thus edge tracking algorithm is based on this property.

The technique used in this approach is as follows

##### i. *Extracting the morphological gradient*

In this method structural elements scale is selected based on the principle that *the geometric dimension of the edge must be larger than that of noise*. According to the dimensional difference between edge and noise, we can get a scale to preserve the edge and remove the noise by using pixel length count.

##### ii. *Tracking the morphologic edges*

To acquire the input image data, the scanning sequence can be divided into two, from top to bottom and from left to right as follows

*Step 1* : Select a proper threshold value as tracking threshold value. If the pixel length exceeds threshold value, this set of pixels would be marked as edge.

*Step 2* : Select a lower threshold value as tracking threshold value. If the tracking value is less than the tracking threshold value, this value is saved as mid value.

*Step 3* : If the edge length (i.e. pixel count greater than tracking threshold) exceeds the mid value, the series of pixels initialized are classified as the sort of noise signal and their gray-level values are set to the background value. If the edge length is less than the mid value, the series of pixels initialized are classified as the sort of edge signals and their values are preserved.

##### iii. *Constructing the final edge image*

The capability of structuring element to remove the noise is weak if its size is small and the false edge detection probability is high. By contrast, the capability of structuring element to eliminate noise is high and it could extract the real edge thus we could increase the weights of big structuring elements properly and decrease the weights of small ones simultaneously.

All this process requires a high computational capability which increases the complexity. This complexity can be reduced using multi thread technology.

#### f) *Multidirectional Structuring Element Morphological Edge Detector*

The shape and size of the structuring elements determine the geometrical features in an image that are preserved or removed. Smaller the size of structuring element, lesser is the noise removing capacity and more the ability to detect edge details. By using large size structuring element one can remove more noise but at

the same time the thickness of edge increases causing smearing of edges.

This smearing of edges can be controlled we can combine eight orientation structuring elements obtained with eight right angles transformation of original structuring element[6].

Once the structuring element is selected its different angles needs to be processed by morphological transformation for edge detection is as follows

1. The enhanced image has fine edge details for detecting edge.
2. Filtering the noise of the enhanced image.
3. Processing of the structural element by morphology transformation.

If the scale of structural element is selected properly, this method reduces the noise more efficiently compared to other methods. Edge detectors employing this method has more connectivity compared to other methods.

### III. CONCLUSION

The analysis of the various morphological edge detection methods yields the results of their advantages and disadvantages. Of all the methods *Multidirectional structuring element morphological edge detector* is more suitable in reducing noise levels and in restoring the thin edges with critical information. Though *multi-scale morphology edge tracking approach* has all the attributes of a good edge detector, its complexity in computation acts as a hurdle against the robust use of it. Therefore by combining the two above said methods, we can improve the efficiency of edge detection even in noisy conditions also.

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# Dynamic Hand Gesture Recognition of Arabic Sign Language using Hand Motion Trajectory Features

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**Abstract** - In this paper we propose a system for dynamic hand gesture recognition of Arabic Sign Language. The proposed system takes the dynamic gesture (video stream) as input, extracts hand area and computes hand motion features, then uses these features to recognize the gesture. The system identifies the hand blob using YCbCr color space to detect skin color of hand. The system classifies the input pattern based on correlation coefficients matching technique. The significance of the system is its simplicity and ability to recognize the gestures independent of skin color and physical structure of the performers. The experiment results show that the gesture recognition rate of 20 different signs, performed by 8 different signers, is 85.67%.

**Keywords** : *arabic sign language; skin color segmentation; gesture recognition; face detection; hu moments; correlation coefficients.*

**GJCST-F Classification**: *1.4.m*



*Strictly as per the compliance and regulations of:*



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Mohamed S. Abdalla<sup>α</sup> & Elsayed E. Hemayed<sup>σ</sup>

**Abstract** - In this paper we propose a system for dynamic hand gesture recognition of Arabic Sign Language. The proposed system takes the dynamic gesture (video stream) as input, extracts hand area and computes hand motion features, then uses these features to recognize the gesture. The system identifies the hand blob using YCbCr color space to detect skin color of hand. The system classifies the input pattern based on correlation coefficients matching technique. The significance of the system is its simplicity and ability to recognize the gestures independent of skin color and physical structure of the performers. The experiment results show that the gesture recognition rate of 20 different signs, performed by 8 different signers, is 85.67%.

