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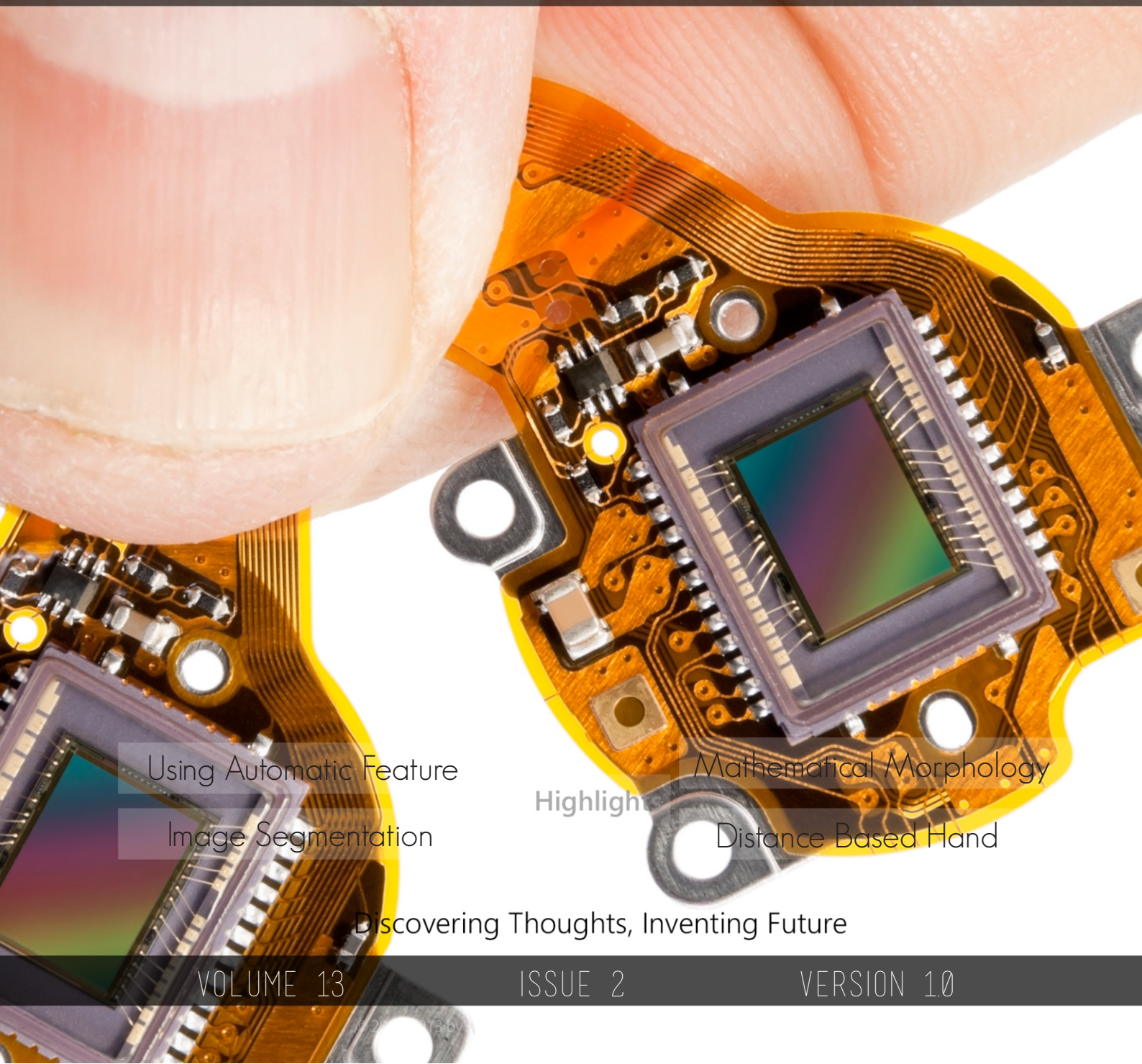

Using Automatic Feature

Image Segmentation

Highlight

Mathematical Morphology

Distance Based Hand

Discovering Thoughts, Inventing Future

VOLUME 13 ISSUE 2 VERSION 1.0

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An Approach to Extract Features from Document Image for Character Recognition

By Mohammad Imrul Jubair & Prianka Banik
Ahsanullah University of Science and Technology, Bangladesh

Abstract - In this paper we present a technique to extract features from a document image which can be used in machine learning algorithms in order to recognize characters from document image. The proposed method takes the scanned image of the handwritten character from paper document as input and processes that input through several stages to extract effective features. The object in the converted binary image is segmented from the background and resized in a global resolution. Morphological thinning operation is applied on the resized object and then the technique scanned the object in order to search for features there. In this approach the feature values are estimated by calculating the frequency of existence of some predefined shapes in a character object. All of these frequencies are considered as estimated feature values which are then stored in a vector. Every element in that vector is considered as a single feature value or an attribute for the corresponding image. Now these feature vectors for individual character objects can be used to train a suitable machine learning algorithms in order to classify a test object. The k-nearest neighbor classifier is used for simulation in this paper to classify the handwritten character into the recognized classes of characters. The proposed technique takes less time to compute, has less complexity and increases the performance of classifiers in matching the handwritten characters with the machine readable form.

Keywords : *character recognition, morphological thinning operation, feature vectors, classifiers.*

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Mohammad Imrul Jubair [α] & Prianka Banik [σ]

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Keywords : character recognition, morphological thinning operation, feature vectors, classifiers.

I. Introduction

Optical character recognition (OCR) has become an important field of research in the current growing period of technology. Automatic recognition of printed and handwritten information present on documents like cheques, envelopes, forms, and other manuscripts has a variety of practical and commercial applications in banks, post offices, libraries, and publishing houses. Basically OCR is a mechanism to convert machine printed or handwritten document file into editable text format [1]. The process of handwriting recognition involves extraction of some defined characteristics called features to classify an unknown handwritten character into one of the known classes. A typical handwriting recognition system consists of some steps, as like- preprocessing, segmentation, feature extraction, and classification [2]. Many methods have been proposed for recognizing the handwritten characters such as, HDCRGF [1], IHDCRFDHMM [2], HCRNN [3], EFHSNNHCR [4], and PABPNN [5] which can recognize the character in image by classifying them, but they take so much time and the methods are too complex and difficult to implement as well.

Recently SMHCR[6] has been proposed where a simplified technique is developed to recognize character from digital image. In that approach, the character object is segmented from the background and morphological thinning operation [7][8] is applied. After that the segmented image containing character object is partitioned into several cells. Feature value is estimated from each cell by calculating the proportion of the number of 0 and 255 intensity pixels. The estimated values for each cells are then stored in a vector and the vector is considered as a feature vector for that image.

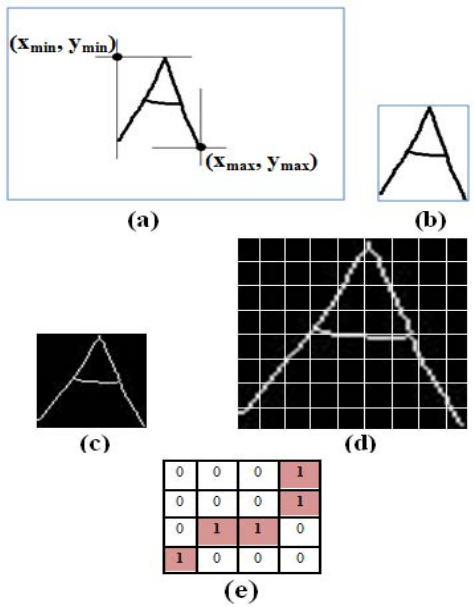

Figure 1 : (a) shows the extraction of character object from image and (b) is the extracted image, (c) is the result of morphological thinning operation on resized image, (d) shows the concept of partitioning the thinned image in same sized cells and (e) shows an example of calculating estimated value for a cell C where nw= 5 and nb= 11, so Pi = 5/11 = 0.454

K-nearest neighbor (KNN) [9] classifier is used here and the feature vectors are used to train the classifier. After training, the classifier is able to classify a

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new test object into a recognized character. Fig. 1 shows the steps of SMHCR[6].

In SMHCR [6], the features are calculated from the proportion of 0 and 255 intensity pixels in a certain cell which is not efficient in all cases. Here the feature values are dependent on counting of pixels, rather than the shape of the object; though the shape is an important factor for recognizing a character. In this paper, a modified technique is proposed where shape of a character object is taken into account in order to estimate a feature value. The techniques searches for different shapes of joint in a character object and calculate the frequencies of their occurrence. The joint-shapes are pre-defined and their frequencies are considered as estimated feature values to be used in a suitable classifier.

II. Proposed Technique

Let **X** is the input character image with size m × n. Generally, documents are prepared by writing or typing on white paper. So, in this paper, we consider the background to be white and the foreground character objects to be black. **X** is converted into a binary image. So the background pixels will be the intensity of 1 and the foreground object pixels will be the intensity of 0. As mentioned earlier, the proposed technique seeks for predefined joint-shape occurrences.

Different kinds of joint-shapes are seen in character objects as indicated in Fig. 2 as an example.

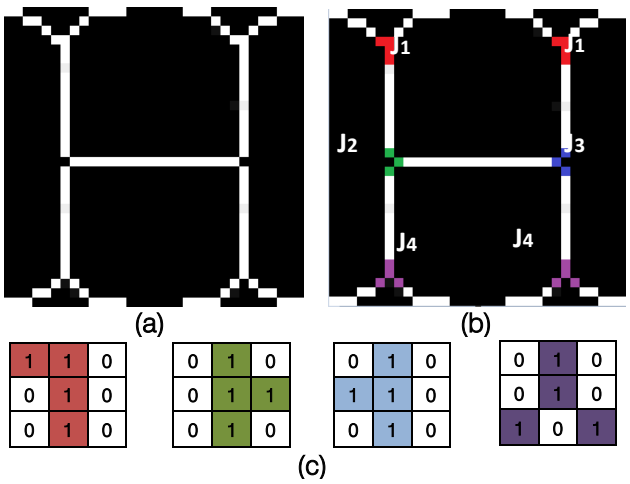


Figure 2 : (a) Shows a resized & thinned object (b) Indicates different joint-shapes J_i detected on the object which are numbered as J_1, J_2, J_3, J_4. and (c) Shows the template of joint-shapes J_1, J_2, J_3, J_4 (from left to right)

The concept of joint-shape detection can be illustrated with the example given in Fig.2. A character object is thinned and our technique searches for the four different predefined joint-shapes which are J_1, J_2, J_3, J_4. As we can see J_1 occurred for 2 times, J_2 occurred for 1 times, J_3 occurred for 1 times and J_4 occurred for 2 times. In this example, we will consider these frequencies to estimate feature values where-

$$\text{Frequency } (J_1) = F1 = 2$$
$$\text{Frequency } (J_2) = F2 = 1$$
$$\text{Frequency } (J_3) = F3 = 1$$
$$\text{Frequency } (J_4) = F4 = 2$$

Now let's consider a vector $F_X = [F1, F2, F3, F4]$
$= [2, 1, 1, 2]$

So, this F_X will be the feature vector for the image **X**. In practical case number of joint-shape template is more (J_1, J_2, J_3, J_4 ……. J_n) and in consequence feature vector contains more element such as **F = [**F1, F2, F3, F4,….,Fn**]** when number of joint-shape template, i = n. We can produce a histogram from the frequencies contained in a vector. Fig. 3 shows an example of histogram obtained by processing an image containing the character "A" where i = 24.

