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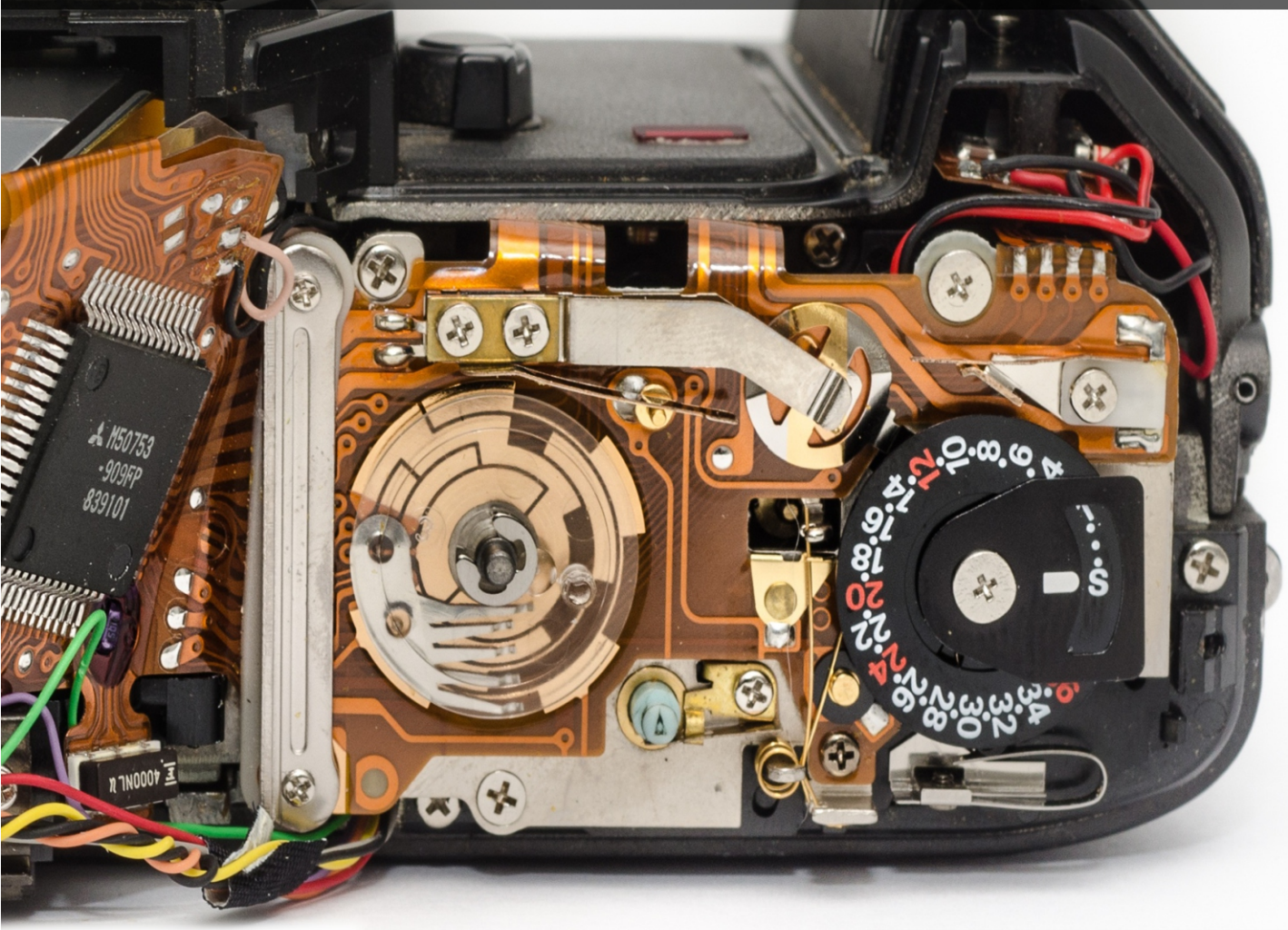

Highlights

Classification of Fast Food

Algorithm on Image Segmentation

Improvement of Single Seeded

Review on Motion Capture Technology

Discovering Thoughts, Inventing Future

VOLUME 18 ISSUE 1 VERSION 1.0

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Facial Age Estimation

By Ramasubramanian. SA, Gowtham. J, Derick Immanuvel. F, Bharat Kumar & V. Sahaya Sakila

Abstract- Age estimation based on the human face remains a significant problem in computer vision and pattern recognition. In order to estimate an accurate age or age group of a facial image, most of the existing algorithms require a huge face data set attached with age labels. This imposes a constraint on the utilization of the huge amount of human photos in the social networks. These images may provide no age label, but it is easily to derive the age difference for an image pair of the same person. To improve the age estimation accuracy, we propose a novel learning scheme to take advantage of these weakly labeled data via the deep Convolutional Neural Networks (CNNs). For each image pair, Kullback-Leibler divergence is employed to embed the age difference information(MS. SWATHI THILAKAN). The entropy loss and the cross entropy loss are adaptively applied on each image to make the distribution exhibit a single peak value. The combination of these losses is designed to drive the neural network to understand the age gradually from only the age difference information. Experimental results on two aging face databases show the advantages of the proposed age difference learning system and the state-of-the-art performance is gained.

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Facial Age Estimation

Ramasubramanian. SA [α], Gowtham. J [σ], Derick Immanuvel. F [ρ], Bharat Kumar [ω] & V. Sahaya Sakila[¥]

Abstract- Age estimation based on the human face remains a significant problem in computer vision and pattern recognition. In order to estimate an accurate age or age group of a facial image, most of the existing algorithms require a huge face data set attached with age labels. This imposes a constraint on the utilization of the huge amount of human photos in the social networks. These images may provide no age label, but it is easily to derive the age difference for an image pair of the same person. To improve the age estimation accuracy, we propose a novel learning scheme to take advantage of these weakly labeled data via the deep Convolutional Neural Networks (CNNs). For each image pair, Kullback-Leibler divergence is employed to embed the age difference information(MS. SWATHI THILAKAN). The entropy loss and the cross entropy loss are adaptively applied on each image to make the distribution exhibit a single peak value. The combination of these losses is designed to drive the neural network to understand the age gradually from only the age difference information. Experimental results on two aging face databases show the advantages of the proposed age difference learning system and the state-of-the-art performance is gained.

Chapter 1

I. Introduction

a) Overview

Face recognition is developed for various purposes and helped in the development of artificial recognition by computer systems. For recognizing human faces, defining age classifier is a major step in this project. This project aims to increase the accuracy of the identification of human faces. The basic concept of images is drawn from pixels. Pixels are the basic forming patterns for any sort of images. Images can be segmented into pixels based on colour patterns. The process of segmenting involves various types such as binary, gray, color. Binary type is a 1-plane pattern having values 0 and 1. Grey type is having shades of black and white and it is a 1- plane pattern and having values from 0 to 255. Color is having 3-plane pattern and designed from value range 0 to 256. Image processing mainly depends on this type of colour images. It is having red, green, blue planes. These planes are considered as the origin of all colour patterns . For example, Red + Green = Yellow, Red + Blue = Magenta, Green + Blue = Cyan, Red + Green + Blue = White, and secondary colours are combined to form black, Magenta + Cyan + Yellow = Black. We can possibly form 25 lakhs of colour patterns using thes colours. Recognising these colours from images are the basic requirement. This process involves various process such as Acquisition, Enhancement, Segmentation, Recognition, Retrieval, Restoration, Fusion, Compression, Watermarking, Cryptography, Steganography, etc. Automatic recognition is one of the emerging areas of artificial intelligence. There are various types of recognition such as Handwritten recognition, Face recognition, Fingerprint recognition, Voice recognition, etc. The process of recognition gets better with years of research and development. The need for identifying human ages with more accuracy motivates the research on this project. Images are acquired from various formats such as GIF, JPG, JPEG, etc. Images can be acquired through face camera or a file of any image format. The product is developed with the implication of GLCM matrix and the KULLBACK LEIBLER divergence formula. Using these techniques, the process of recognition continues and CNN network is used to estimate the age. The process will be updated and learned with every input images.

Figure 1.1: Black and White image

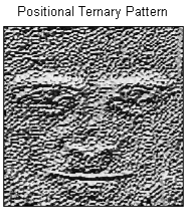

Figure 1.2: Gray scale image

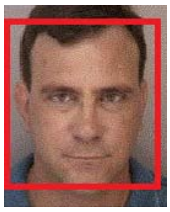

Figure 1.3: Colour image

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Chapter 2

II. Literature Survey

a) Image Acquisition

In Data Acquisition (DAQ) orImage acquisition, the recognition system acquires a scanned image as an input image. The image should have a specific format such as JPEG, BMP etc. This image is acquired through a scanner, digital camera or any other suitable digital input device. Data samples for the experiment have been collected from different individuals.

b) Face recognition

In this process of identification of ages using human faces ivolves segmentation of left eye, right eye, nose and mouth. In this process of identification first the boundaries of face happens and the process of identifying each parts will be continued. firstly the whole face will be identified and segmented and convert into 256*256 pixels. Then use the process of using cvision toolbox and call the face detection function to capture the image boundary and surrounded it with red rectangle(Rowley et al., 1996). Hold it for more time.

c) Preprocessing

Preprocessing involves the process of converting image required for face detection. To enhance the image, converting into black and white is essential. Finding four vectors for face detection namely x,y,w,h are essential. Then crop the target face into 180*180 pixels with four vector features obtained. Then convert the image having colour into grey image. Obtain the figure and hold the figure using image processing toolbox in MATLAB.

d) Face and Landmark detection

By the same way finding the face using function in image processing toolbox, face and landmark detection also obtained from the toolbox functions. Use detect face parts function for the process of identifying face parts. The parameters used are bbox, bbx, faces, bbfaces. bbox is used to bound parts of each part such as left eye, right eye, nose and mouth. Finding faces with box is used for the development of program. And also images with found faces determined into array are contributed into bbx. Faces is used for the found faces stored as cell array. bbfaces is used for the found faces with boxes stored as cell array. Each part having different cropping technique. Each part obtaining four essential features such as contrast, correlation, entropy and homogeneity(Chang and Chen, 2015). Contrast stands for the effect of pixels on the basis of colour depth. Correlation stands for the connection between two things. Entropy stands for the change in two differential functions. Homogeneity stands for the similarity in pixels. For left eye, the segmented ratio will be 5:8.For right eye, segmented ratio will be 9:12. For nose, segmented ratio will be 17:20. For mouth, segmented ratio will be 13:16. Display all these images combinely and calculate gray level co occurence matrix. Display the ternary image of the GLCM matrix.

e) Loading Databases and Training datasets

Using mathematical equations define the output by describing the amount of age present in the system input. Firstly, find the Least Square (LS), Mean Absolute Error (MAE) and the mean shifted input images. Then calculate the eigen vectors and eigen values. Then retain the top eigen vectors. Then project the image into subspace to generate the feature vectors. Then save the loaded data and then train the network and display the age classified using the network.