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## I. INTRODUCTION

A gesture is a form of non-verbal communication made with a part of body, used instead of or in combination with verbal communication. Gestures are ambiguous and incompletely specified. Similar to speech and handwriting, gestures vary from a person to another, and even for the same person between different instances. Arabic Sign Language (ArSL) is a dominant Sign Language of the deaf community in Egypt, and in many other countries of the Arab world. Recognition of the gesture is difficult because of spatial variation and temporal variation among gestures performed by different signers.

Many researches have been conducted to provide appropriate methods and tools to enable deaf people to interact easily and efficiently with regular people. Various sign language recognition systems have been developed by manufacturers around the world to serve these people but they are neither flexible nor cost-effective for the end users who have difficulties communicating in verbal form. Our goal is to help these less fortunate people to mingle in the society. Thus, there is a need for a system that helps in the communication between the deaf and regular hearing people. To realize this system, an efficient gesture recognition method is needed, which recognizes the sign language video stream for particular gesture. Since

sign language is a native language, our research is targeting Arabic sign language (ArSL).

The remainder of this paper is organized as follows; a short survey of related work is presented in Section 2. Our proposed system architecture is explained in Section 3. Followed by Section 4 where we discuss the experimental results. We conclude in Section 5.

## II. RELATED WORK

Hand gesture recognition was firstly proposed by Krueger [1] as a new form of human computer interaction in the middle of the seventies, and there has been a growing interest in it recently. Hand gestures can be classified into two categories: static and dynamic. A static gesture is a particular hand shape and pose, represented by a single image. A dynamic gesture is a moving gesture, represented by a sequence of images. Our approach focuses on the recognition of dynamic gestures.

Many researchers have proposed different methods to recognize hand gestures. Two main approaches were introduced to support these researches; glove-based methods [2], [3] and vision-based methods [4], [5]. The glove based system [6], [2] relies on electromechanical devices. Here the person must wear some sort of wired gloves that are interfaced with many sensors. Vision-based recognition systems do not use special device such as glove, special sensor, or any additional hardware except simple webcam, image processing, and artificial intelligence to recognize and interpret hand gestures [7], [8]. In addition, the user's motions are not limited comparing with the use of glove. On the other hand, vision based systems have problems such as illumination changes, data clutter and hand occlusion due to hand motion. Several researches in vision-based approaches were introduced to overcome these problems.

The system developed by Hamada et al. [9] introduces a hand shape estimation approach to overcome occlusion by using multi-ocular images using two cameras. Tanibata et al. [10] provided a prototype approach based on feature extraction to solve hand occlusion problem for Japanese sign language recognition. The system developed by Wu et al. [11] presented real-time face/hand localization by using

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color-based image segmentation and non-stationary color-based target tracking using appearance based statistical.

The system developed by Tomasi et al. [12] presented 3D tracking for hand finger spelling motions by using a Real-time combination of 2D image classification and 3D motion interpolation using hand model based statistical. The system developed by Ye et al. [13] presented classifying manipulative and controlling gestures by computing 3D hand appearance using a region based coarse stereo matching algorithm.

The system developed by Lin et al. [14] presented tracking the articulated hand motion in a video sequence by searching for an optimal motion estimate in a high dimensional configuration space using hand model based statistics. The system developed by Feris et al. [15] proposed an approach to exploit depth discontinuities for finger spelling recognition to differentiate between similarities of some signs by using multi flash camera. The system developed by Barczak et al. [16] presented a real-time hand tracking by appearance based statistics using the Viola-Jones method. This system is implemented only in a restricted single posture (hand palm). The system developed by Zhou et al. [17] presented articulated object (e.g. body/hand postures) recognition using inverted indexing in an image database using local image features hand model based statistics. The system developed by Salleh et al. [18] provided a good idea to convert sign language to voice recognition based on feature extraction and HMM from grey scale images. Dreuw [19] investigated the use of appearance based features for the recognition of gestures using video input. He used 1st time derivative of original images thresholded by their skin probability and a camshift tracker. A finger spelling recognition method by using distinctive features of hand shape proposed by Tabata et al. [20] The system developed by Qiong et al. [21] presents detailed description of a real-time hand gesture recognition system using embedded DSP board and image processing approaches. The system developed by Foong et al. [22] proposed a sign to voice system prototype which is capable of recognizing hand gestures by transforming digitized images of hand sign language to voice using Neural Network approach. Zabulisy et al. [23] proposed a vision-based hand gesture recognition system for Human-Computer Interaction.