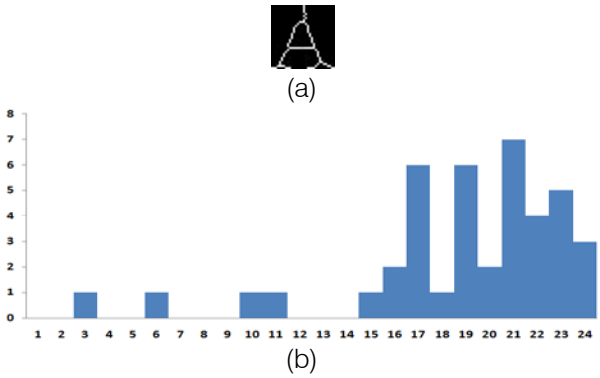


Figure 3 : (b) Shows the histogram of the feature vector obtained from (a) Image

In order to train a classifier, more images are processed to obtain feature vector and these vectors are passed into classifier to define individual classes. For an example, if we train classifier for the class "A" with 11 feature vectors from 11 objects, we get the following graph.

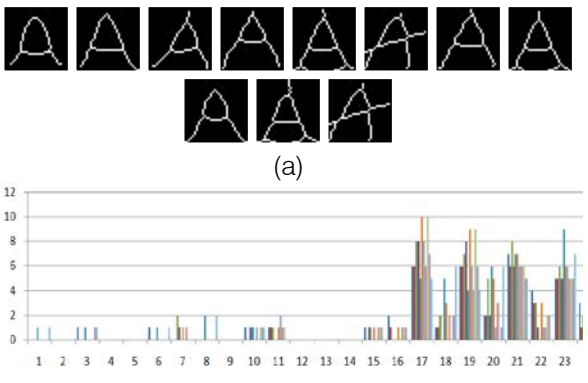


Figure 4 : (b) Shows Feature-vector histograms obtained from several training objects in (a)

III. Simulation

The proposed technique has been simulated using Matlab programming language. In our simulation, we have used 24 templates of joint-shapes. Fig. 5 shows the several templates.

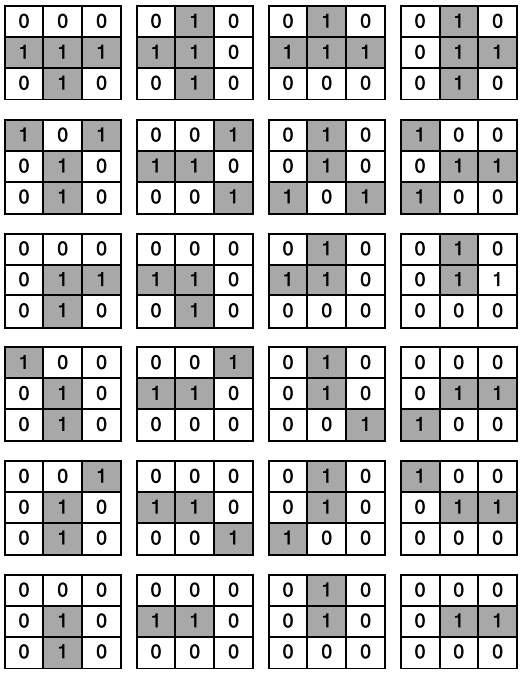


Figure 5 : Several joint-shape templates

The joint-shapes are used as window and they slide through the image to find out any match. In every matching the frequency values are incremented by 1.

Several character images are used to extract feature vectors and k-nn classifiers is used and is trained to determine the class of a testing object. Fig.6 shows some of the training images and feature vector histograms for several training classes are shown in Fig.7.

Figure 6 : Example of some training image objects

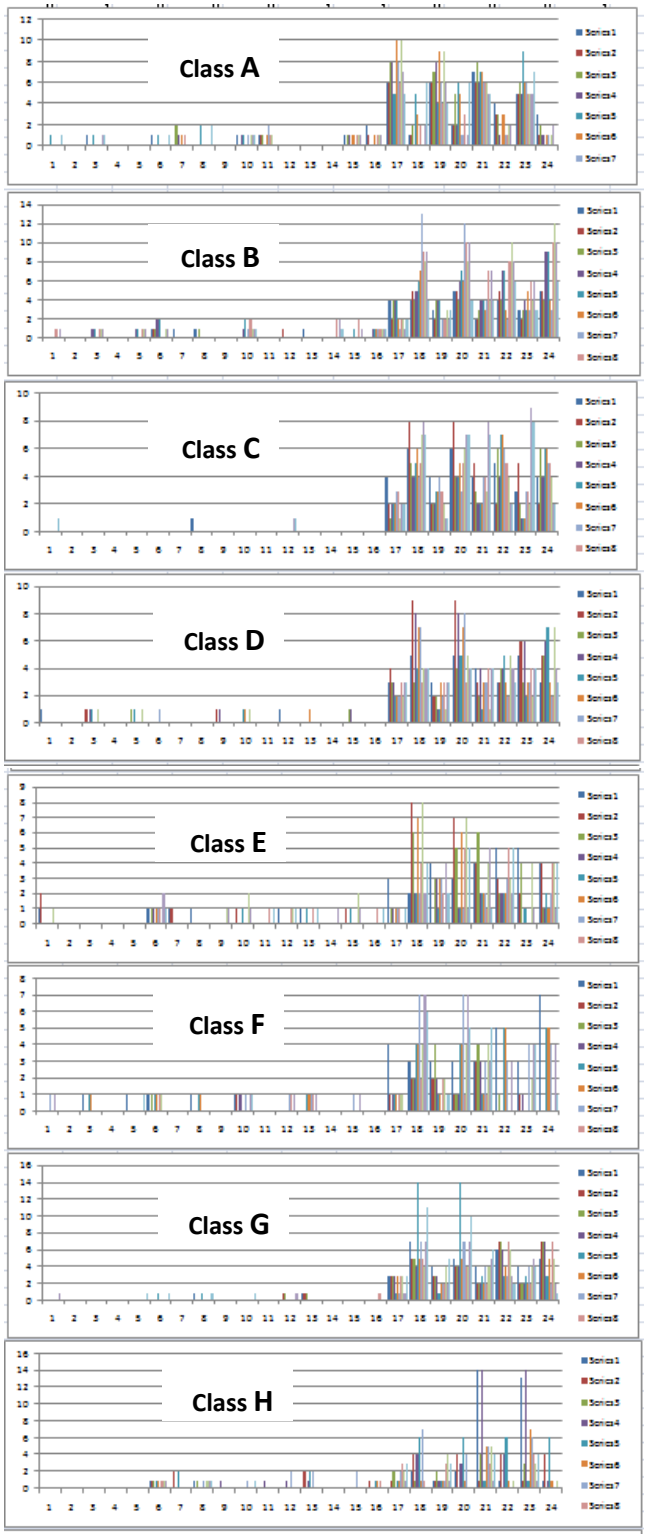


Figure 7 : Histograms of features vectors for several character classes (for simplicity only A to H are shown)

Total 650 number of sample images with different handwritten characters collected from different people has been tested using the proposed method and the result shows that the proposed method performs successfully to recognize handwritten

characters from document images and its average accuracy rate is 97.21%. The rate of success in recognizing sample images for different individual characters are shown in Fig 6 and a comparison between the proposed technique and SMHCR [6] is also presented.

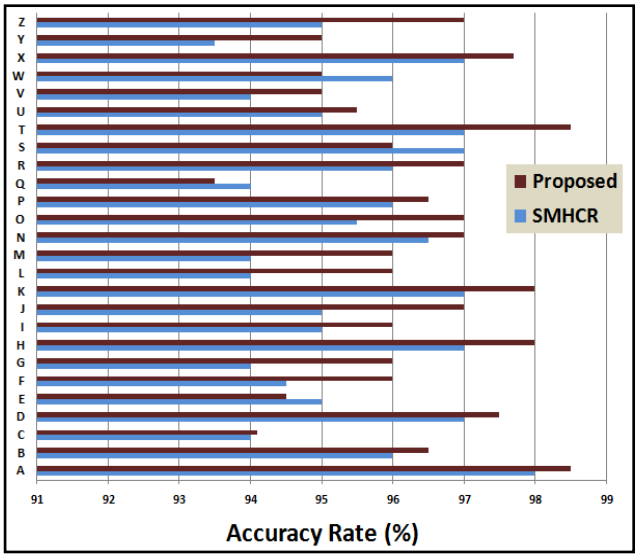
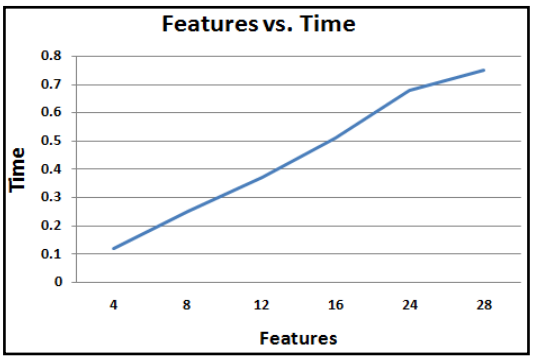
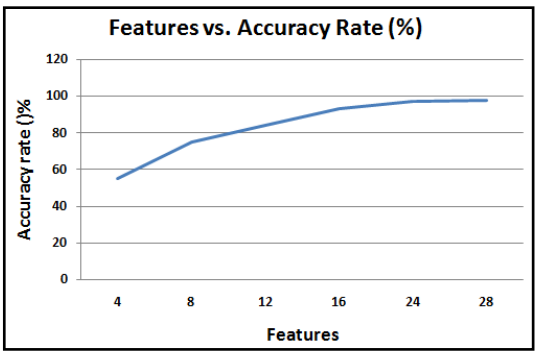


Figure 8 : Shows the accuracy rate of k-nn classifier in recognizing character using the proposed feature extraction method



(a)



(b)

Figure 9 : (a) Shows the number of feature element vs. running time graph and (b) Shows the number of feature element vs. accuracy rate graph

Fig. 9 shows some scenario related to feature vector's size. We can see that if we increase the number of elements in feature vector (i), the classifier needs more time to be trained (a) and as well as we will get more accuracy rate also (b).