Figure 2.1: Face Detection

Figure 2.2: Preprocessing

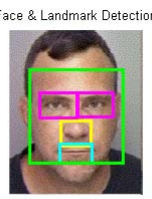

Figure 2.3: Face and Landmark Detection

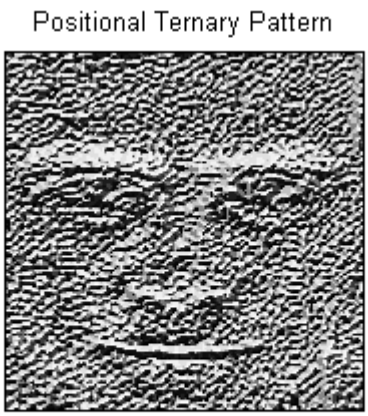

Figure 2.4: Positional ternary Pattern

Chapter 3

III. Existing System

a) Local Binary Pattern

The original LBP operator was introduced by Ojala et al. This operator works with the eight neighbors of a pixel, using the value of this center pixel as a threshold. If a neighbor pixel has a higher gray value than the center pixel (or the the same gray value) than a one is assigned to that pixel, else it gets a zero. The LBP code for the center pixel is then produced by concatenating the eight ones or zeros to a binary code. Later the LBP operator was extended to use neighborhoods of different sizes(Md. Abdur Rahim, 2013). In this case a circle is made with radius R from the center pixel. P sampling points on the edge of this circle are taken and compared with the value of the center pixel. To get the values of all sampling points in the neighborhood for any radius and any number of pixels, (bilinear) interpolation is necessary. If the coordinates of the center pixel are (xc, yc) then the coordinates of his P neighbors (xp, yp) on the edge of the circle with radius R can be calculated with the sinus and cosines.

b) Artificial Neural Network

Artificial Neural Network (ANN) system operates in two stages: it first applies a set of neural network-based filters to an image, and then arbitrates the filter outputs. The filters examine each location in the image at several scales, looking for locations that might contain a face. The arbitrator then merges detections from individual filters and eliminates overlapping detections. The first component of our system is a filter that receives as input a 20x20 pixel region of the image, and generates an output ranging from 1 to -1, signifying the presence or absence of a face, respectively. To detect faces anywhere in the input, the filter is applied at every location in the image. To detect faces larger than the windowsize, the input image is repeatedly sub sampled by a factor of 1.2, and the filter is applied at each scale. 1. Create an initial set of non-face images by generating 1000 images with random pixel intensities. Apply the preprocessing steps to each of these images. 2. Train the neural network to produce an output of 1 for the face examples, and -1 for the non-face examples. The training algorithm is standard error backpropogation. On the first iteration of this loop, the network weights are initially random. After the first iteration, we use the weights computed by training in the previous iteration as the starting point for training. 3. Run the system on an image of scenery which contains no faces. Collect subimages in which the network incorrectly identifies a face (an output activation 0). 4. Select up to 250 of these subimages at random, apply the preprocessing steps, and add them into the training set as negative examples. Go to step 2.

Drawbacks over existing systems:

1. In appearance based methods, less accurate of features description because of whole image consideratioin.
2. In geometric based methods, the geometric features like distance between eyes, face length and width, etc., are considered which not provides optimal results.

Chapter 4

IV. Coding, Testing

In this chapter, the program coding related to our work using MATLAB is designated.

a) Image Acquisition

In Image acquisition, the recognition system acquires a scanned image as an input image. The image should have a specific format such as JPEG, BMP etc.

```
cd Image
[file,path] = uigetfile('*.jpg;*.png','pick an image file');
img = imread(file);
```

b) Face recognition

In this process of identification of ages using human faces ivolves segmentation of left eye, right eye, nose and mouth. In this process of identification first the boundaries of face happens and the process of identifying each parts will be continued.

```
Fdetect = vision.CascadeObjectDetector;
Bvectors = step(Fdetect,tinp);
figure('Name','Face Detection','MenuBar','none');
imshow(tinp);
hold on;
```

c) Preprocessing

Preprocessing involves the process of converting image required for face detection. To enhance the image, converting into black and white is essential. Finding four vectors for face detection namely x,y,w,h are essential.

```
Freg = imcrop(tinp,Bvectors(1,:));
Freg = imresize(Freg,[180,180]);
if size(Freg,3)>1
Freg = rgb2gray(Freg);
end
figure;
imshow(Freg);
title('Preprocessing');
```

d) Face and Landmark detection

By the same way finding the face using function in image processing toolbox, face and landmark

detection also obtained from the toolbox functions. Use detect face parts function for the process of identifying face parts. The parameters used are bbox,bbx, faces,bbfaces.

```
detector = buildDetector();
[bbox,bbimg,faces,bbfaces] =
detectFaceParts(detector,img,3);
figure;imshow(bbimg);
title('Face Landmark Detection');
leye = imcrop(img,bbox(:,5:8));
PTPleye = ptp(leye);
[cont1; corr1; En1; Homo1] = GLCM(PTPleye);
Feat1 = [cont1; corr1; En1; Homo1];
```

e) Loading Databases and Training datasets

Using mathematical equations define the output by describing the amount of age present in the system input. Firstly, find the mean image and the mean shifted input images. Then calculate the eigen vectors and eigen values.Then retain the top eigen vectors. i = 1:size(Dfeatures, 2)

```
if M==0
N =N+1;
M = 0;
else
M = M-1;
end
T(1,i) = N;
end
disp('Training Feature Vectors :');
disp(Dfeatures);
helpdlg('Training Process Completed');
```

The following picture demonstrates the total output of the system being developed.

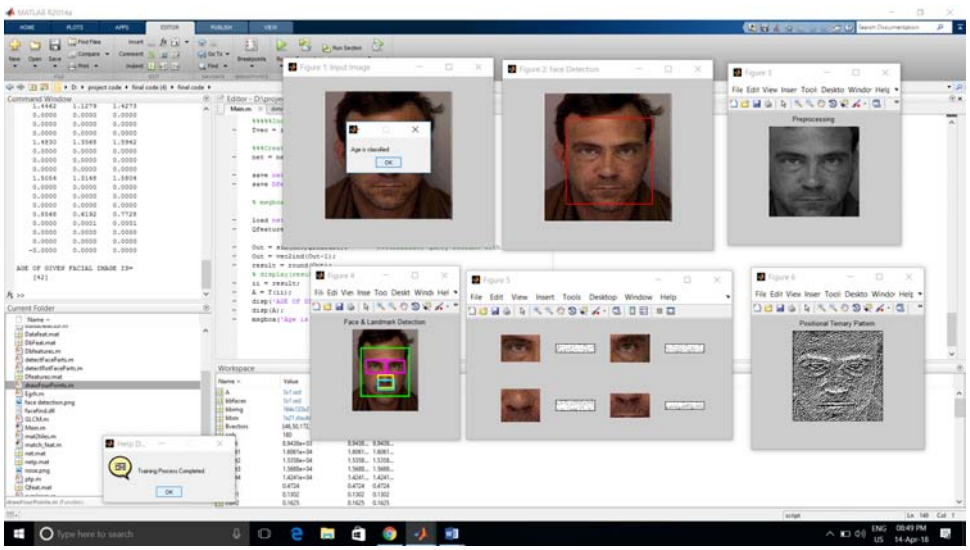

Figure 4.1: Final output screenshot

Chapter 5

V. Conclusion

Facial age recognition becomes one of the emerging technologies and the necessary one in the emerging computer world. to be correct on its own, it requires a 100 percent accuracy and develop the system with lots of training systems. Thus the developed systems are constrained towards the process of developing the accuracy of systems. The system developed in further steps of high definition. It helps in the higher sort of proposed definition. Network is developed for identifying further images with no label. The combination of these losses is designed to drive the neural network to understand the age gradually from only the age difference information. We also contribute a data set, including more than 100 000 face images attached with their taken dates. Each image is both labeled with the timestamp and people identity. Experimental results on two aging face databases show the advantages of the proposed age difference learning system, and the state-of-the-art performance is gained. Estimating human age from images is a problem that has recently gained attention from the computer vision community due to its numerous applications as well as the challenges that face a satisfactory solution. Beside traditional challenges in captured facial images under uncontrolled settings such as different lighting, varying poses and expressions, aging effects on appearance depends on many other factors such as life style. In this thesis, a new automatic age estimation framework is proposed. A single image is required as input for the subject of interest to estimate his age.