In the system developed by Xin-Yan et al. [5], a method of gesture segmentation from the video image sequence based on monocular vision is presented by skin color and motion cues. The system developed by Paulraj et al. [24] presented a simple sign language recognition system that has been developed using skin color segmentation and Artificial Neural Network. The system developed by Hsieh et al. [25] presented a simple and fast motion history image based method. In

the system developed by Jiatong et al. [26] the dominant movement direction of matched SURF points in adjacent frames is used to help describing a hand trajectory without detecting and segmenting the hand region. The system developed by Mekala et al. [27] proposed an architecture using the neural networks identification and tracking to translate the sign language to a voice/text format. Zaki and Shaheen [28] presented a novel combination of vision based features in order to enhance the recognition of underlying signs. They used three features; kurtosis position, principal component analysis PCA, and motion chain code. Several systems have been proposed specifically for the Arabic sign language. The system developed by Mohandes [29] introduced a prototype system based on support vector machine (SVM) and an automatic Translation system to translate Arabic Text to Arabic Sign Language. An Arabic sign language translation system on mobile devices was introduced by Halawani [30]. The system developed by Farouk et al. [31] represent a multistage hierarchical algorithm for hand shape recognition using principal component analysis (PCA) as a dimensionality reduction and a feature extraction method. Al-Roussan et al. [32] presented an automatic Arabic sign language recognition system based on hidden Markov models. He used the discrete cosine transform to extract features from the input gestures by representing the image as a sum of sinusoids of varying magnitudes and frequencies. He used 30 isolated words from the Standard Arabic sign language database where gloves worn by the participants were marked with six different colors at six different hand regions.

The system developed by Nashwa et al. [33] presented an automatic translation system of gestures of the manual alphabets in the Arabic sign language. Hemayed and Hassanien [34] Dynamic Hand Gesture Recognition of Arabic Sign Language Using Hand Motion Trajectory Features introduced a new Arabic finger spelling technique that uses the edges of a segmented hand gesture as a feature vector and probabilistic neural networks to measure the similarity between the signs feature vectors.

From the previous survey of related works we find that the vision based approach is widely used for sign language recognition because of it its naturalness and low cost. Pervious works of sign language recognition systems have some constraints; these constraints affect the reliability and flexibility of these systems. There is a still a room for improving the accuracy of recognition systems. Moreover, most pervious works for Arabic sign language (ArSL) recognition systems deal with static hand posture.

The proposed system tries to eliminate some of previous systems' limitations to make the recognition process more practical and reliable in various conditions and applications. We are addressing mainly dynamic hand gesture of Arabic sign language.

### III. SYSTEM ARCHITECTURE

Our Arabic sign language recognition system, as shown in Fig. 1, consists of three main modules; hand extraction, features extraction, and gesture recognition module. The hand extraction module extracts the hand area from the input video stream. The feature extraction module calculates 14 features for the hand motion trajectory. The features of the reference gestures are stored in the system database in the learning phase. Then the object recognition module uses correlation coefficient to match the features of the input gesture to the stored ones. More details about each module are discussed in the next sections.