IV. Future Plan

The proposed technique can be improved to make it more efficient. Predefined joint-shape templates can be selected carefully so that unused templates can be removed which will reduce time complexity. More powerful machine learning algorithms can be used in here in order to improve the recognition rate. Integration of this feature extraction method into the neural network is also a future plan of this work.

V. Conclusion

In this paper a method in presented to extract features from a document image. The features are extracted by seeking the occurrence of some joint-shapes in thinned object. The frequencies of occurrence are stored as feature elements in a vector. The feature vectors can be used through the classifiers in order to recognize a character object. The proposed feature extraction technique is less complex, easy to implement and integrate while recognizing the characters from document scanned image accurately.

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Two State of Art Image Segmentation Approaches for Outdoor Scenes

By Anju. J. A & Mr. Jenopaul. P
PSN College of Engineering and Technology, Tirunelveli

Abstract - The main research objective of this paper is to detecting object boundaries in outdoor scenes of images solely based on some general properties of the real world objects. Here, segmentation and recognition should not be separated and treated as an interleaving procedure. In this project, an adaptive global clustering technique is developed that can capture the non-accidental structural relationships among the constituent parts of the structured objects which usually consist of multiple constituent parts. The background objects such as sky, tree, ground etc. are also recognized based on the color and texture information. This process groups them together accordingly without depending on a priori knowledge of the specific objects. The proposed method outperformed two state-of-the-art image segmentation approaches on two challenging outdoor databases and on various outdoor natural scene environments, this improves the segmentation quality. By using this clustering technique is to overcome strong reflection and over segmentation. This proposed work shows better performance and improve background identification capability.

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Anju. J. A [α] & Mr. Jenopaul. P [σ]

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I. Introduction

Image segmentation is the process of partitioning a digital image into multiple segments. One of the fundamental problem in computer vision is considered as image segmentation. The primary goal of image segmentation is to simplify or change the representation of an image into something that is more meaningful and easier to analyse[1]. In general, the outdoor scenes can be categorized into two namely, unstructured objects (e.g., sky, roads, trees, grass, etc.) and structured objects (e.g., cars, buildings, people, etc.). The unstructured objects mainly consists of backgrounds of images and structured objects consists of foreground of images. The background objects usually have nearly homogenous surfaces and are distinct from the structured objects in images. So many appearance based methods are used to achieve high accuracy in recognizing these background object classes[2],[3],[4]. The challenge for outdoor segmentation comes from the structured objects that are often composed of multiple parts, with each part having distinct surface characteristics. Without certain knowledge about an object, it is difficult to group these parts together[5],[6]. The research objective of this paper is to explore detecting object boundaries in outdoor scene images only based on some general properties of the real-world objects, such as perceptual organization laws, without depending on a priori knowledge of the specific objects.

Perceptual organization plays an important role in human visual perception. Perceptual organization, refers to the basic capability of the human visual system to derive relevant groupings and structures from an image without prior knowledge of its contents. The Gestalt psychologists summarized some underlying principles (e.g., proximity, similarity, continuity, symmetry, etc) that lead to human perceptual grouping. The classic Gestalt laws pointed out that convexity also plays an important role on perceptual organization because many real-world objects such as buildings, vehicles, and furniture tend to have convex shapes. These can be summarized by a single principle, i.e., the principle of nonacidentalness, which means that these structures are most likely produced by an object or process, and are unlikely to arise at random [7].

For applying Gestalt laws to real world applications there are several challenges. One of challenge is to find quantitative and objective measures of these grouping laws. The Gestalt laws are in descriptive forms. Therefore, one needs to quantify them for scientific use. Another challenge consists of finding a way to combine the various grouping factors since object parts can be attached in many different ways. Under different situations, different laws may be applied. Therefore, a perceptual organization system requires combining as many Gestalt laws as possible. The greater the number of Gestalt laws incorporated, the better chance the perceptual organization systems may apply appropriate Gestalt laws in practices. Ren [8] developed a probabilistic model of continuity and closure built on a scale-invariant geometric structure to estimate object boundaries. Jacobs emphasized that convexity plays an important role in perceptual organization and, in many cases, overrules other laws such as closure.

The main contribution of this paper is a developed perceptual organization model (POM) for boundary detection. The POM quantitatively incorporates a list of Gestalt laws and therefore is able to capture the nonaccidental structural relationships among the constituent parts of a structured object. With this model, we are able to detect the boundaries of various salient structured objects under different outdoor

Author α σ : Department of Electronics and Communication Engineering, PSN College of Engineering and Technology, Tirunelveli, Tamil Nadu, India. E-mails : anju1589@gmail.com, jenopaul1@rediffmail.com

environments.The proposed method outperformed two state-of-the-art studies [9],[10] on two challenging image databases consisting of a wide variety of outdoor scenes and object classes.

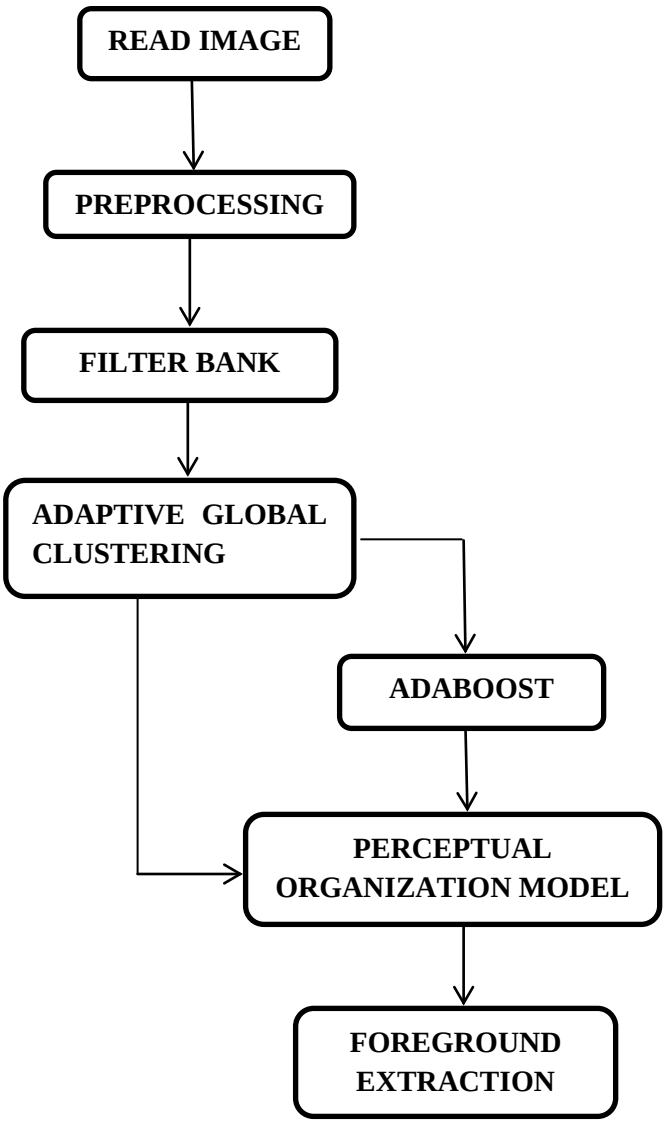


Figure 1 : Block diagram of proposed work

II. Methodology

The proposed system consists of three main steps for recognizing the common background and foreground objects.

a) Background Identification in Outdoor Natural Scenes

The objects seeming in natural scenes can be roughly divided into two categories namely, unstructured and structured objects. Unstructured objects typically have nearly similar surfaces, whereas structured objects typically consist of several essential parts, with each part having distinct appearances in their color, texture, etc. The common backgrounds in outdoor natural scenes are those unstructured objects such as skies, roads, trees, and grasses and these objects have low visual variability in most cases and are distinct from other structured objects in an image. For instance, a sky commonly has a identical form with blue or white colours; a tree or a grass usually has a textured presence with green colours. Hence, these background objects can be precisely predictable only based on appearance data. Assume if we use a bottom-up segmentation method to segment an outdoor image into uniform regions. Then, some of the regions must belong to the background objects. To recognize these background regions, we use a technique similar [2].

The key for this method is to use textons to represent object appearance information. The term texton is first presented for describing human textural perception. The whole textonization process proceeds as follows: First, the training images are converted to the perceptually uniform CIE color space. Then, the training images are convolved with a 17-D filter bank. We use the same filter bank as that in, which consists of Gaussians at scales 1, 2, and 4; the and derivatives of Gaussians at scales 2 and 4; and Laplacians of Gaussians at scales 1, 2, 4, and 8. The Gaussians are applied to all three color channels, whereas the other filters are applied only to the luminance channel. By doing so, we obtain a 17-D response for each training pixel. The 17-D response is then augmented with the CIE channels to form a 20-D vector. After augmenting the three color channels, we can achieve slightly higher classification accuracy [3]. Then, the Euclidean-distance –means clustering algorithm is performed on the 20-D vectors collected from the training images to generate cluster centers. These cluster centers are called textons. Finally, each pixel in each image is assigned to the nearest cluster center, producing the texton map. After this textonization process, each image region of the training images is represented by a histogram of textons. We then use these training data to train a set of binary Adaboost classifiers to classify the unstructured objects (e.g., skies, roads, trees, grasses, etc.). to achieve high accuracy on classifying these background objects in outdoor images.

b) Perceptual Organization Model (POM)

Most images consist of background and foreground objects and these foreground objects are structured objects that are often composed of multiple parts, with each part having distinct surface characteristics. Assume that we can use a bottom-up method to segment an image into uniform patches, then most structured objects should be oversegmented to multiple parts. After the background patches are identified in the image, the majority of the remaining image patches correspond to the constituent parts of

structured objects. The challenge here is how to piece the set of constituted parts of a structured object together to form a region that corresponds to the structured object without any object-specific knowledge of the object. To tackle this problem, we develop a POM. Accordingly, our image segmentation algorithm can be divided into the following three steps.