Chapter 6

VI. Future Enhancement

The work can be used for enhancing the age estimation through the performance of assigning the adaptive weights to MLBP features of each sub block based on fuzzy systems. In addition, other effects of race, image resolution, and focusing condition on the performance of age estimation will be studied. From the experiments it can be encountered that it can be recommended that age group prediction algorithm could be effectively employed in many applications such as Age- Specific Human Computer Interaction, web application in order to prevent the under- age from, not to have access or from buying the adult contents or materials, and Security and Surveillance system for locating animals. This work can also be focus on testing the video for age estimation.

Abbreviations

ANN Artificial Neural Network

DAQ Data Acquisition

LS Least Square

MAE Mean Absolute Error

References Références Referencias

1. Chang, K.-Y. and Chen, C.-S. (2015). "A learning framework for age rank estimation based on face images with scattering transform." Image Processing, IEEE Transactions on, 24(3):785âA ¸S798, 2015.
2. Md. Abdur Rahim, Md. Najmul Hossain, T.W. M. S. A. (2013). "Face recognition using local binary patterns (lbp)." In Global Journal of Computer Science and Technology, Vol. 13.
3. MS. SWATHI THILAKAN, MS. SABA, M. S. S. K. M. S. V. "Automatic human age estimation system for face images.
4. Rowley, H. A., Baluja, S., and Kanade, T. (1996). "Neural network-based face detection." In Computer Vision and Pattern Recognition, 1996.

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Recognition and Classification of Fast Food Images

By Amatul Bushra Akhi, Farzana Akter, Tania Khatun
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Abstract- Image processing is widely used for food recognition. A lot of different algorithms regarding food identification and classification has been proposed in recent research works. In this paper, we have use an easy and one of the most powerful machine learning technique from the field of deep learning to recognize and classify different categories of fast food images. We have used a pre trained Convolutional Neural Network (CNN) as a feature extractor to train an image category classifier. CNN's can learn rich feature representations which often perform much better than other handcrafted features such as histogram of oriented gradients (HOG), Local binary patterns (LBP), or speeded up robust features (SURF). A multiclass linear Support Vector Machine (SVM) classifier trained with extracted CNN features is used to classify fast food images to ten different classes. After working on two different benchmark databases, we got the success rate of 99.5% which is higher than the accuracy achieved using bag of features (BoF) and SURF.

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Recognition and Classification of Fast Food Images

Amatul Bushra Akhi [α], Farzana Akter [σ], Tania Khatun [ρ] & Mohammad Shorif Uddin [ω]

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I. Introduction

Automatic food identification and calorie estimation become an important issue in last few years because of the negative impact of obesity in our health. Obesity may cause cardiovascular diseases, diabetes mellitus type 2, obstructive sleep apnea, cancer, osteoarthritis, asthma, etc. [1] Researchers said that junk foods and processed foods are responsible for increasing the childhood obesity[2]. Eating extra calories can harm the healthy production and functioning of the synapses of our brain. Fried chicken, pizza, burger, etc. are favorite fast food for both child and adults. People often buy these high-calorie foods to control their appetite especially when they are busy and unable to take their meal in time. Today's people are more conscious about their health issues and try to maintain a healthy diet. Due to the availability of smart phone and computer-aided object recognition techniques become more popular for dietary assessment. Although the identification of food and estimation of its calorie is a very challenging task but many effective steps already have taken in this regards. We also propose an easy but more effective calorie measurement technique that helps people to identify the amount of junk food and snacks they can intake as well as to decide whether the food is harmful or not good for their health. We use both PFID datasets and our own data sets and apply deep neural network with SVM classifier. Deep learning neural networks have multi-layer structure which can easily extract complicated features from input images and supervised learning classifier SVM can efficiently perform a non-linear classification [3]. Our experimental result shows the better performance of CNN with a higher accuracy rate.

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II. Literature Review

Obesity is conceding a great problem in today's life. The preeminent reason of obesity is consuming more calories than we burn which can seriously undermine the quality of life. Researchers says, accurately assessing dietary intake is an important factor to reduce this risk. To meet this exigency, researches have taken some approaches to measure the calorie of a food. In 2009, an extensive food image and video dataset was built named the Pittsburgh Fast-Food Image Dataset (PFID), containing 4545 still images of 101 different food items, such as "chicken nuggets" and "cheese pizza" etc. [1]. The researcher applied Support Vector Machine (SVM) classifier on this dataset and achieved a classification accuracy of 11% with the color histogram method and 24% with the bag-of-SIFT (Scale-Invariant Feature Transform)-features method [2]. Chen et al. (2012) focused on this major issue and proposed a method of food identification and quantity estimation for dietary assessment. They use Gabor and color features to represent food items. A multi-label SVM classifier combined with multi-class Adaboost algorithm is used to show that the new technique can successfully improve the performance of original SIFT and LBP feature descriptors. Around 50 categories (100 sample images of each) of food such as soup, dumplings etc. are used and achieved 68.3% accuracy [3]. Probst et al. (2015) is motivated to introduce another prototype for dietary assessment with the help of smart phone as well as the features of image processing and pattern recognition. Scale invariant feature transformation (SIFT), local binary patterns (LBP), color etc. common visual features are used for espying food images. The bag-of-words (BoW) model is used to perceive the images taken by the phone [4].

Deep learning gradually becomes a very powerful image recognition technique, and CNN is the most popular deep learning architecture. In 2015, Yanai et al. applied deep convolutional neural network (DCNN) technique on ImageNet dataset and achieved accuracy

78.77% for UEC-FOOD100 and 67.57% for UEC-FOOD256 dataset [5]. Kagaya et al., applied CNN on their own dataset for the identification and recognition of the food item. CNN provide higher accuracy than traditional support-vector-machine-based methods where the accuracy rate for recognition was 73.70% and for detection was 93.80% [6]. In 2016, Hassannejad et al. proposed a deep convolutional neural network (DCNN) technique having a depth of 54 layers on UEC FOOD 100, ETH Food-101 and UEC FOOD 256 dataset and achieved 88.28%, 76.17% and 81.45% as top-1 accuracy and 97.27%, 96.88% and 92.58% as top-5 accuracy for dietary assessment [7].Christodoulidis et al. applied a 6-layer deep convolutional neural network on their own dataset containing 573 food items to classify food and the accuracy rate was 84.9% [8]. In 2016, Singla et al., proposed a new method of identifying food/non-food items and recognizing food category successfully using a GoogLeNet model based on deep convolutional neural network. According to their experimental results they achieved a high accuracy rate of 99.2% in food/non-food item classification and 83.6% in food item recognition [9]. Liu et al. [10], propose a new Convolutional Neural Network (CNN)-based food image recognition algorithm and applied it on UEC-256 and Food-101 data sets and achieved 87.2% and 94.8% accuracy respectively. In [11], a five-layer CNN with bag-of-features (BoF) and support vector machine was applied on a dataset containing 5822 images of ten categories and the overall accuracy of 56%. After that researcher applied Data expansion techniques to increase the size of training images for which the accuracy was increased by 90%.

Due to the complexity of food images, many of the previously-proposed methods for food recognition achieved low classification accuracy. In our proposed system we used two training data sets one is publicly available PFID data set another is manually created by us with images captured by smart phone or camera. We use Support Vector Machine (SVM) classifier with a trained CNN to extract and to classify fast food images of ten different classes and achieved accuracy 99.5

III. Dataset

Two benchmark datasets such as Pittsburg Fast-food Image Dataset (PFID) and Food-101 Dataset images are used in this paper to evaluate the accuracy of food recognition. The PFID collection is proposed by Chen et al. is used to measure the accuracy of recognition algorithms consists of 4,545 still images is divided into 101 categories of standard computer vision approach. This dataset of foods each of which is categorized into three instances. For each categories of foods both images and videos are captured in both restaurant conditions and a controlled lab setting. Each instance of each food has four still images in restaurant environment, six still images in the laboratory setting. In Food-101, a challenging data set of 101 food categories, with 101000 real world images in total are introduced. It includes very diverse but also visually and semantically similar food classes where each class consists of 1000 of image among which 250 are manually reviewed test images and 750 are training images.

IV. Methodology

At the very beginning of our experimental method, it is very important to do several preprocessing to make the images ready for work properly. Fig 1 shows the complete methodology of our proposed system.

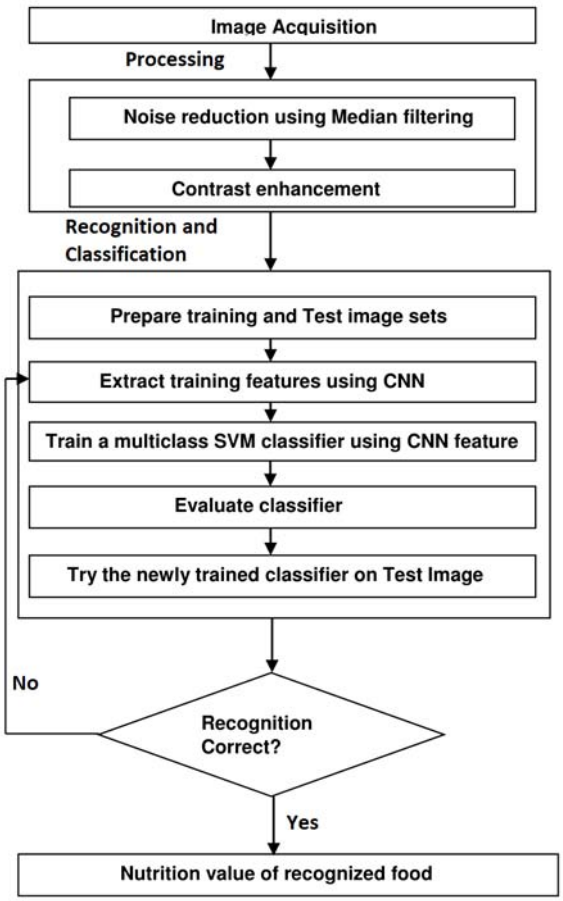

Fig.1: Block diagram of the proposed methodology

a) Preprocessing

A raw image contains of certain factors such as noise, climatic conditions, poor resolution and unwanted background for which it is not suitable enough to classification and identification. So it is important to improve image quality and prepare the image for further processing to detect the object as accurately as possible. In this paper the pre-processing process consists of noise reduction and contrast enhancement.

i. *Noise reduction using median filter*

The contamination of digital image by salt-and-pepper noise is largely caused by error in image acquisition. Thus, noise reduction is essential for the accuracy of further processing. In salt-and-pepper noise a certain percentage of individual pixels in digital image are randomly digitized into two extreme intensities. To remove this kind of noise effectively we use a non-linear median filter which can remove salt and pepper noise without significantly reducing the sharpness of an image.