#### a) The Hand Extraction Module

In this module, the hand area is extracted from the full color image. First the system captures video stream of gesture. From this captured frames we detect the face using Haar classifier [35]. The detected face location is replaced by a black ellipse to eliminate the confusion between the hand and the face. The system executes accurately even if there are multiple faces in the image. The process of face detection and removal is as shown in Fig. 1(a).

color from the YCbCr image. In order to detect the hand from the YCbCr color image, we use the Cb and Cr components to define the skin profile. The thresholds are chosen by defining the lower and upper value of Cb skin color [Cb\_min, Cb\_max], and the lower and upper value of Cr skin color Color [Cr\_min, Cr\_max] [36]. The process of skin color detection to extract hand using YCbCr color space is as shown in Fig. 1(b). Then morphological operations (opening followed by dilation) [2] are used to fill in small disconnected areas. The result of this operation is a binary image that contains connected areas representing the hand blob. Fig. 1(c) shows the binary image, which shows only the hand area as white color in black background.

#### b) Feature Extraction Module

The output of the hand extraction stage is a binary image, which shows only the hand blob. The hand features extraction subsystem takes this binary image and find the contour shape of the hand blob as shown in Fig. 1(d). From that contour, we calculate 14 features. These features are the center of gravity for that contour (Fig. 1(e)) and then tracking the movement of hand in each frame to calculate the velocity of the hand movement and angle. In addition, the area, perimeter, orientation and 7-Hu moments features for contour shape are calculated. The details of the features calculations are as follows:

##### i. Center of Gravity, Velocity and Angle Calculations

The zeroth and first order moments [37] contain information about the center of gravity (Xc , Yc) of the object, where:

$$x_c = \frac{M_{1,0}}{M_{0,0}} \tag{1}$$

$$y_c = \frac{M_{0,1}}{M_{0,0}} \tag{2}$$

From one frame to the next, the center is moving, say from (X1, Y1) to (X2, Y2). Then the velocity and the angle of the hand motion can be calculated as follows:

$$V_x = X_1 - X_2 \tag{3}$$

$$V_y = Y_1 - Y_2 \tag{4}$$

$$V = \sqrt{V_x^2 + V_y^2} \tag{5}$$

$$\theta = \tan^{-1} \left( \frac{Y_1 - Y_2}{X_1 - X_2} \right) \tag{6}$$

Where  $\Theta$  is the angle and  $V_x, V_y$  are the corresponding velocity in x-axis and y-axis.

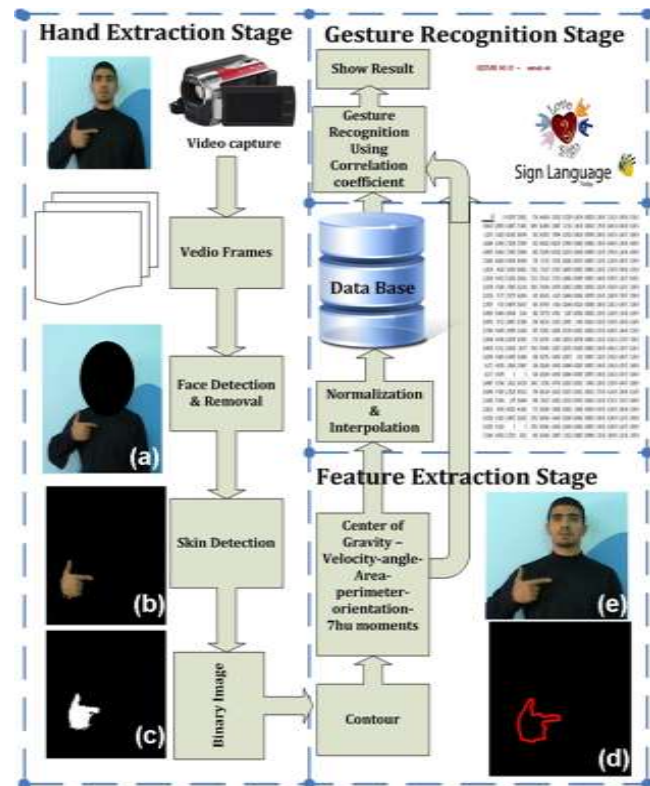


Figure 1 : Gesture recognition system architecture (a) Face detection and removal, (b) Hand extraction using YCbCr skin color detection Algorithm, (c) Hand extraction with binary image, (d) The contour of the hand blob & (e) The center of gravity