- Given an image, use a bottom-up method to segment it into uniform patches.
- Use background classifiers to identify background patches.
- Use POM to group the remaining patches (parts) to larger regions that correspond to structured objects or semantically meaningful parts of structured objects.

We now go through the details of our POM. Even after background identification, there is still a large number of parts remaining. Different combinations of the parts form different regions. We want to use the Gestalt laws to guide us to find and group these kinds of regions. Our strategy is that, since there always exist some special structural relationships that obey the principle of nonaccidentalness among the constituent parts of a structured object, we may be able to piece the set of parts together by capturing these special structural relationships. The whole process works as follows: We first pick one part and then keep growing the region by trying to group its neighbors with the region. The process stops when none of the region's neighbors can be grouped with the region. To achieve this, we develop a measurement to measure how accurately a region is grouped. The region goodness directly depends on how well the structural relationships of parts contained in the region obey Gestalt laws. In other words, the region goodness is defined from perceptual organization perspective. With the region measurement, we can go find the best region that contains the initial part. In most cases, the best region corresponds to a single structured object or the semantically meaningful part of the structured object.

c) Image Segmentation Algorithm

The POM can capture the special structural relationships that obey the principle of nonaccidentalness among the constituent parts of a structured object. To apply the proposed POM to real-world natural scene images, we need to first segment an image into regions so that each region approximately corresponds to an object part. In this implementation, Felzenszwalb and Huttenlocher's approach [11] are used to generate initial superpixels for an outdoor scene image. We select this method because it is very efficient and the result of the method is comparable to the mean-shift algorithm [12]. To further improve the segmentation quality, we apply a segment-merge method on the initial superpixels to merge the small size regions with their neighbors. These small size regions are often caused by the texture of surfaces or by the inhomogeneous portions of some part surfaces. Since these small size image regions contribute little to the structure information of object parts, we merge them together with their larger neighbors to improve the performance of our POM. In addition, if two adjacent regions have similar colors, we also merge them together. By doing so, we obtain a set of improved superpixels. Most of these improved superpixels approximately correspond to object parts. We now turn to the image segmentation algorithm.

Given an outdoor scene image, we first apply the segment-merge technique described above to generate a set of improved superpixels. Most of the superpixels approximately correspond to object parts in that scene. We build a graph to represent these superpixels: Let be an undirected graph. Each vertex corresponds to a superpixel, and each edge corresponds to a pair of neighboring vertices. We then use our background classifiers are divide into two parts: backgrounds such as sky, roads, grasses, and trees and structured parts. We then apply our perceptual organization algorithm at the beginning, all the components in are marked as unprocessed. Then, for each unprocessed component to detect the best region that contains vertex . Region may correspond to a single structured object or the semantically meaningful part of a structured object. We mark all the components comprising as processed. The algorithm gradually moves from the ground plane up to the sky until all the components in are processed. Then, we finish one round of perceptual organization procedure and use the grouped regions in this round as inputs for the next round of perceptual organization on. At the beginning of a new round of perceptual organization, we merge the adjacent components if they have similar colors and build a new graph for the new components. This perceptual organization procedure is repeated for multiple rounds until no components in can be grouped with other components. In practice, we find that the result of two rounds of grouping is good enough in most cases. At last, in a post process procedure, we merge all the adjacent sky and ground objects together to generate final segmentation.

III. Experimental Results

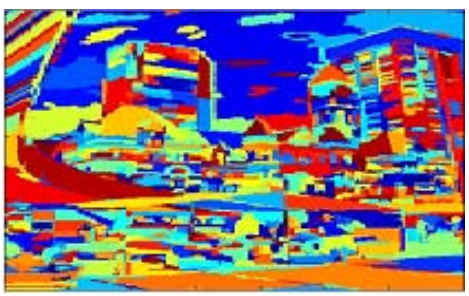
a) Gould Database

First we test image segmentation algorithm using Gould image data set (GDS). This data set contains 715 images of urban and rural scenes assembled from a collection of public image data sets: LabelMe, MSRC-21, PASCAL and geometric context. The images on this data set are downsampled to approximately 320 pixels × 240 pixels. The images contain a wide variety of man-made and biological

objects such as buildings, signs, cars, people, cows, and sheep. This data set provides ground truth object class segmentations that associate each region with one of eight semantic classes (sky, tree, road, grass, water, building, mountain, or foreground). In addition, the object class labels, the ground truth object segmentations that associate each segment with one physical object, are also provided. Following the same setup we randomly split the data set into 572 training images and 143 testing images. Gould09 data set also used superpixels as a starting point. We used the normalized cut algorithm to generate 400 superpixels for use in the Gould09 method. The Gould09 method is a slight variant of the baseline method and achieved comparable result against the relative location prior method in Shotton's method and Yang's method on the MSRC-21 data set. Gould09 is trained on the training set and tested on the testing set. We first use the training images to train five background classifiers for background identification. Then, we test our POM method on both the testing set and the full GDS data set. We choose the method proposed by Martin as the measurement for segmentation accuracy.

The segmentation accuracy score is defined as where and represent the set of pixels in the ground truth segment of an object and the machine-generated object segment, respectively. Because all the images in this data set are downsized to 320 pixels 240 pixels, we set the parameters of Felzenszwalb's algorithm to small values to generate the initial superpixels from the input images. We found that Felzenszwalb's algorithm with this set of parameters works well for small size images . We set parameters for our POM and we used the 572 training images to learn five binary Adaboost classifiers to identify five background object classes (i.e., sky, road, grass, trees, and water). This compares the performance of our method.

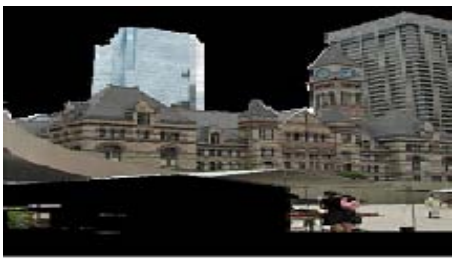
(a)



(b)

(c)

(d)



(e)

Figure 2 : Illustration of segmentation of an outdoor scene (a)input image, (b)segmentation of an input image: for background objects identification. Sky is labeled as blue, ground is labeled as yellow, and vegetations (tree or grass) are labeled as green, (c) label the input images, (d) and (e) shows the extraction of background and foreground objects of an image.

With that of the baseline method (Gould09) on the GDS. The segmentation accuracy measurement is based on the average value. For each class, the score is averaged over all the salient object segments in the class. For overall objects, the score is averaged over all the detected salient object segments. If the size of a ground truth object segment is smaller than 0.5% of the image size, it is not a salient object and will not be accounted for in the segmentation accuracy. In total, we detected 2757 salient objects from143 testing images and, on average, 19 objects per image. We are able to achieve an average improvement of 16.2% over the performance of the Gould09 method. Among 2757 salient objects detected in the testing images, the structured objects (buildings foregrounds) account for 52.6%. Our method significantly outperforms the Gould09 method on segmenting the structured objects.

For the full data set, we detected 13 430 salient objects from 715 images and, on average, 18.8 objects per image. Structured objects account for 54.8% of the total detected salient objects.

For the structured objects, POM does not gain any prior knowledge from training images. Our POM achieves very stable performance on segmenting the difficultly structured objects on the full data set. This shows that our POM can successfully handle various structured objects appearing in outdoor scenes. Pixel-level accuracy reflects how accurate the classification is for multiclass segmentation methods. Pixel-level accuracy is computed as the percentage of image pixels correct class label. Our POM is not a multiclass segmentation method because it does not label each pixel of an image with one of eight semantic classes as Gould09. Therefore, our POM does not have pixel-level accuracy. Gould09 seems to be adaptable to the variation of the number of semantic classes. The method achieved 70.1% pixel-level accuracy on the 21-class MSRC database according to and achieved impressive 75.4% pixel-level accuracy on the 8-class GDS. However, the foreground class in GDS includes a wide variety of structured object classes such as cars, buses, people, signs, sheep, cows, bicycles, and motorcycles, which have totally different appearance and shape characteristics. This makes training an accurate classifier for classifying the foreground classes difficult. As a result, the Gould09 method cannot handle complicated environments where multiple foreground objects may appear close to each other. In such cases, the Gould09 method often labeled the whole group of physically different object instances such as people, car, and sign as one continuous foreground class region. This affects the performance of Gould09 on the object-level segmentation. If the foreground class can be further divided into more semantic object classes, the performance of the Gould09 method can be expected to improve on the GDS. The small number of semantic classes does not affect our method. Our method only requires identifying five background object classes (i.e., sky, trees, road, grass, and water). The remaining object classes are treated as structured objects.

b) Berkeley Segmentation Data Set

POM image segmentation method can be evaluated by using Berkeley segmentation data set (BSDS). BSDS contains a training set of 200 images and a test set of 100 images. For each image, BSDS provides a collection of hand-labeled segmentations from multiple human subjects as ground truth. BSDS has been widely used as a benchmark for many boundary detection and segmentation algorithms in technical literature. We directly evaluate our POM method on the test set of BSDS. The sizes of images in this data set are 481 321, which are larger than the sizes of images in GDS. We use larger parameters for Felzenszwalb's algorithm to generate the initial superpixels for an input image. We use the same background classifiers trained in the GDS data set to identify background objects in this data set. Examples of our POM segmentation algorithm on the BSDS data set.

The region-based segmentation accuracy measurement is still. For each image, BSDS provides a collection of multiple human-labeled segmentations. For simplicity, we only select the first human-labeled segmentation of the collection as ground truth for the image. The score is averaged over all the salient object segments. If the size of a ground truth segment size is smaller than % 0.5 of the image size, it is not a salient object and will not be accounted for segmentation accuracy. In total, we detect 681 salient objects from 100 images and, on average, 6.8 objects per image. Our POM achieved an averaged segmentation accuracy score of 53% on the test set of BSDS. For the boundary-based measurement, we use the precision– recall framework recommended by BSDS. A precision–recall curve is a parameterized curve that captures the trade off between accuracy and noise. Precision is the fraction of detections that are true boundaries, whereas recall is the fraction of true boundaries that are detected. Thus, precision is the probability that the segmentation algorithm's signal is valid, and recall is the probability that the ground truth data is detected. These two quantities can be combined in a single quality measure, i.e., F-measure, defined as the weighted harmonic mean of precision and recall. Boundary detection algorithms usually generate a soft boundary map for an image.