Fig. 2: Example from Food 101 dataset. Left: Image with 'Salt & Pepper' noise Right: Image after reducing noise with median filter

ii. *Contrast enhancement*

Image contrast is an important factor which is used to evaluate image quality in addition to distinguish one object from another as well as background. In image processing, contrast enhancement is used to improve the appearance of an image for human visual analysis or subsequent machine analysis. It is created by the difference in luminance reflected from two adjacent surfaces as well as the difference in the color and brightness of the object. In this paper, to contrast the test image we use histogram equalization technique.

Fig. 3: Contrast enhancement using histogram equalization

b) Recognition and classification

This section describes the way to recognize the test image classify the image category by using well established deep learning approach called Convolutional Neural Network (CNN). Object recognition using deep learning is one of the most successful object classification techniques and our target is to classify a given image into one of the pre-determined training objects.

i. *Prepare Training and Test image sets*

We have split up the entire dataset into two subsets namely the training set and validation or testing dataset. 30% images were randomly selected for training dataset and the remainder 70% images for test datasets. Our data set is contrived by ten different types of fast food such as chicken wings, chocolate cake, ice-cream, French fries, pizza, hamburger etc. To perform this experiment, we use 1000 images for each categories of food. The training set contains 750 images and testing set contains 250 images for each of the food category. We have trained our classifier engine by using a pertrained CNN as a feature extractor. Some sample images from training dataset are given below:

Fig. 4: Sample images from training data set

Some sample images from our test image set has been given below:

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Fig. 5: Sample images from test data set

ii. *Extract training features using a pretrained CNN*

Convolution neural networks (CNN), a widely used deep learning tools are inspired from the biological structure of a visual cortex. Along with input and output layer CNN consists of multiple hidden layers, such as convolutional layers followed by max-pooling layers, and fully-connected layers. The architecture of a convolution neural networks can vary depending on the types and numbers of layers included.

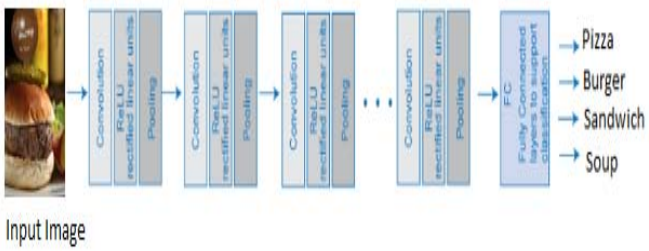

Fig. 6: CNN

In each layer, convolution networks are arranged in 3-D manner to produce a 3-D output from 3-D input. In the first convolutional layer, the neurons are connected to the regions of 3-D input images to transform them into a 3-D output. The hidden units (neurons) in each layer learn nonlinear combinations of the original inputs, which is called feature extraction. The focus is to capture basic image features such as edges and blobs from the beginning layer of the network to extract the feature of the image. These basic image features are preprocessed by deeper network layers to form higher level image features which are better suited for recognition tasks as they are the combination of all the primitive features into a richer image representation. In this work, "ResNet-50" has been used as a pretrained network model loaded using resnet50 function from Neural Network Toolbox in Matlab, trained on the ImageNet dataset, which has 1000 object categories and 1.2 million training images.

We have manipulate this pretrained CNN by changing the initial learning rate lower than the default and the maximum number of stages to 20 for preventing it from over fitting our data. The following figure represent the performance of this fine-tuned network on our data:

Epoch	Iteration	Time Elapsed (seconds)	Mini-batch Loss	Mini-batch Accuracy	Base Learning Rate
3	50	145.73	0.2541	91.41%	0.000100
5	100	289.74	0.1266	98.44%	0.000100
7	150	433.96	0.0398	100.00%	0.000100
9	200	578.37	0.0274	100.00%	0.000100
11	250	722.87	0.0586	99.22%	0.000100
14	300	867.10	0.0300	100.00%	0.000100
16	350	1011.27	0.0304	100.00%	0.000100
18	400	1155.47	0.0170	100.00%	0.000100
20	450	1299.65	0.0081	100.00%	0.000100

Fig. 7: Performance of network on few Epochs

We have resized all the images because net can only work on RGB images which are 224-by-224-by-3. Each and every layer of a CNN produces a response to input images but only few of them are capable for image feature extraction. At the very beginning the layer extract specially the blobs and edges features. Fig 5 displays the network filter weights from the first convolutional network. It gives an illustration about the reason behind well performance of the features extracted using CNN.

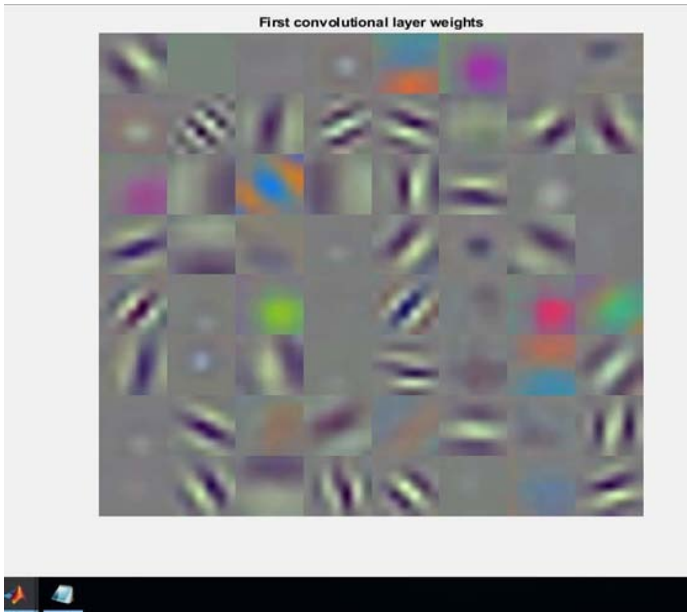

Fig. 8: First convolutional layer weights

The deeper network layer then further process these unrefined features extracted by the first layer and create a richer imager feature representation. These higher level features are more suitable for a recognition task than the first one [15].The easiest way to extract deeper layer features using the activations method in matlab.

iii. *Train Multi class SVM classifier using CNN features*

In this step extracted CNN features are used to train a multiclass SVM classifier. At the very beginning SVM were designed for binary classification which separates the binary classes (k = 2) with a maximized margin criterion [16]. But real life problems sometimes require the classification for more than two categories. These type of problems can be solved by the construction of multiclass SVMs, where we create a two-class classifier over a feature vector $\emptyset(\vec{x},y)$ obtained from the pair consisting of the input features and the class of the data. During the test, the classifier chooses the class,

$$y=\text{argmax}_{y'} \vec{w}^{\top} \emptyset(\vec{x},y') \quad (1)$$

The margin during training is the gap between this value for the correct class and for the nearest other class, and so the quadratic program formulation will require that,

$$\forall_i \forall_y \neq y_i \ \vec{w}^{\top} \emptyset(\vec{x}_i, y_i) - \vec{w}^{\top} \emptyset(\vec{x}_i, y) \geq 1 - \overline{\zeta_i} \quad (2)$$

This general method can be extended to give a multiclass formulation of various kinds of linear classifiers [17].In this work a fast Stochastic Gradient Descent solver is used for training by setting the fitcecoc function's 'Learners' parameter to 'Linear' because this algorithm is specially suitable when training data size is huge. This helps speed-up the training when working with high-dimensional CNN feature vectors [18]. When training deep learning models, the objective function is considered as a sum of a finite number of functions:

$$f(x) = \frac{1}{n} + \sum_{i=1}^{n} f_i \text{ (x)} \quad (3)$$

Where *fi*(**x**) is a loss function depending on the training data instance indexed by *i*. It is important to highlight that the per-iteration computational cost in gradient descent scales linearly with the training data set size *n*. Hence, when *n* is huge, the per-iteration computational cost of gradient descent is very high. [19].

iv. *Evaluate the classifier*

To evaluate the trained classifier, first of all we extract the CNN features from the images of our test set. These test features are then passed to the classifier to calculate the accuracy of the trained classifier.

V. Experimental Result

Our proposed system creates a classifier depending on the extracted features of CNN for identification of the object. The obtained success rate of recognition and classification has been represented using a confusion matrix. A confusion matrix also called an error matrix is a contingency table that comprise of the information about actual and predicted classifications done by a classification system. Fig 10 and Fig 11 shows the confusion matrix that appraises the Accuracy rate of the classification using our algorithm.