Second, the image is converted into YCbCr color space. A skin profile [5] is used to detect the skin

ii. *Area (A)*

The area of a contour is the number of pixels inside this contour. The zeroth order moment describes the area A of the contour of object.

$$A = M_{0,0} \tag{7}$$

iii. *Perimeter (T)*

The perimeter of a contour is the length of curve or boundary of this contour. The contour perimeter of the object is calculated as the sum of lengths of segments between subsequent points of boundary.

$$T = \sum_{i=1}^{N-1} d_i = \sum_{i=1}^{N-1} |x_i - x_{i+1}| \tag{8}$$

Where  $X_1, \dots, X_N$  is the boundary coordinate list.

iv. *Orientation*

The second order moments known as the moments of inertia, can be used to determine an important image feature, orientation. In terms of moments, the orientations of the principal axes,  $\Theta$ , are given by Horn [38]:

$$\theta = \frac{1}{2} \tan^{-1} \left( \frac{2M_{1,1}}{M_{2,0} - M_{0,2}} \right) \tag{9}$$

v. *Seven Hu Moments*

Hu [37] defines the seven functions, computed from central moments through order three, that are invariant with respect to object scale, translation and rotation. Therefore, these seven Dynamic Hand Gesture Recognition of Arabic Sign Language Using Hand Motion Trajectory Features functions are good features to describe the objects.

The same Gestures may vary between performers and even for the same performer between different instances. Neither all the gestures have the same numbers of frames nor have the same start point. To provide better matching criteria for pattern matching, all the data should be normalized and interpolated. These two processes convert the original data sets into a new form, which provides better matching criteria.

c) *The Gesture Recognition Module*

There are several pattern recognition techniques used for gesture recognition. In this paper we use correlation coefficient [26] technique. Correlation coefficient is a simple statistical method with short processing time and it needs only one reference sample to learn each gesture.

If we have a series of n measurements of A and B written as  $A_i$  and  $B_i$  where  $i = 1, 2, \dots, n$ , then the

sample correlation coefficient can be used to estimate the population correlation r between A and B as follows:

$$r = \frac{\sum_{i=1}^n (A_i - \bar{A})(B_i - \bar{B})}{\sqrt{\sum_{i=1}^n (A_i - \bar{A})^2 \cdot \sum_{i=1}^n (B_i - \bar{B})^2}} \tag{10}$$

Where  $\bar{A}$  and  $\bar{B}$  are the sample means of A and B.

In our system, A refers to the data set of the input gestures, B refers to the data set of the reference gestures stored in our database, and n is the number of frames in each gesture. We calculate the correlation coefficients between the input gesture and the reference gestures. The correlation coefficient is calculated for each feature separately.

Then we count, for each gesture, number of correlation coefficient that is greater than a predefined threshold. In our experiments, the used threshold was 0.65. Finally the gesture with the highest count is selected as the matched gesture and its corresponding text is shown to the user.

IV. RESULTS AND DISCUSSION

Due to the unavailability of a dataset for dynamic gestures from Arabic sign language, we had to build our own gestures database. We collected 20 different signs (Table 1) from eight different signers (seven males and one female) at different situations with resolution  $720 \times 480$ , as shown in Fig. 2.

Table 1 : List of Selected Gestures

Gesture No.	Gesture name in Arabic	Gesture meaning in English
G1	ما اسمك؟	WHAT IS YOUR NAME?
G2	غني	RICH
G3	شجاع	BRAVE
G4	بطاطس	POTATO
G5	بيض	EGGS
G6	نحيف	EMACIATED
G7	لبن	MILK
G8	ليل	NIGHT
G9	إعصار	hurricane - Tornado
G10	رسول	PROPHET
G11	مدينة 6 أكتوبر	6 october CITY
G12	ضابط	OFFICER
G13	مهم	IMPORTANT
G14	مدير	MANAGER
G15	نادي	CLUB
G16	غائب	ABSENT
G17	ينزل	DESCEND- GET DOWEN
G18	يهد	WANT - DESIRE
G19	يعطي	GIVE
G20	بسرعة	RAPIDLY - QUICKLY



Figure 2 : Eight different singers for our Arabic sign language dataset

We collected 63 feature vectors for each gesture. Thus in total our database has 1260 feature vectors. Only 20 gestures were used for training, one from each gesture. The proposed system is implemented on a PC with 2.0GHz CPU and 2G memory running Windows 7. The system is coded by C#, and the OpenCV SDK is used. The overall processing speed was 10-30 frames/Sec. Thus it can be used in a real time interaction.