IV. Conclusion

The main contribution of this paper is to develop a perceptual organization model for extracting background and foreground images of an object. Our experimental results show that our future method outpaced two competing state-of-the-art image segmentation approaches and achieved good segmentation quality on two challenging outdoor scene image data sets. It is well accepted that segmentation and recognition should not be separated and should be treated as an interleaving procedure. In this method mainly follows the scheme and requires identifying some background objects as a starting point and compared to the large number of structured object classes. There are only a few common background objects in outdoor scenes and these objects have low visual variety and hence can be reliably recognized. After background objects are identified, we roughly know where the structured objects are and delimit perceptual organization in certain areas of an image. Our method can piece the whole object or the main portions of the objects together without requiring recognition of the individual object parts. In other words, for these object classes, our method provides a way to separate

segmentation and recognition. This is the major difference between our method and other class segmentation methods that require recognizing an object in order to segment it. This paper shows that, for many fairly articulated objects, recognition may not be a requirement for segmentation. The geometric relationships of the constituent parts of the objects provide useful cues indicating the memberships of these parts.

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Bangla Character Recognition System is Developed by using Automatic Feature Extraction and XOR Operation

By Md. Mojahidul Islam, Md. Imran Hossain & Md. Kislu Noman
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Abstract - This paper presents off-line bangle character recognition system using automatic feature extraction and XOR operation. In this system, the Bangla text is accepted as an image file which is first segmented into lines and words and then each word is segmented into characters. The pixels outside the boundary of the character are eliminated. The characters are scaled to a size equal to the database image. A XOR operation is performed between the scaled image and the database image and the error (%) is calculated. Finally, depending on the minimum error, the system recognizes the character to use in the output. The average recognition accuracy rate of the system was about 80%.

Keywords : *character recognition; character segmentation; automatic feature extraction; XOR operation.*

GJCST-F Classification: *I.5.0*

Strictly as per the compliance and regulations of:

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Md. Mojahidul Islam [α], Md. Imran Hossain [σ] & Md. Kislu Noman [ρ]

Abstract - This paper presents off-line bangle character recognition system using automatic feature extraction and XOR operation. In this system, the Bangla text is accepted as an image file which is first segmented into lines and words and then each word is segmented into characters. The pixels outside the boundary of the character are eliminated. The characters are scaled to a size equal to the database image. A XOR operation is performed between the scaled image and the database image and the error (%) is calculated. Finally, depending on the minimum error, the system recognizes the character to use in the output. The average recognition accuracy rate of the system was about 80%.

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I. Introduction

The subject of character recognition has been receiving considerable attention in recent years due to the advancement of the automation process. Automatic character recognition improves the interaction between man and machine in many applications like office automation, cheque verification, mail sorting, and a large variety of banking, business and data entry applications. We are concerned here with the recognition of character in Bangla language. Bangla is the mother language of Bangladesh and approximately 10% of the world's population speaks in Indian, Chinese and other languages trying to develop the complete character recognition system. In our country, research works in this field have achieved a limited success so far as compared to the other foreign languages. Though, the achievement in this fascinating field is not enough to reach the ultimate goal. But the progress of such research with Bangla language is still in an initial level. This research is a simple flourish to implement that dream as the initial step to convert the Bangla text to computer readable form that is development of complete Bangla Character Recognition system. Individual Bangla characters were recognized using various techniques such as geometric shape analysis, black runs and concavity measurement technique.

II. Implementation of Character Recognition System

The character recognition system can be divided as segmentation of text document into character and recognition of the character. The whole process is shown in Fig 1.

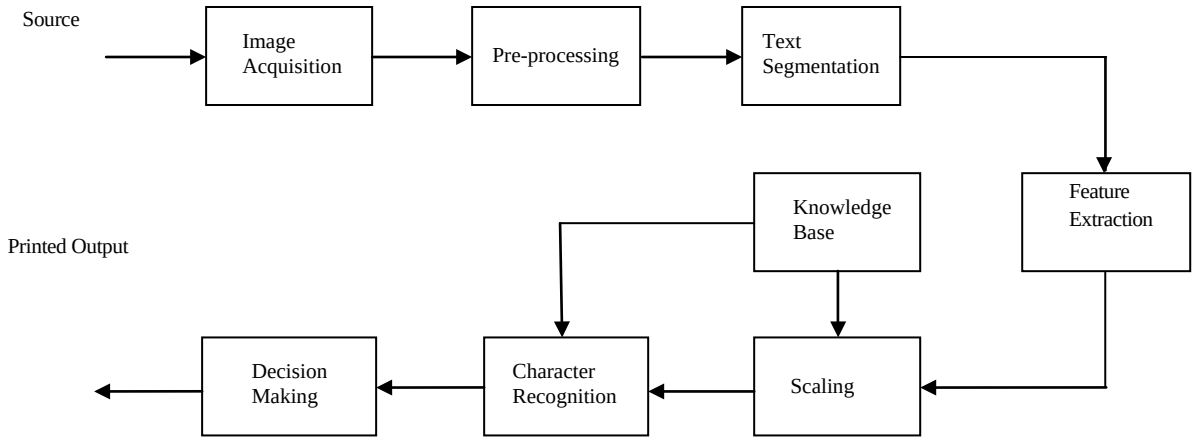

Figure 1 : Block diagram of character recognition system

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a) Image Acquisition

The input images are acquired from documents containing text by using scanner as an input device or using Adobe Photoshop or Paint. Acquired images are then stored in Hard Disk in JPG picture format. This image is then passed for preprocessing.

b) Pre-Processing

The scanned image is converted into binary image. At first, the RGB image is converted into grayscale image and then binary image i.e. an image with pixel 0 (white) and 1 (black). After converting the image, the unnecessary pixels (0s) from the original image is removed.

c) RGB to Grayscale and Gray to RGB Conversion

In practical cases most of the images are generally color (RGB), but it is complex to work with a three-dimensional array. So it needs to convert the RGB image into the grayscale image. The RGB to grayscale conversion is performed by MATLAB command.

I = rgb2gray(f)

For ease of analysis, the grayscale image is converted into binary image by using the following MATLAB command.

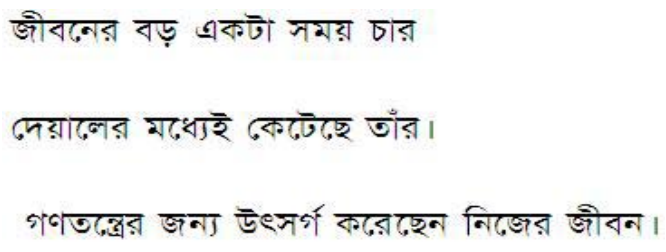
BW = im2bw(I)

III. Text Segmentation

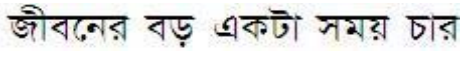
Text segmentation is a process where the text is partitioned into its elementary entities i.e. characters [10]. The total performance of the character recognition process depends on the accuracy of the segmentation process of the text into the characters. In the segmentation phase, first the document is segmented into text lines, the text lines are segmented into text words and then the words are segmented into characters.

a) Line Segmentation

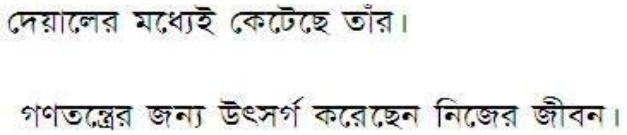
Text line segmentation is performed by scanning the input image horizontally. Frequency of black pixels in each raw is counted to separate the line. The position between two consecutive lines, where the number of black pixels in a raw is zero denotes a boundary between the lines [13]. The output image is shown in Fig 2.



(a)



(b)

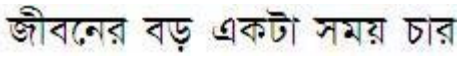


(c)

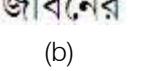
Figure 2 : Line Segmentation (a) Bangla input text image, (b) Image of first segmented line and (c) Text image without first line

b) Word Segmentation

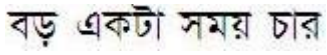
In English text there is a minimum gap between two consecutive characters and two consecutive words. The minimum gap between two consecutive words is greater than two consecutive characters. Although maximum characters in Bangla text line are connected by matra line with each other, the same case occurs if the gap exists between them. For word segmentation from the text line, the vertical scan is performed. If there exists n consecutive scan that find no black pixel, we denote it to be a marker between two words. The value of n is the minimum gap between two consecutive words which is taken experimentally. The output is shown in Fig 3



(a)



(b)

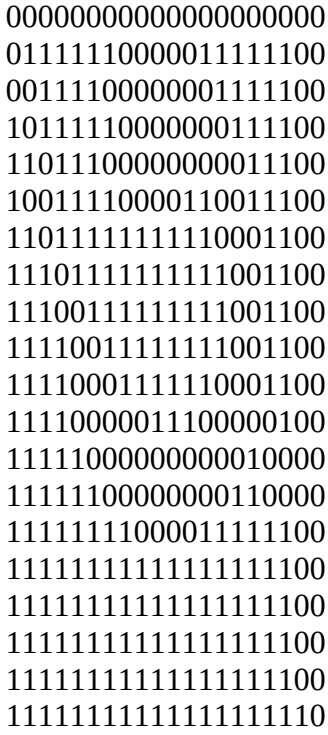


(c)

Figure 3 : Word Segmentation (a) Bangla Text Line, (b) Image of first segmented word and (c) Image without first word

c) Character Segmentation

For character segmentation from the word, the vertical scan is performed. The starting boundary of a character is the first column where the first black is found. After finding the starting boundary of a character, it continues scanning until a column without any black pixel is found, which is the ending boundary of the character being processed [14]. Fig. 4 shows a single segmented character and its corresponding binary format.



(a)

Figure 4 : (a) Binary Form of a Segmented Character

d) Knowledge Base

The knowledge base is designed based on the feature matrix of various characters. In order to build the knowledge base, first, the RGB character image is converted into grayscale image then it is converted into binary image. After getting the binary image, the unnecessary pixels from the character boundary is eliminated.