Convolution Neural Network Confusion Matrix over BAR Image Set (Accuracy 99.13%)

KNOWN	Burger	Chicken_ Breasts	Chicken_ Nuggets	Chicken_salad	Cake	Pizza	Sandwich	Soup
Burger	1.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00
Chicken_ Breasts	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Chicken_ Nuggets	0.00	0.10	0.70	0.00	0.00	0.00	0.00	0.20
Chicken_salad	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00
Cake	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00
Pizza	0.07	0.00	0.00	0.00	0.00	1.00	0.00	0.00
Sandwich	0.00	0.00	0.00	0.00	0.00		0.90	0.00
Soup	0.00	0.10	0.00	0.10	0.00	0.00	0.00	0.90

PREDICTED CLASS

Fig. 9: Confusion Martix for Barfood 101 image dataset

Convolution Neural Network Confusion Matrix over PFID Image Set (Accuracy 95.78%)

KNOWN	Burger	Chicken_ Breasts	Chicken_ Nuggets	Chicken_salad	Cake	Pizza	Sandwich	Soup
Burger	1.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00
Chicken_ Breasts	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Chicken_ Nuggets	0.26	0.10	0.00	0.00	0.00	0.00	0.00	0.00
Chicken_salad	0.00	0.00	0.03	1.00	0.00	0.00	0.00	0.10
Cake	0.00	0.00	0.00	0.10	0.93	0.00	0.00	0.10
Pizza	0.00	0.00	0.04	0.00	0.00	1.00	0.00	0.00
Sandwich	0.03	0.00	0.00	0.00	0.00	0.00	0.89	0.00
Soup	0.05	0.10	0.00	0.00	0.00	0.00	0.00	0.90

PREDICTED CLASS

Fig. 10: Confusion Martix for PFID image dataset

The entries in the matrix are True Positive (TP) rate, True Negative (TN) rate, False Positive (FP) rate, False Negative (FN) rate for each type of dataset. The accuracy (*AC*) is the ratio of the total number of predictions that were correct. It is derived by the equation:

$$\text{Accuracy} = \frac{TP+TN}{TP+FP+TN+FN} \quad (4)$$

The confusion matrix shows that we get different accuracy but very closer via the same algorithm.We got 99.13% accuracy for Barfood 101 dataset whereas we achieved around 95.79% accuracy over PFID dataset which is higher than the accuracy obtained with Bag of SIFT or Bag of Surf (94%).Fig 12 shows the final output that truly identify a food item.

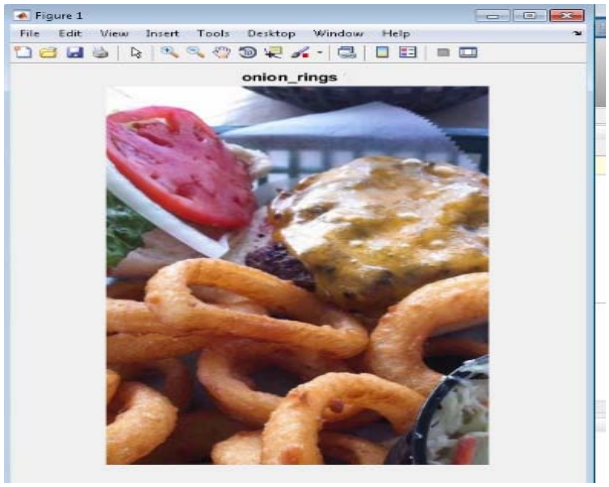

Fig. 11: True recognition of food item

Fig. 13 represents true detected result of sample image and shows an output image for False Negative predicted result. The output image shows this is an onion ring but the sample image contain a hamburger. This error is occurred due to different texture, shape or color feature and lighting effect.

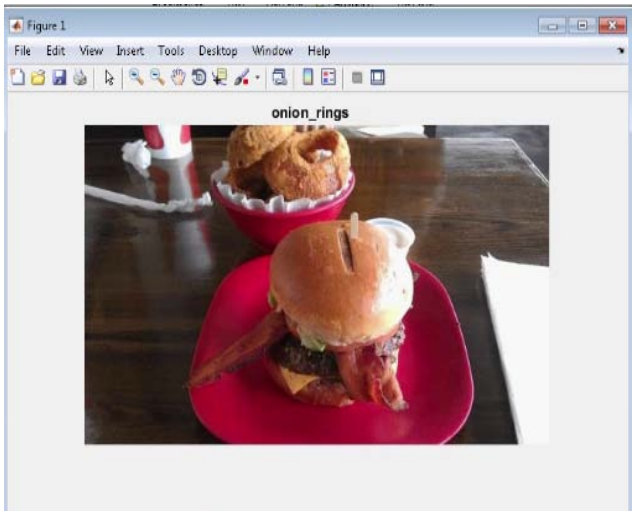

Fig. 13: False positive prediction

VI. Conclusion

In this paper, we proposed a method to classify and to identify high calorie snacks (such as burger, pizza etc.) from the test image to measure the amount of calories has taken. In our experiment we apply CNN in PFID dataset that provides the accuracy 94% which is better than BOF. Also the false positive rate is not so high. People today are very conscious about their health. So, along with the patient, the health conscious person who has a major effect of food calories can be benefitted with this approach. In future, we will try to improve the accuracy by building a robust system which will identify all kinds of snacks more accurately.

References Références Referencias

1. Dixon, J. B. (2010). The effect of obesity on health outcomes. Molecular and cellular endocrinology, 316(2), 104-108.
2. www.google.com
3. www.wikipedia.com
4. Chen, M.; Dhingra, K.; Wu, W.; Yang, L.; Sukthankar, R.; Yang, J. PFID: Pittsburgh Fast Food Image Dataset. In Proceedings of the ICIP 2009, Cairo, Egypt, 7–10 November 2009; pp. 289–292
5. Lowe, D.G. Object Recognition from Local ScaleInvariant Features. In Proceedings of the ICCV'99, Corfu, Greece, 20–21 September 1999; pp. 1150–1157.
6. Chen, M. Y., Yang, Y. H., Ho, C. J., Wang, S. H., Liu, S. M., Chang, E., & Ouhyoung, M. (2012, November). Automatic chinese food identification and quantity estimation. In SIGGRAPH Asia 2012 Technical Briefs (p. 29). ACM.
7. Probst, Y., Nguyen, D. T., Tran, M. K., & Li, W. (2015). Dietary assessment on a mobile phone using image processing and pattern recognition techniques: Algorithm design and system prototyping. Nutrients, 7(8), 6128-6138.
8. Yanai, K., & Kawano, Y. (2015, June). Food image recognition using deep convolutional network with pre-training and fine-tuning. In Multimedia & Expo Workshops (ICMEW), 2015 IEEE International Conference on (pp. 1-6). IEEE.
9. Kagaya, H.; Aizawa, K.; Ogawa, M. Food Detection and Recognition using Convolutional Neural Network. In Proceedings of the MM'14, Orlando, FL, USA, 3–7 November 2014; pp. 1055– 1088.
10. Hassannejad, H., Matrella, G., Ciampolini, P., De Munari, I., Mordonini, M., & Cagnoni, S. (2016, October). Food image recognition using very deep convolutional networks. In Proceedings of the 2nd International Workshop on Multimedia Assisted Dietary Management (pp. 41-49). ACM.

11. Christodoulidis, S., Anthimopoulos, M., & Mougiakakou, S. (2015, September). Food recognition for dietary assessment using deep convolutional neural networks. In International Conference on Image Analysis and Processing (pp. 458-465). Springer, Cham.
12. Singla, A.; Yuan, L.; Ebrahimi, T. Food/Non-Food Image Classification and Food Categorization using Pre-Trained GoogLeNet Model. In Proceedings of the MADiMa'16, Amsterdam, The Netherlands, 15–19 October 2016; pp. 3–11.
13. Liu, C.; Cao, Y.; Luo, Y.; Chen, G.; Vokkarane, V.; Ma, Y. Deep Food: Deep Learning-Based Food Image Recognition for Computer-Aided Dietary Assessment. In Proceedings of the ICOST 2016,Wuhan, China,25–27 May 2016; pp. 37–48.
14. Lu, Y. (2016). Food Image Recognition by Using Convolutional Neural Networks (CNNs). arXiv preprint arXiv:1612.00983.
15. Krizhevsky, Alex, Ilya Sutskever, and Geoffrey E. Hinton. "Imagenet classification with deep convolutional neural networks." Advances in neural information processing systems. 2012.
16. Cortes, C., Vapnik, V.: Support vector networks. Mach. Learn. 20(3), 273–297 (1995).
17. https://nlp.stanford.edu/IRbook/html/htmledition/multiclass-svms-1.html
18. https://www.mathworks.com/help/vision/examples/image-category-classification-using-deeplearning.html
19. http://gluon.mxnet.io/chapter06_optimization/gd-sgd-scratch.html#Stochastic-gradient-descent

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Improvement of Single Seeded Region Growing Algorithm on Image Segmentation

By Mahbubun Nahar, Md. Sujan Ali & Dr. Md. Mijanur Rahman
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Abstract- To form a hybrid approach for image segmentation, several researches have been done to combine some techniques for better improvements. This article is concerned with image segmentation using combined methods.

To separate foreground from background in image the pixel intensities have been considered. For image segmentation region growing with seed pixel is one of the most important segmentation methods. In single seeded region growing, it is very difficult to find out the proper position of the pixel during the selection. By considering the limitation of single seeded region growing an improved algorithm for region growing has proposed. The position of the seed pixel can be chosen before growing the region for segmentation using the proposed technique. Then combine this method with existing single seeded region growing algorithm. After the comparison using segmentation evaluation parameters it can be seen that, this combined method works better than others existing methods.

Keywords: image segmentation, seed pixel, region growing, homogeneity criteria.

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I. Introduction

According to the information technology, an image is a visual representation of something on the Earth. A digital image is a set of pixels that is, comprises of a two dimensional array of individual picture elements called pixels represented in columns and rows. Each pixel expresses an area on surface of the Earth.