In our experiment, we measure the discrimination effectiveness of the proposed system by testing the recognition of each sign. Our results indicate that the recognition rate was between 80% and 100% with an average of 85.67%. Fig. 3 shows the similarity matrix between the input and reference gestures. From the shown graph, it is clear that all of the signs have high similarity with its counterpart along the diagonal axis with some minor similarity off the diagonal axis.

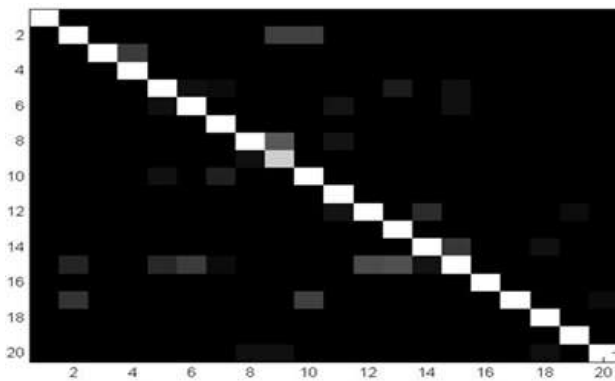


Figure 3 : The similarity matrix for our proposed system

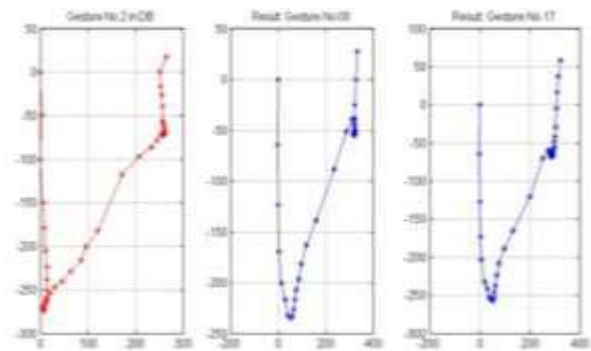


Figure 4 : The motion trajectory of gesture 2, 8 and 17. The graph shows the position of the hand's center of gravity at consecutive frames

We also analyzed the misclassification cases to measure the consistency of the proposed system. Fig. 4 shows the motion trajectory of three gestures; No 2, 8 and 17, that our system confuses them. These three gestures are very similar and their motion trajectories are very similar too. Several gestures in the Arabic sign language look similar and could be difficult to a computer vision system to differentiate between them.

In another experiment, we apply our system to the RWTH dataset developed and tested by Dreuw [19]. RWTH dataset is a German finger spelling alphabet database and it contains 35 gestures with video sequences for the signs A to Z and SCH, the German umlauts Ä, Ö, Ü and the numbers from 1 to 5. Dreuw [19] achieved an error rate of 87.1% and was able to improve it to 44%.

Using our proposed system, we were able to achieve a better error rate of 27.6%. It was not possible to compare our work with several available systems, because they differ in many aspects such as the type of data acquisition; direct measurement or vision-based. Even in the vision based approach some systems require the signer to wear colored gloves. Another problem arises from the lack of a common database for the evaluation of sign language recognition systems. Almost all databases used by the different research groups are not publicly available. Additionally, the available databases differ in language, vocabulary size, grammar restriction and selection of signs.

## V. CONCLUSION

We proposed a new gesture recognition system that can recognize the dynamic Arabic Sign Language gestures independent of skin color and physical structure of signers. In addition, the Dynamic Hand Gesture Recognition of Arabic Sign Language Using Hand Motion Trajectory Features system works in different places with normal intensity of light. The proposed features, measured from the motion trajectory of the right hand, were able to encode the gesture and to differentiate between 20 different Arabic gestures

collected from eight different signers, with an average recognition rate of 85.67%. The error rate was mainly due to the high similarity between the gestures.