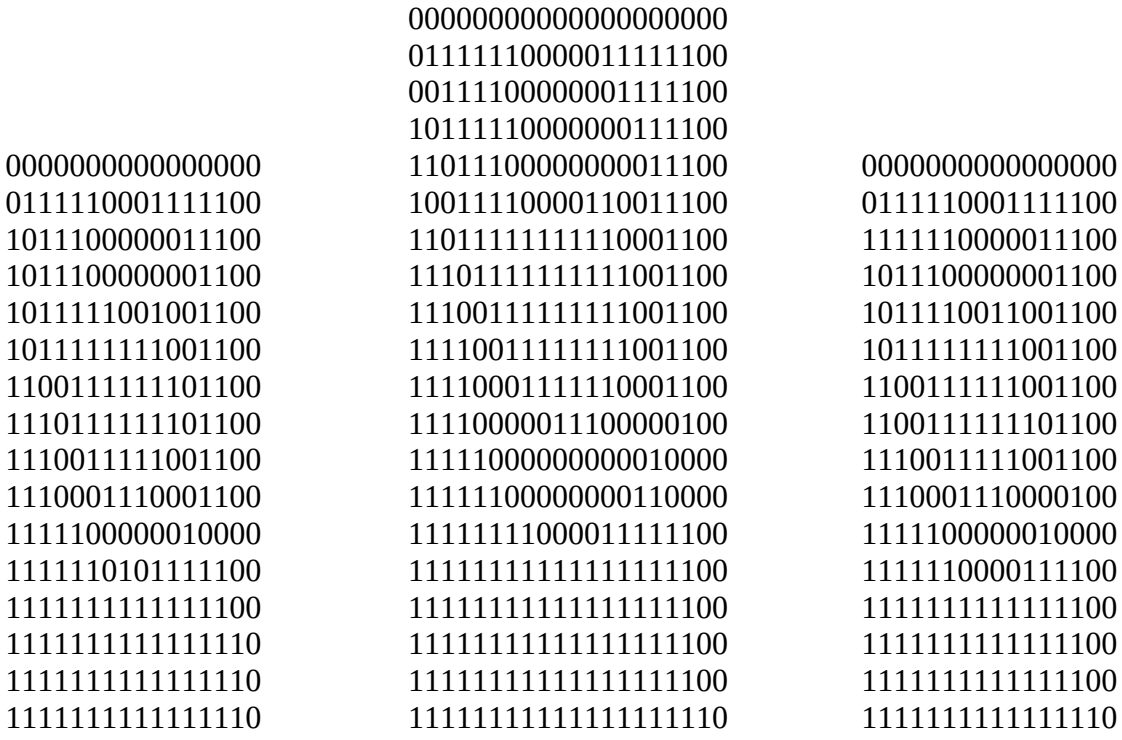
e) Feature Extraction

Feature extraction is the process of extracting essential information content from the image segment. It plays an important role in the whole recognition process [10].

f) Scaling

Depending on the height and width of the database image the segmented characters are scaled. If the size of the segmented character is higher than the database character then the system will be scaled down all the segmented characters to the size of the database character, otherwise scaled up. If C be the segmented character then the scaled image S is obtained by the following MATLAB command: S = imresize(C, [height, width]).

Where, height and width is the dimension of the database character. Fig 5(a) shows a database character অ whose size is 16×16. The segmented character অ of size 20×20 shown in Fig 5(b) is scaled down to the size of database character 16×16 shown in Fig 5(c). This is repeated for all database characters and finally for all segmented characters.



(a) (b) (c)

Figure 5 : Image scaling (a) Database image of size 16×16, (b) Segmented image of size 20×20, and (c) Scaled image of (b) of size 16×16

g) Character Recognition

Character recognition performance depends on the scaling. If the segmented character is too higher or too lower than the database image then the character recognition performance is reduced. The character recognition procedure is described in following Algorithm:

BEGIN

1. Calculate $total_{pixel}$ = height×width.
2. Take XOR between first database character and scaled character S.
3. Calculate no. of correct pixels (0 is the correct pixel), $correct_{pixel.}$
4. Calculate percentage of error using $\text{error}(\%) = \frac{\text{total}_{\text{pixel}} - \text{correct}_{\text{pixel}}}{\text{total}_{\text{pixel}}} \times 100\%$ and save error (%).
5. Repeat Step 1 to Step 4 for all database characters.
6. Calculate minimum error (%) (e_{min}) obtaining from Step 4 for database characters.
7. Define a error tolerance, $error_{tolerance}$.
8. If $e_{min} < error_{tolerance}$
   Compare e_{min} for all %error
   If e_{min}=error(i) (%)
   Then print the i^{th} character
   endif
   else
   Print 'the character is not recognized'
   endif.
9. Repeat Step 1 to Step 8 for all segmented characters
10. End

0000000000000000	0000000000000000	0000000000000000
0111110001111100	0111110001111100	0000000000000000
1011100000011100	1111110000011100	0100010000000000
1011100000001100	1011100000001100	0000000000000000
1011111001001100	1011110011001100	0000001010000000
1011111111001100	1011111111001100	0000000000000000
1100111111101100	1100111111001100	0000000000100000
1110111111101100	1100111111101100	0010000000000000
1110011111001100	1110011111001100	0000000000000000
1110001110001100	1110001110000100	0000000000001000
1111100000010000	1111100000010000	0000000000000000
1111110101111100	1111110000111100	0000000101000000
1111111111111100	1111111111111100	0000000000000000
1111111111111110	1111111111111100	0000000000000010
1111111111111110	1111111111111100	0000000000000010
1111111111111110	1111111111111110	0000000000000000
(a)	(b)	(c)

Figure 6 : Character recognition (a) Database image of size 16×16, (b) Scaled image of size 16×16, (c) Image after XOR between (a) and (b)

Total number of pixels, $total_{pixel}$ = 16×16 = 256
Total number of correct pixels (0_s), $correct_{pixel}$ = 221

$$\text{error}(\%) = \frac{\text{total}_{\text{pixel}} - \text{correct}_{\text{pixel}}}{\text{total}_{\text{pixel}}} \times 100\%$$

$$= \frac{256 - 221}{256}$$

$$= 13.6719\%$$

In this way, for all database character the error (%) calculation is repeated. If the database character exactly or approximately matches with the segmented character then the error (%) will minimum. So base on the minimum error, the system gives the corresponding output character.

IV. Result and Performance Analysis

The system is divided in two main phases: segmentation and character recognition. So the overall performance of the system directly depends on the performance of the two individual phases.

The accuracy of this system is measured as the success rate for the recognition of characters. It is measured using Eq. (1):

$$\text{Accuracy}(\%) = \frac{\text{Number of Success}}{\text{Number of Test}} \times 100\%$$

a) Segmentation Performance

The segmentation performance of this system is shown in Table 1.

Table 1 : Text Document Segmentation Result

No. of Lines in a Text Document	Line Segmentation Accuracy (%)	Word Segmentation Accuracy (%)	Character Segmentation Accuracy (%)
4	100	97	89.05
5	100	97.5	92.50
6	100	94	90.71
7	100	96.67	92.69
8	100	94	90.32

b) Segmented Character Recognition Performance

For character recognition, this system uses XOR operation which is a very simple matching technique. The character recognition performance of this system is shown in Table 2 for Shoroborno and table 3 for Numerical Character.

Table 2 : Bangla Character (Shoroborno) Recognition Result

No. of Test Sample	Total No. of Characters	Total No. of Success	Success Rate (%)	Average Success Rate (%)
1	120	90	75	76.96368
2	150	116	77.33333	
3	125	94	75.2	
4	130	102	78.46154	
5	170	134	78.82353	

Table 3 : Bangla Numerical Character Recognition Result

No. of Test Sample	Total No. of Characters	Total No. of Success	Success Rate (%)	Average Success Rate (%)
1	50	42	84	83.27363
2	70	53	75.71429	
3	65	56	86.15385	
4	40	33	82.5	
5	50	44	88	

V. Discussion and Conclusion

The aim of this system is to recognize Bangla characters. This system can recognize these characters with slight limitations. The limitations are discussed in the following section.

a) Limitation

The performance of this system depends on the segmentation and recognition. If the characters of text are in very close or overlap to each other, then the system fails to segment the characters. For Bangla characters, different font size is possible in practical. It is not possible to store all the front size in database. So it needs to scale the character which causes distortion in character shape. It should create a problem but the system should not fail always.

b) Further Scope

Due to the limitations described in previous section the system is not suitable for on-line applications. The overlapping character can be segmented by using Flood fill and Boundary fill algorithm. It is further target to perform this work.

c) Conclusion

In this paper the off line bangle character recognition system is developed by using automatic feature extraction and XOR operation. The efficiency of this system is not so high. In future, MLP and SVM classifier can be used for character recognition.

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A Distance Based Hand Gesture Recognition Representing Numbers

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Abstract - Information communication between two peers can be done using various mediums. These mediums can be either linguistic or gestures. The development of procedure for realizing gestures into meaningful information plays a pivotal role in instances where linguistic feature cannot be taken as a basis and gestures can be used as the alternative for the conveying the same. This project basically presents a very effective and efficient approach for recognizing the hand gesture that represents numbers. The work basically represents the active and in-active fingers with Boolean true or false respectively, in different combination for representing different numbers. The method of representing the hand gesture in binary pattern contributes a lot for increasing the performance of classification process. The binary Support Vector Machine (SVM) is considered as a recognition tool.

GJCST-F Classification : *I.5.4*

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A Distance Based Hand Gesture Recognition Representing Numbers

Ashis Pradhan [α], Dr. M.K. Ghose [σ] & Mohan Pradhan [ρ]

Abstract - Information communication between two peers can be done using various mediums. These mediums can be either linguistic or gestures. The development of procedure for realizing gestures into meaningful information plays a pivotal role in instances where linguistic feature cannot be taken as a basis and gestures can be used as the alternative for the conveying the same. This project basically presents a very effective and efficient approach for recognizing the hand gesture that represents numbers. The work basically represents the active and in-active fingers with Boolean true or false respectively, in different combination for representing different numbers. The method of representing the hand gesture in binary pattern contributes a lot for increasing the performance of classification process. The binary Support Vector Machine (SVM) is considered as a recognition tool.