Image segmentation can be classified into two ways. First one is edge based segmentation and the second one is region based segmentation. Gray histogram and Gradient based method [1] are the main method of edge based segmentation. Common gradient based method are sobel operator, robert operator, prewitt operator, canny operator, Laplace operator, Laplacian of Gaussian (LOG) operator & so on, canny is the most promising one [2], but computation time is more as compared to sobel operator. The main methods of region based segmentation are region growing [3], region splitting and merging [4], watershed [2], [5]; cluster based segmentation and threshold based segmentation are also included in the region based segmentation method. Clustering [6], [7] based segmentation includes hard clustering or K-means clustering and Fuzzy clustering [8], where the threshold [9] based includes basic global thresholding, optimal thresholding using Otsu's method, multiple thresholding, variable thresholding, and multivariable thresholding.

For most of the image analysis and machine vision applications image segmentation is an essential process, and the seeded region growing (SRG) algorithm is one of the most fundamental methods used in image object segmentation. Region-based algorithms grouped neighboring pixels which have similar values and dividing groups of pixels which are heterogeneous in value. Regions may be grown from manually-positioned `seed' points, for example, selection of seed position by aggregation of pixel values. Research has shown that, seeded region growing was focused primarily on the selection of initial seeds, image object features, and the definition of region homogeneity. The objective of region growing is to map the input image into sets of connected pixels, called regions, according to a predefined criterion which generally examines the features of local groups of pixels. Basically, for image segmentation region growing algorithm is a general technique. The basic scheme consists of joining adjacent pixels to form regions followed by adjacent regions are then merged to obtain larger regions. The association of neighboring pixels or regions in the region growing process is governed by a homogeneity criterion that must be satisfied in order to combine pixels and regions. The homogeneity criterion is application dependent and may be dynamic within a given application. For solving the region growing problem, there are many algorithms in the literature. The performance of a particular algorithm depends on the application area i.e. domain and the image to be segmented [10]. Region based methods rely on the postulate that all neighboring pixels within the one region have similar value or a specific range [11].

Segmentation procedure becomes semi-automatic starting with an interactive seed point selection step, followed by the region growing process [12].

From many segmentation techniques, region growing is one of the easiest and efficient algorithms. In seeded region growing, the seed selection is a challenging process. By considering this limitation a method has been developed where a new seed selection technique is combined with the existing single seeded region growing method. In seed pixel selection process, after smoothing the input image by Gaussian

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filter the image has been divided into sub regions both row and column wise. Following the summation of the pixel intensity of the sub regions independently observe the sub region which have the highest summation values both row and column wise. After choosing a pixel position from the pragmatic region this algorithm has been combined with existing single seeded region growing.

For the experiment purpose an image dataset is taken from Berkeley Segmentation Dataset [13] containing a set of images with training and corresponding ground truth images for experiment and performance evaluations. The objective evaluation can be performed using three performance evaluation parameters. From the experimental results, it is concluded that the proposed method shows better efficiency than the other existing algorithms. In this experiment, the MATLAB 7.10.0 (R2010a) is used to process the images.

II. Seeded Region Growing Technique

a) Seed Point Pixel

Seeded region growing performs the segmentation of an image according to a set of pixels, known as seed pixel. These pixels should be brightest for better segmentation. An ideal candidate seed point should have these properties: i) It should be inside the region and near the centre of the region ii) Assume most of the pixels in the region of interest (ROI) belong to the region, the feature of this seed point should be close to the region average iii) The distances from the seed pixel to its neighbors should be small enough to allow continuous growing [11].

b) Seeded Region Growing Process

Seeded region growing (SRG) method for segmentation introduced by [14], is a simple and robust method of segmentation which is rapid and free of tuning parameters. Seeded region growing is a semi-automatic method of the merge type. User control over the high level knowledge of image components in the seed selection process makes it a better choice for easy implementation and applying it on a larger dataset.

There are two types of seeded region growing. One is *single seeded growing*, in which a single seed pixel is used to grow the region which is chosen manually. Another is *multiple seeded growing*, where a set of seed pixels are used to grow the region.

The growing process starts from a pixel which is known as the seed point initially selected by the user. The pixel can be chosen based on either its distance from the seed point, features of the image or the statistical properties of the neighborhood. Then each of the 4 or 8 neighbors of that pixel are visited to determine if they belong to the same region. This growing expands further by visiting the neighbors of each of these 4 or 8 neighbor pixels. This recursive process continues until either some termination criterion is met or all pixels in the image are examined. The result is a set of connected pixels determined to be located within the region of interest.

Seeded region growing approach to image segmentation is to segment an image into regions with respect to a set of q seeds as presented in [12] is discussed here. Given the set of seeds, S1, S2, …., Sq, each step of SRG involves identifying one additional pixel to one of the seed sets. Moreover, these initial seeds are further replaced by the centroids of these generated homogeneous regions, R1, R2, ……, Rq, by involving the additional pixels step by step. The pixels in the same region are labeled by the same symbol and the pixels in variant regions are labeled by different symbols. All these labeled pixels are called the allocated pixels, and the others are called the unallocated pixels [15].

c) Homogeneity Criteria

Success of region grow algorithm depends on the initial seed selection and criteria used to terminate the recursive region grow process. Hence choosing appropriate criteria is the key in extracting the desired regions. In general, these criteria include region homogeneity, object contrast with respect to background, strength of the region boundary, size, conformity to desired texture features like texture, shape, color [11]. In our work this criteria pay a dominant rule.

d) Limitations

Though region growing is effective for noisy image, the seeded region growing has a great drawback. This is the difficulty in initial seed selection. It is because, the selection of seed pixel during region grow process leads to different final segmentation results. That is why the process is time consuming if the effective pixel is not selected. In this article it has been analyzed and proposed an algorithm where the effective seed pixel can be selected.

III. Proposed Approach

In this research, an improved algorithm has been proposed for seeded region growing in image segmentation. The proposed improved algorithm is worked with single seed pixel. The seed pixel has chosen through a new technique. Then grow the region using existing region growing technique. The flowchart of the overall work is given in Fig. 7. The total procedure is described below.

a) Seed Selection using New Technique

In seeded region growing, the seed pixel should be selected before the regions grow. The seed selection procedure using the new technique is given below:

1. Consider the input image as one region.
2. Divide the total image region into three sub-region row wise and column wise respectively.
3. Calculate the summation of the pixels of each region both row wise and column wise.
4. Select a region where the summation of the pixels is maximum both row and column wise.
5. Select the seed pixel position manually from the selected region.

The following example shows the total process of seed position selection by selecting the region with maximum pixels value. Fig. 1(a) shows the pixels of original image, (b) shows the row wise division of the total image region, the summation of the pixel intensity values of each row wise sub-regions is shown in (c), (d) shows the selection of maximum valued sub-region from row wise calculation, where (e) shows the column wise division of total image region, the summation of the pixel intensity values of each column wise sub-regions is shown in (f), the selection of maximum valued sub-region from column wise calculation has shown in (g) and (h) shows the region which is selected finally after row and column wise selection. For growing the region a pixel's position has been selected for seed from the selected region.

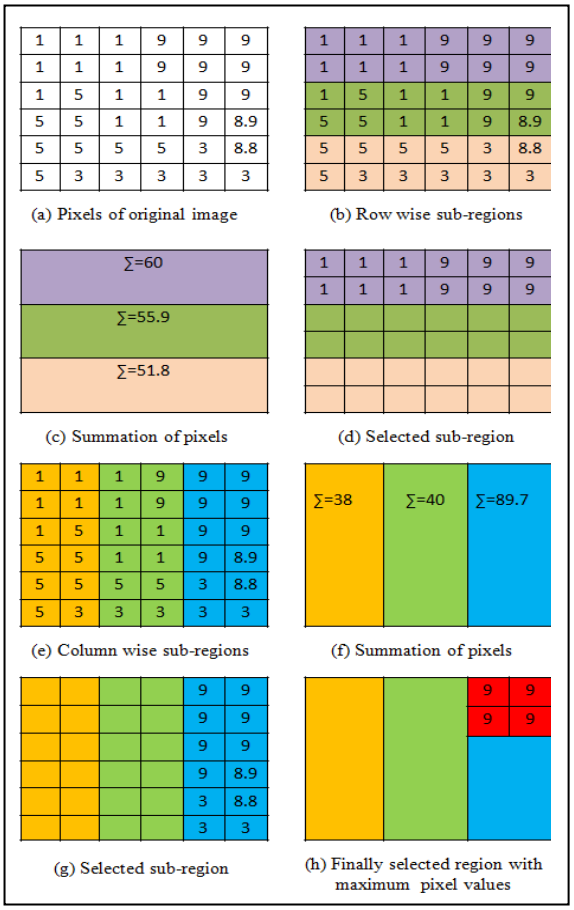


Fig.1: Seed pixel selection process

b) Set up Homogeneity Criterion

In region growing technique, the region growing depends on a homogeneity criterion which is used to set up the stopping rule. In the proposed method, the difference between a pixel's intensity value and the region mean (δ) is used for homogeneity criterion. If the value of δ is less than a certain threshold then the pixel is under consideration and added to the growing region otherwise excluded from consideration. For the threshold value 0.2 has to be used.

c) Region Growing Process

For the segmentation of the image the region growing process is described below through an example. Fig. 2(a) shows the pixel values of the smoothed image with the seed pixel. By using the homogeneity criteria the neighboring pixels of the initial seed points can be checked. If the neighbor pixel values met the homogeneity criteria, they can be added to the growing region. It is going on until the value of δ is less than a certain threshold, which is 0.2 for the proposed algorithm. To grow the region by growing the neighboring pixels the 4-connected neighborhood is used in proposed method.

d) Proposed Algorithm

The proposed algorithm mainly segments the foreground from an image. The algorithm works with spatial domain of the input image. The improved algorithm for single seeded region growing is shown in below:

Step 1: Smooth the input image using Gaussian filter.