The proposed system was able to improve the error rate in recognizing the difficult RWTH dataset from 44% to 27.6%. In future work we will search for other clues to be able to increase the recognition accuracy especially in case of highly similar gestures. Also, handling gestures that use both hands or interfere with the face will be addressed in future work.

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



**27. Refresh your mind after intervals:** Try to give rest to your mind by listening to soft music or by sleeping in intervals. This will also improve your memory.

**28. Make colleagues:** Always try to make colleagues. No matter how sharper or intelligent you are, if you make colleagues you can have several ideas, which will be helpful for your research.

**29. Think technically:** Always think technically. If anything happens, then search its reasons, its benefits, and demerits.

**30. Think and then print:** When you will go to print your paper, notice that tables are not be split, headings are not detached from their descriptions, and page sequence is maintained.

**31. Adding unnecessary information:** Do not add unnecessary information, like, I have used MS Excel to draw graph. Do not add irrelevant and inappropriate material. These all will create superfluous. Foreign terminology and phrases are not apropos. One should NEVER take a broad view. Analogy in script is like feathers on a snake. Not at all use a large word when a very small one would be sufficient. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Amplification is a billion times of inferior quality than sarcasm.

**32. Never oversimplify everything:** To add material in your research paper, never go for oversimplification. This will definitely irritate the evaluator. Be more or less specific. Also too, by no means, ever use rhythmic redundancies. Contractions aren't essential and shouldn't be there used. Comparisons are as terrible as clichés. Give up ampersands and abbreviations, and so on. Remove commas, that are, not necessary. Parenthetical words however should be together with this in commas. Understatement is all the time the complete best way to put onward earth-shaking thoughts. Give a detailed literary review.

**33. Report concluded results:** Use concluded results. From raw data, filter the results and then conclude your studies based on measurements and observations taken. Significant figures and appropriate number of decimal places should be used. Parenthetical remarks are prohibitive. Proofread carefully at final stage. In the end give outline to your arguments. Spot out perspectives of further study of this subject. Justify your conclusion by at the bottom of them with sufficient justifications and examples.

**34. After 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 through which your research is going to be in print to 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 in 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 criterion for grading the final paper by peer-reviewers.

### Final Points:

A purpose of organizing a research paper is to let people to interpret your effort selectively. The journal requires the following sections, submitted in the order listed, each section to start on a new page.

The introduction will be compiled from reference matter and will reflect the design processes or outline of basis that direct you to make study. As you will carry out the process of study, the method and process section will be constructed as like that. The result segment will show related statistics in nearly sequential order and will direct the reviewers next to the similar intellectual paths throughout the data that you took to carry out your study. The discussion section will provide understanding of the data and projections as to the implication of the results. The use of good quality references all through the paper will give the effort trustworthiness by representing an alertness of 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 the 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 evade

- Insertion a title at the foot of a page with the subsequent text on the next page
- Separating a table/chart or figure - impound each figure/table to a single page
- Submitting a manuscript with pages out of sequence

In every sections of your document

- Use standard writing style including articles ("a", "the," etc.)
- Keep on paying attention on the research topic of the paper
- Use paragraphs to split each significant point (excluding for the abstract)
- Align the primary line of each section
- Present your points in sound order
- Use present tense to report well accepted
- Use past tense to describe specific results
- Shun familiar wording, don't address the reviewer directly, and don't use slang, slang language, or superlatives
- Shun use of extra pictures - include only those figures essential to presenting results

### **Title Page:**

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



**Abstract:**

The summary should be two hundred words or less. It should briefly and clearly explain the key findings reported in the manuscript-- must have precise statistics. It should not have abnormal acronyms or abbreviations. It should be logical in itself. Shun citing 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 approach 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. Yet, use comprehensive sentences and do not let go readability for briefness. You can maintain it succinct by phrasing sentences so that they provide more than 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 maintain the initial two items to no more than one ruling each.