I. Introduction

Digital Cameras are now integrated into personal computers, mobile cellular devices and handheld systems. These devices usually include a powerful microprocessor, capable of performing millions of computations per second. The technology on digital cameras and microprocessors are advancing rapidly that it is possible to create a human computer interfaces using these resources. The Gesture recognition system acts as a communication channel between humans and machines.

The human-machine interaction is similar to human-human interaction, in which, the valuable information are communicated using the human organs like hand gesture, etc. The design of a gesture recognition system should be based on common hardware support such as web-cams or mobile-integrated cameras, to be applicable to current PCs, mobile devices, Digital Cameras, etc. While designing such systems, certain parameter like uniform or non-uniform background, different light intensity, etc. has to be considered, so that the system functions correctly.

This paper presents the design of a hand gesture recognition system that is divided into various modules. Initially, system is designed taking into consideration that the system is able to classify the input hand gesture representing number given at vertical position with respect to x-axis considering little or no deviation to images stored in database. The system is then modified again to recognize the hand gestures given at specified range of angle to make the system more flexible.

II. Literature Survey

Several approaches have been already used to design a hand gesture recognition system. All approaches gave primary focus on feature extraction of the hand gesture and was found that the better feature extraction step is performed, better will be the performance of classification. Ilan Steinberg et. al [4], proposed a method of recognizing hand gesture, by considering each pixel of the binary image as a feature. Omlin and Vapnik et. al. in [5, 6], have recognized user hand gesture using color histogram as their feature, in which, the whole image was divided into smaller blocks and plot the corresponding histogram, for classification. Mokhtar M. Hasan et. al. [1], observed that the finger tip can also be used as a feature for recognition.

Nasser H. Dardas in [3], used a bag of feature for classifying hand gesture. In this approach, all the key points of the training images were extracted and these key points are mapped to its corresponding histogram feature vector for classification. Oleg Rumyantsev et. al. introduced an efficient method for recognizing hand gesture, based on PCA method [2], in which, the test image and database images were represented using Eigen values and the hand gestures were correctly classified using the Euclidean distance of these Eigen values.

III. Methodology

This paper basically deals with the design of a system that acquires a user's hand gesture and classifies it based on the predefined hand gestures, stored in a database. The figure 1 shown below is the list of gestures that the system will recognize it correctly:

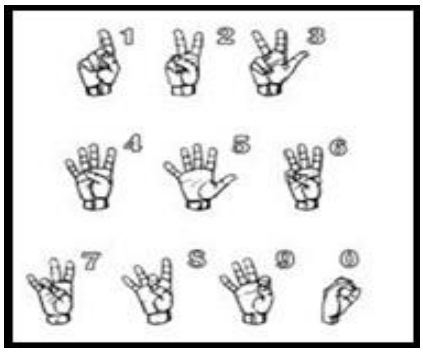

Figure 1 : Gesture Representing Numbers

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The work uses low-resolution web cam for capturing the hand gestures and an algorithm that processes the acquired images and then classifies the hand gesture correctly. The work mainly emphasizes on the feature extraction from the hand gestures and use that features in the recognition algorithms. Initially, the system will contain a setup procedure, in which, the algorithm is trained based on significant feature extracted for different hand gestures. Once the setup in completed, the system will be able to classify the given hand gesture based on the database knowledge.

The design of hand gesture recognition system is broadly divided into two phase: preprocessing phase and classification phase. The performance of Classification phase is directly proportional to task performed during preprocessing phase. The task of pre-processing stage is to:

i. Extract the hand portion from an image
ii. Remove the noises and unwanted feature
iii. Convert processed image to binary image
iv. Extract significant features from binary image to form a feature set for classification.

The figure 2 represents general methodology followed for each module during the design of a system. For classification, the binary SVM (Support Vector Machine) is used, which is a machine learning algorithm.

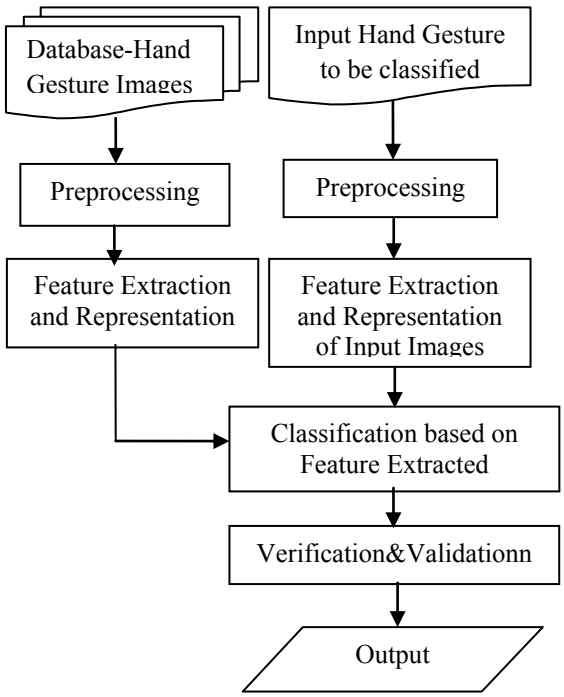


Figure 2 : General flow diagram of a System for each module

The figure 3 below is describes abstract design of system that is divided into different modules.

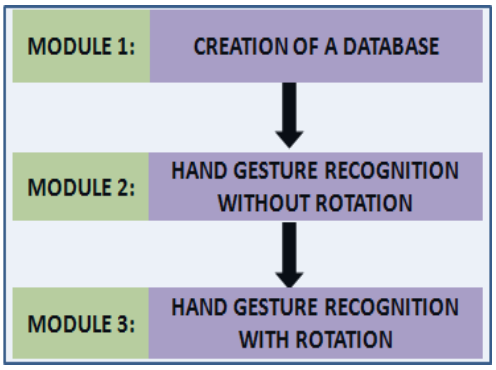


Figure 3 : Representation of different modules of a system

a) Module 1: Creation of Database

Creation of dataset pertaining to the various gestures is essential for any inferential studies related to gesture recognition. This reference dataset created not only store features related to gestures, it also ease the process initiated for the gesture recognition. Hence the dataset set created should be concise yet effective. This module aims at creating reference dataset for various gestures in which the gestures are represented with the help of a Boolean trail, where each Boolean is set to either true or false based on the requirement of a gesture. In order to create a Boolean trail, the following steps should be initiated.

Step 1: Image Acquisition: In this step, the scene containing hand portion as a major object is stored. Here, constrain is included in system, that is, the images is taken at equidistant for both training and testing.

Step 2: Color segmentation taking basis as tone of human skin to remove unwanted feature: The second step extract the hand portion from uniform or non-uniform background. This task was accomplished by considering the tone of human hand.

Step 3: Converting the output of step 2 to binary image and noise removal: To reduce computation complexity for feature extraction, the processed image was converted into binary image using a thresholding technique. The noises were handled using median filter. The morphological operator (erosion) is also used for removing small unwanted details.

Step 4: Fingertip detection: The next immediate process is the feature extraction. The paper focuses only on identifying the active and in-active finger, represented by 1 and 0 respectively. To identify the active and in-active finger, the first task performed was the finger tip detection. First, skeletonization technique is used to thin the finger portion. Then, for each 3x3 mask over whole image, the number of neighbors is calculated with respect to centered pixel. If the number of neighbor is exactly equal to one then that center pixel is considered as fingertip. For each fingertip detected, the coordinate values for such pixels are stored.

Step 5: Determination of centroid: The centroid of a hand is calculated as:

$$\overline{X} = \frac{\sum_{i=0}^{k} xi}{k}, \qquad \overline{Y} = \frac{\sum_{i=0}^{k} yi}{k}$$

Where represents the centroid of the hand, xi and yi are x and y coordinates of the ith pixel representing hand region and k represents total pixels representing hand.

Step 6: Determination of distance between centroid and finger tips: The distance between the centroid and the fingertip is calculated using Euclidean distance shown below:

$$\text{Distance, } D2 = (x2 - x1)2 - (y2 - y1)2$$

Where (x1, x2) and (y1, y2) represent the two co-ordinate values. Here one pair represents fingertip location and other pair represents centroid location.

Step 7: Creating Boolean trails for gestures taking distance as feature: Through manual process, it was found that the distance from centroid to different fingertip were different. So, this distance can be used as a significant feature for identifying the active or in-active finger. Based on predefined distance for each finger from Centroid, the active fingers were represented by 1 and the in-active finger was represented by 0. Hence, we extract Boolean trail for each gesture. For example, the Boolean trail for gesture representing 1 is will be 01000. This Boolean trail for different gesture representing different number will be different. For consistency, the numbering of finger is done form left to right. The following is the Boolean trails stored in repository for different hand gestures representing a number from 0 to 9.

Binary Code	Equivalent Number
00000	0
01000	1
01100	2
11100	3
01111	4
11111	5
01110	6
01101	7
01011	8
00111	9

Table 1 : Lookup Table or Number Pattern

b) Module 2: Hand Gesture Recognition without Rotation

In this module, the system is tested by extracting the Boolean trail for any given input hand gesture and matching that Boolean trail with the trails stored in the repository. If there is any match found then the corresponding equivalent number is displayed otherwise the system will generate an invalid gesture message. This module identifies hand gestures given in an upright position, that is, fist of hand is approximately perpendicular to horizontal x- axis. The following steps are performed to during implementation:

Step 1: Repeat step 1 to 6 from module 1

Step 2: Extraction of Boolean trail for an input hand gesture: Here certain range of distance is considered to identify active and in-active finger and hence to increase the efficiency of a sytem. So that, system can also recognize the hand gesture correctly even there is a small bents of finger during acquisition. Hence, if the distance for any finger is within specified range, then the corresponding bit is set to 1 else 0. In this way, the Boolean trial is extracted for a given gesture representing number.