Step 2: Select the seed pixel by the following steps:

a) Divide the smoothed image into three regions row wise and column wise.
b) Calculate the summation of the pixel intensities of each region separately for both row and column wise.
c) Find out the two maximum summation values from both row and column wise grouped region.
d) Select a pixel position from the maximum summation valued regions.

Step 3: Set up a stopping rule by selecting a certain homogeneity criterion.

Step 4: According to the criterion grow the region by adding similar neighbouring pixels.

Step 5: When no more pixels met the criterion stop growing for inclusion that region.

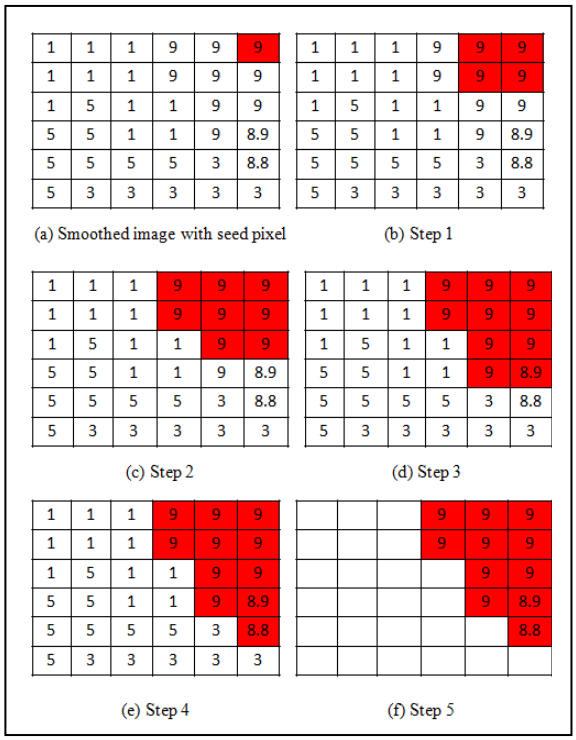


Fig. 2: Region growing process using proposed method

IV. Experimental Results and Analysis

Segmentation procedure becomes semiautomatic starting with an interactive seed point selection step, followed by the region growing process [12]. In this paper an image dataset is taken from *Berkeley Segmentation Dataset* [13] containing a set of images with training and corresponding ground truth images for experiment and performance evaluations. The objective evaluation can be performed using three performance evaluation parameters. Through these parameters it can be shown that the proposed method has better performance. For the performance evaluation we use several sample images. For the experiment, all the methods and algorithms are implemented in MATLAB 7.10.0 (R2010a) toolbox for processing the images.

a) Segmentation Evaluation Parameters

Yet a reliable way cannot be found in performance evaluation for quantitatively measure the state of different image segmentation techniques. In previous works, segmentation performance can be evaluated through subjectively or objectively judging on several sample images [16]. In this paper, three segmentation performance evaluation parameters have been studied. These are rand index (RI), global consistency error (GCE), and variations of information (VoI).

i. *Rand Index (RI)*

The greater the Rand Index value the better the segmentation is. The equation for rand index is as follows [16].

$$RI = \frac{a+b}{a+b+c+d} = \frac{a+b}{\binom{n}{2}} \quad (1)$$

Where, a + b means the number of agreements between X and Y and c + d means the number of disagreements between X and Y.

ii. *Global Consistency Error (GCE)*

If the global consistency error value is smaller the segmentation performance is better. The equation for global consistency error (GCE) is as follows [16].

$$GCE = \frac{1}{n} min\left\{\sum_i E(S_1, S_2, pi), \sum_i E(S_1.S_2, pi)\right\} \quad (2)$$

Where, segmentation error measure takes two segmentations S_1 and S_2 as input, and produces a real valued output in the range [0::1] where zero signifies no error.

iii. *Variations of Information (VoI)*

For the better segmentation performance of an image the variations of information should be low. The equation for variations of information is as follows,

$$VI(X;Y) = H(X) + H(Y) - 2I(X,Y) \quad (3)$$

Where *H*(*X*) is entropy of *X* and *I*(*X*,*Y*) is mutual information between *X* and *Y*. VI(X,Y) measures how much the cluster assignment for an item in clustering X reduces the uncertainty about the item's cluster in clustering Y.

b) Analysis of the Experimental Result

The segmentation result has been evaluated hrough two ways. These are *objective evaluation* and *subjective evaluation*. The comparisons between different segmentation techniques have shown in the Table 1, which is the objective evaluation. The subjective evaluation of the different segmentation techniques is shown in Fig.4. From the experimental result analysis and evaluation, it is concluded that the proposed algorithm has the best overall performance with the above mentioned parameters.

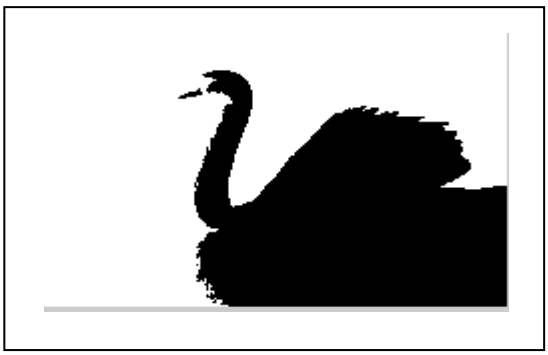
i. *Subjective Evaluation*

In this research, the subjective evaluation has been performed through the visual comparison of different types of segmentation algorithm. The comparison has been performed between the segmented images. Fig. 3 shows the original image, and Fig. 4(a)-(f) show the segmented images of the original image using different segmentation techniques with the proposed one.

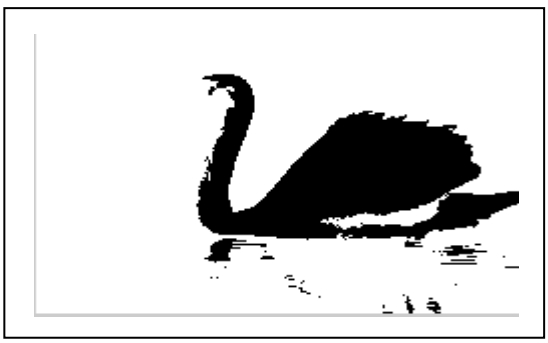
The experiment is also done with noisy image. Fig. 5 shows the input image with noise. The output of different segmentation techniques with proposed one have shown in Fig. 6, where 6(c) shows the proposed method and rest show the other methods.

Fig. 3: Original Image

(a) Otsu's Thresholding

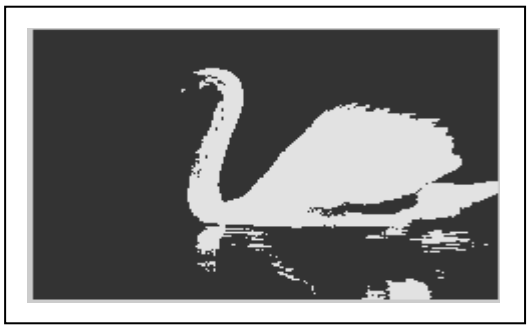


(b) Existing seeded Region Growing



(c) Proposed

(d) Watershed



(e) K-mean clustering

(f) Region Splitting and Merging

Fig. 4: Segmented images of the original image using different segmentation techniques and proposed algorithm

Table I : The Comparisons Between Different Image Segmentation Techniques

Parameters / Methods	Rand Index (RI)	Global Consistency Error (GCE)	Variation of Information (VoI)
Otsu's thresholding	0.54123	0.31011	2.11010
Existing Single seeded Region Growing	0.49996	0.30955	2.26006
Proposed	**0.54641**	**0.31005**	**2.08395**
Watershed	0.32012	0.30818	7.63398
K-mean Clustering	0.54167	0.31011	2.10854

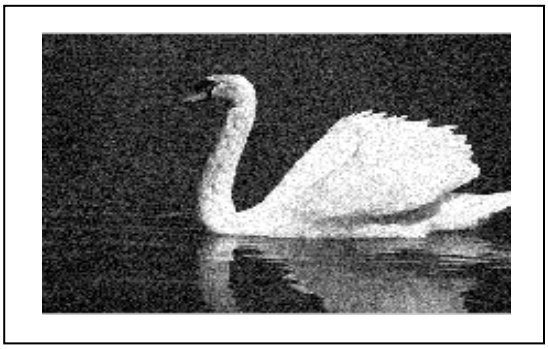
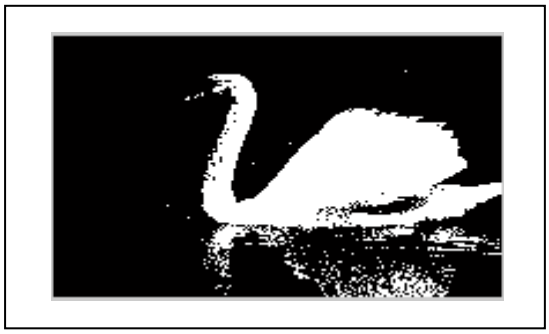
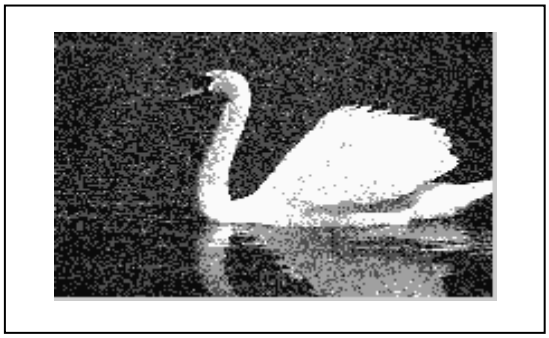