- Reason of the study - 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 quantitative data; results of any numerical analysis should be reported
- Significant conclusions or questions that track from the research(es)

**Approach:**

- Single section, and succinct
- As a outline of job done, it is always written in past tense
- A conceptual should situate on its own, and not submit to any other part of the paper such as a form or table
- Center on shortening results - bound background information to a verdict or two, if completely necessary
- What you account in an conceptual must be regular with what you reported in the manuscript
- Exact spelling, clearness 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 to comprehend and calculate the purpose of your study without having to submit to other works. The basis for the study should be offered. Give most important references but shun difficult to make a comprehensive appraisal of the topic. In the introduction, describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will have no attention in your result. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here. Following approach can create a valuable beginning:

- Explain the value (significance) of the study
- Shield the model - why did you employ this particular system or method? What is its compensation? You strength remark on its appropriateness from a abstract point of vision as well as point out sensible reasons for using it.
- Present a justification. Status your particular theory (es) or aim(s), and describe the logic that led you to choose them.
- Very for a short time explain the tentative propose and how it skilled 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 with every section. If you make the four points listed above, you will need a least of four paragraphs.





- Present surroundings information only as desirable in order hold up a situation. The reviewer does not desire to read the whole thing you know about a topic.
- Shape the theory/purpose 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 sound written Procedures segment allows a capable scientist to replacement 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 for the least amount of information that would permit another capable scientist to spare 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 object, mention the specific item describing a way but draw the basic principle while stating the situation. The purpose is to text 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:**

- Explain materials individually only if the study is so complex that it saves liberty this way.
- Embrace particular materials, and any tools or provisions that are not frequently found in laboratories.
- Do not take in frequently found.
- If use of a definite type of tools.
- Materials may be reported in a part section or else they may be recognized along with your measures.

#### **Methods:**

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

#### **Approach:**

- It is embarrassed or not possible to use vigorous voice when documenting methods with no using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result when script up the methods most authors use third person passive voice.
- Use standard style in this and in every other part of the paper - avoid familiar lists, and use full sentences.

#### **What to keep away from**

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings - save it for the argument.
- 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 a 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. Carry on to be to the point, by means of statistics and tables, if suitable, to present consequences most efficiently. You must obviously differentiate material that would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matter should not be submitted at all except requested by the instructor.



## Content

- Sum up your conclusion in text and demonstrate them, if suitable, with figures and tables.
- In manuscript, explain each of your consequences, point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation an exacting study.
- Explain results of control experiments and comprise 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 in manuscript form.

### What to stay away from

- Do not discuss or infer your outcome, report surroundings information, or try to explain anything.
- Not at all, take in raw data or intermediate calculations in a research manuscript.
- Do not present the similar data more than once.
- Manuscript should complement any figures or tables, not duplicate the identical information.
- Never confuse figures with tables - there is a difference.

### Approach

- As forever, use past tense when you submit to 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 part.

### Figures and tables

- If you put figures and tables at the end of the details, make certain that they are visibly distinguished from any attach appendix materials, such as raw facts
- Despite of position, each figure must be numbered one after the other and complete with subtitle
- In spite of position, each table must be titled, numbered one after the other and complete with heading
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### Discussion:

The Discussion is expected the trickiest segment to write and describe. A lot of papers submitted for journal are discarded based on problems with the Discussion. There is no head of state for how long a 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 implication of the study. The purpose here is to offer an understanding of your results and hold up for all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of result should be visibly 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 with prospect, and let it drop at that.

- Make a decision if each premise is supported, 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 the experiment might be personalized to accomplish a new idea.
- Give details all of your remarks as much as possible, focus on mechanisms.
- Make a decision if the tentative design sufficiently addressed the theory, and whether or not it was correctly restricted.
- Try to present substitute explanations if sensible alternatives be present.
- One 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 available information
- Submit to work done by specific persons (including you) in past tense.
- Submit to generally acknowledged facts and main beliefs in present tense.



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<i>Introduction</i>	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
<i>Methods and Procedures</i>	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
<i>Result</i>	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
<i>Discussion</i>	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
<i>References</i>	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring



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ISSN 9754350