Step 3: Comparison of Boolean trail for an input hand gesture with repository: The Boolean trail extracted from step 2, for input hand gesture is compared with the each Boolean trail of repository created in step 7 of module 1. Finally, if there is match with any one of the binary pattern, the corresponding index value of the matched binary pattern is displayed, which is considered as the matched gesture. The Binary SVM is used for classification, in which, the input image is classified as either correct or incorrect. Therefore, number of binary SVM comparison has to be made with repository.

c) Module 3: Hand Gesture Recognition with Rotation

This method basically includes the recognition of hand gestures given at any angle. This module is included in system to include the property rotation invariant. So, several tasks were performed, where, the input hand gesture given at certain angle (i.e. gesture formed by rotating palm in clockwise or anti-clockwise direction) can also be identified correctly. The following are the steps initiated to include the property rotation invariant in the gesture recognition system:

Step 1: Repeat step 1 to 3 from module 1

Step 2: Identification of fist for any input gesture: The fist of the hand is identified by scanning the hand on row basis starting from the centroid of hand onwards directly to reduce unnecessary computation. If the number of continuous pixel representing hand portion, is in the range 50-60, then that row is considered as portion of fist. Here, we consider the fact that in whichever angle the palm is oriented the fist of hand is always coincide with horizontal axis. Once the initial row value and final row value representing fist region of a hand gesture is found, the mid-point for that the initial row value and final row value representing fist is to be calculated. Let (x, y) and (i, j) represents the mid-point coordinate value for initial row value and final row value representing fist of hand, respectively. An imaginary line is drawn between points (x, y) and (i, j) and let H represents this line, which basically represents the deviation from imaginary vertical line.

Step 3: Calculating the deviation of hand: For calculating deviation, the angle between line H and an imaginary horizontal line (i.e. x-axis) is calculated. Consider an imaginary horizontal line along x-axis starting from coordinate (i, j). Now, from analysis, coordinate (x, y) and (x, j) represents the imaginary horizontal line. Let B represents this line. Now, it can be noted that line H and B meet at (x, y). Also, it is noted that by drawing a line from (x, y) of line H to (i, y) of line B forms a right angled triangle. Hence, a cosine law can be used to find an angle between line H and B. Let (theta) is the angle between line H and B.

So,

$$\text{Cos}(\ ) = \frac{B}{H}$$

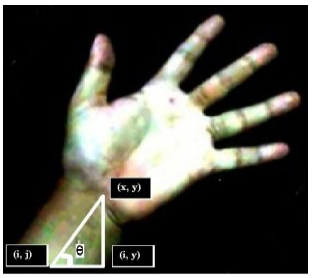


Figure 4 : Imaginary Triangle for Rotation

Step 4: Calculating deviation with respect to vertical y-axis: Finally, the deviation of hand from vertical axis is calculated using following expression: Deviation= 90 – (if is an acute angle).

Step 5: Performing rotation on the input gesture by an angle "Deviation": Finally, the output of Step 4 is rotated using the rotating function of matlab with an angle 'Deviation'.

i.e. Output= **imrotate** (Input Image, Deviation);

Step 6: Repeat Step 4 to 6 from module 1: The outcome of this step is the distance matrix that gives the distance between active finger and the centroid.

Step 7: Extraction of Boolean pattern from output of step 6: In this step, repeat the Step 2 of module 2 considering the output from above Step number 6, to extract the Boolean pattern.

Step 8: Repeat the Step 3 of Module 2 considering the output from above step 7 and display the result.

IV. Results and Discussion

The result of the hand gesture recognition system is very simple, but the paper aims at the efficient way of representing data or information for comparison and focuses on the method to reduce the complexity during comparison for a hand gesture image to be tested and hence to increase the correctness of the system. It not only follows a simple approach for recognition but also include a feature like rotation invariant and orientation independent. The figure 5 shown below is the abstract view of result of the system.

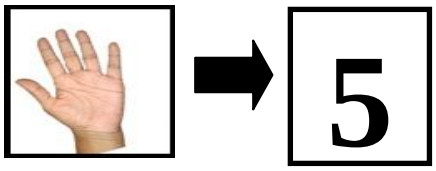


Figure 5 : Input Gesture and Output Gesture

The lots of task are carried out to design a system that will correctly classify and give the above sample output for its corresponding input. The first task after image acquisition was to extract only the hand portion from any complex or uniform background, which was accomplished with the help of skin color of hand and convert the resultant image to binary image. The thresholding technique was used to convert image into binary image. While working in real time, there exists some noise in an image. This appearance of noise may be due to low resolution cameras that it used during image acquisition step or due to the environmental factor. Hence, the image in which the hand portion is extracted also contain some noises. So, the median filtering technique, followed by erosion morphological operation is used on the segmented image to remove noise and to remove un-necessary small sharp detail in an image, respectively. The outcome of these operations is the noise free regularized image, in which, the maximum area in an image is covered with the object of interest only. Finally, the resultant image is processed to determine the finger tips and store its co-ordinate values. The Skeletonization technique is used to determine the finger tip. In the next step, the centroid of a hand region is calculated. The significance for calculating the centroid is to determine the actively raised finger. The actively raised fingers were determined by calculating the distance between the centroid and the finger tip. Visually, it can be determined that the distance between centroid and the different fingers of a hand are different. Hence, this concept is used to create a binary pattern for actively raised finger in an image. The deviation of 10% (approximately) is included in the system for distance to determine actively raised finger. The active raised finger is marked 1 and the in-active fingers is marked 0. These different combinations of 0's and 1's represent any one number between 0 and 9. Thus, a database is created for different hand gesture that represents number. The table 1, table 2 and table 3 shown describes the result achieved for module 1(i.e. Repository Creation for each image representing gesture from number 1 to 9), gesture recognition without rotation and gesture recognition with rotation, respectively.

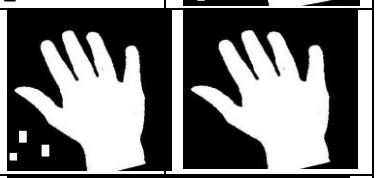
Process	Input	Output
RGB to Binary		
Noise Removal		
Skeletonization		
Repository Creation		11111

Table 2 : Sample Result for Module 1

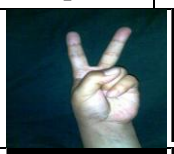
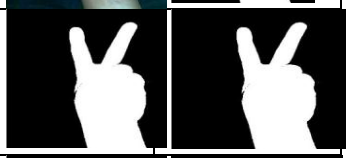
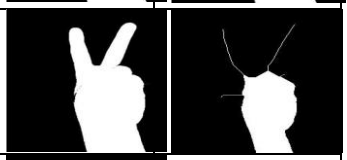
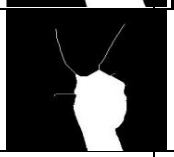
Process	Input	Output
RGB to Binary		
Noise Removal		
Skeletoniza-tion		
Pattern Extraction		01100
Pattern Comparison	01100	2

Table 3 : Sample Result for Module 2

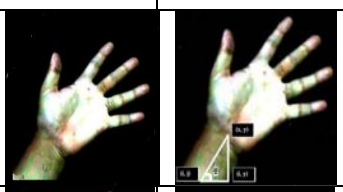
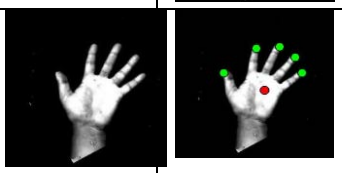
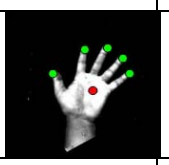
Process	Input	Output
Calculate deviation		
Rotate Input Image		
Centroid and Fingertip Detection		
Pattern Extraction		11111
Pattern Comparison	11111	5

Table 4 : Sample Result for Module 2

Initially, the system is trained by extracting binary pattern for different hand gestures representing numbers and thus creating a repository that is used later in recognition phase. After the creation of database, the testing phase starts. In testing phase, any input image is taken that represent number. Same tasks are carried out for the input image, as described above, to extract the binary pattern. Finally, this binary pattern is matched with the repository to recognize it as correct gesture and hence display the result.

V. Conclusion

The hand gesture recognition system designed is trained with different gestures and is able to classify it correctly. Some assumption are considered while designing a system, that is, the input image to be classified during testing phase has to be taken at same distance and at similar intensity as that of training phase. Initially, system classify the hand gesture representing number given at approximately upright position which is further extended to recognize gesture given at any angle between 0 to 180 degree, by considering the fact, that, the base of the fist is always coinciding with the horizontal x-axis. The system can be further extended as future scope to recognize alphabets, expressions, etc. Furthermore, the search procedure can be enhanced to increase the performance of the system. The designed system is able to classify only the static images which can be

extended more to recognize hand gesture in videos as well. There are lots of applications for gesture recognition system. For example, sometimes, it can also be used as communication device. There is a rapid growth on application development considering gesture recognition system. For example, now days, in smart T.V, gesture recognition system is included to change channel, increase volume, etc. Lots of research is still going on this related topic to ease the life of human being and to enhance the technology.

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20. Use good quality grammar: Always use a good quality grammar and use words that will throw positive impact on evaluator. Use of good quality grammar does not mean to use tough words, that for each word the evaluator has to go through dictionary. Do not start sentence with a conjunction. Do not fragment sentences. Eliminate one-word sentences. Ignore passive voice. Do not ever use a big word when a diminutive one would suffice. Verbs have to be in agreement with their subjects. Prepositions are not expressions to finish sentences with. It is incorrect to ever divide an infinitive. Avoid clichés like the disease. Also, always shun irritating alliteration. Use language that is simple and straight forward. put together a neat summary.

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

22. Never start in last minute: Always start at right time and give enough time to research work. Leaving everything to the last minute will degrade your paper and spoil your work.

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

24. Never copy others' work: Never copy others' work and give it your name because if evaluator has seen it anywhere you will be in trouble.

25. Take proper rest and food: No matter how many hours you spend for your research activity, if you are not taking care of your health then all your efforts will be in vain. For a quality research, study is must, and this can be done by taking proper rest and food.

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 though 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
- All figure and table must be adequately complete that it could situate on its own, divide from text

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.

Administration Rules Listed Before Submitting Your Research Paper to Global Journals Inc. (US)

Please carefully note down following rules and regulation before submitting your Research Paper to Global Journals Inc. (US):

Segment Draft and Final Research Paper: You have to strictly follow the template of research paper. If it is not done your paper may get rejected.

- The **major constraint** is that you must independently make all content, tables, graphs, and facts that are offered in the paper. You must write each part of the paper wholly on your own. The Peer-reviewers need to identify your own perceptive of the concepts in your own terms. NEVER extract straight from any foundation, and never rephrase someone else's analysis.

- Do not give permission to anyone else to "PROOFREAD" your manuscript.

- Methods to avoid Plagiarism is applied by us on every paper, if found guilty, you will be blacklisted by all of our collaborated research groups, your institution will be informed for this and strict legal actions will be taken immediately.)
- To guard yourself and others from possible illegal use please do not permit anyone right to use to your paper and files.

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

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

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