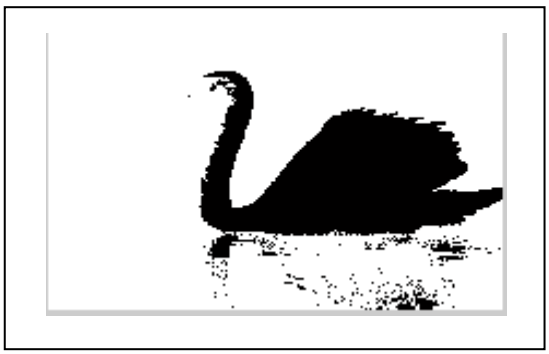
Fig. 5: Original Image with noise



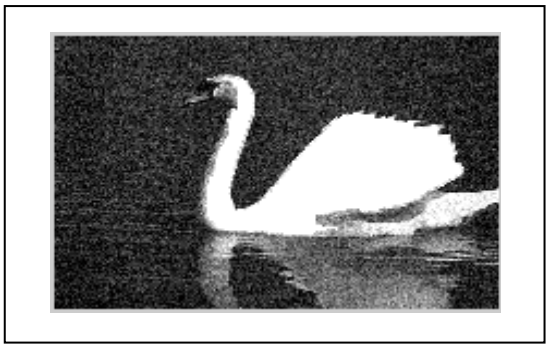
(a) Otsu's Thresholding



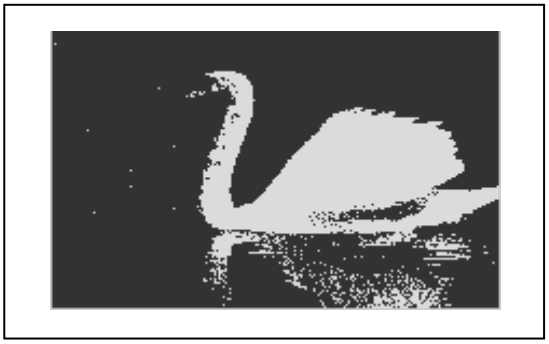
(b) Existing Seeded Region Growing



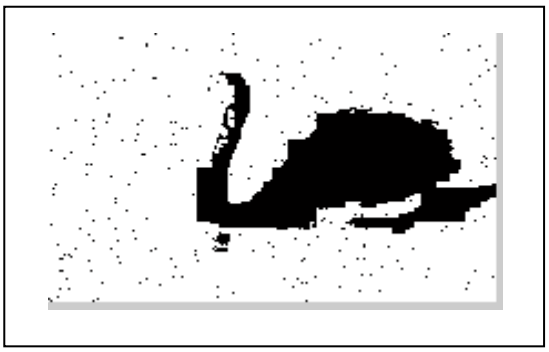
(c) Proposed



(d) Watershed



(e) K-mean clustering



(f) Region Splitting and Merging

Fig. 6: Segmented images of the noisy original image using different segmentation techniques and proposed algorithm

ii. *Objective Evaluation*

In this research, the objective evaluation has been performed using three segmentation evaluation parameters such as rand index, global consistency error, and variation of information. It is known that for the better segmentation performance the rand index should be high and the other two should be low. Table 1 shows the comparison of various segmentation techniques using the segmentation evaluation parameters. In the proposed method, it is seen that the segmentation evaluation parameters that is the rand index value is high, global consistency error value is low, and variation of information value is low than the other techniques.

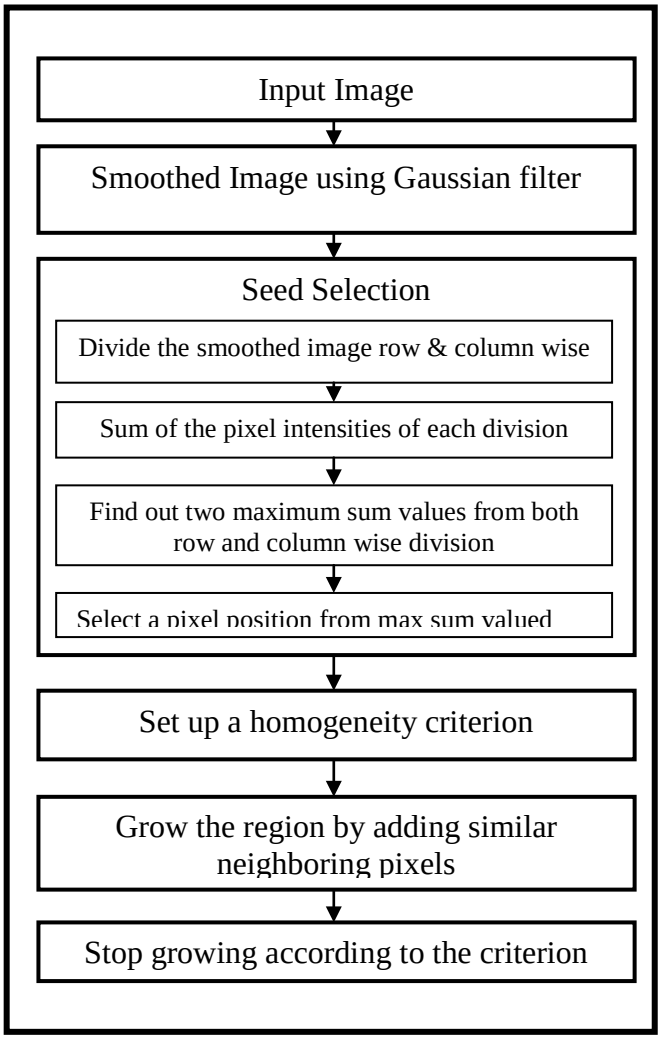


Fig. 7: The block diagram of the methodological steps of our research works

V. Conclusion

It is known that not all methods are equally good or efficient for a particular type of images and particular method is not good or efficient for all images. In this research, the images which background intensity value is less than the foreground intensity value are used for experiment. The proposed algorithm works with such kind of images efficiently. Since many researchers has been worked to form hybrid (combined two or more than two existing methods) methods for image segmentation, a hybrid method is described in this article; where the single seeded region growing algorithm is combined with proposed seed selection technique.

The performance of proposed algorithm is effective such kind of image which foregrounds pixel's intensity value is higher than the background. The proposed method is very similar to existing single seeded region growing exception with seed selection method. The experimental images has taken from the Berkeley Segmentation Dataset [13] containing a set of images with training and corresponding ground truth images.

From the investigation, it has been shown the efficiency of proposed method for segmentation is better than others. The proposed algorithm also works better with noisy image. The proposed region based method is efficient to identify the blood vessels in MRA and CTA volume data.

In future a hybrid method would be implemented by combining the K-mean clustering and multiple seeded region growing methods. The performance and efficiency may better than others.

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References Références Referencias

1. W. X. Kang, Q. Q. Yang, R. R. Liang, "The Comparative Research on Image Segmentation Algorithms", IEEE Conference on ETCS, pp. 703-707, 2009.
2. Rafael C. Gonzalez, Richard E. Woods, "Digital Image Processing", 2nd ed., Beijing: Publishing House of Electronics Industry, 2007.
3. Zucker, S.: Region growing: Childhood and adolescence. Computer Graphics and Image Processing 5 (1976) 382–399.
4. S.Aksoy,"Image Segmentation", Department of Computer Engineering, Bilkent Univ.
5. http://disp.ee.ntu.edu.tw/meeting/%E6%98%B1%E7%BF%94/Segmentation%20tutorial.pdf.
6. Yang Yang, Yi Yang, Heng Tao Shen, Yanchun Zhang, Xiaoyong Du, Xiaofang Zhou," Discriminative Nonnegative Spectral Clustering with Out-of-Sample Extension", Digital Object Indentifier 10.1109/TKDE.2012.1181041-4347/12/$31.00 © 2012 IEEE.
7. J. Senthilnath, S. N. Omkar, V. Mani, Tejovanth N, P.G Diwakar, and Archana Shenoy B," Hierarchical Clustering Algorithm for Land Cover Mapping Using Satellite Images", IEEE JOURNAL OF SELECTED TOPICS IN APPLIED EARTH OBSERVATIONS AND REMOTE SENSING, VOL. 5, NO. 3, JUNE 2012.
8. H.P. Narkhede, "Review of Image Segmentation Techniques", International Journal of Science and Modern Engineering (IJISME), ISSN: 2319-6386, Volume-1, Issue-8, July 2013.

9. Y. Zhang, H. Qu, Y. Wang, "Adaptive Image Segmentation Based on Fast Thresholding and Image Merging", Artificial reality and Telexistence-Workshops, pp. 308-311, 1994.
10. A.B.M. Faruquzzaman, Nafize Rabbani Paiker, Jahidul Arafat, M. Ameer Ali, "A SURVEY REPORT ON IMAGE SEGMENTATION BASED ON SPLIT AND MERGE ALGORITHM", Journal of Advanced Computations, Vol: 2, No: 2, 086 – 101, IETECH Publications, 2008.
11. M. M. Abdelsamea, "An Automatic Seeded Region Growing for 2D Biomedical Image Segmentation ", 2011 International Conference on Environment and BioScience.
12. Jianping Fan, Guihua Zeng, Mathurin Body, Mohand-Said Hacid. Seeded region growing: an extensive and comparative study. Pattern Recognition Letters 26 (2005), 1139–1156.
13. https://www.eecs.berkeley.edu/Research/Projects/CS/vision/bsds/
14. R. Adams and L. Bischof. Seeded region growing. IEEE Trans. Pattern Analysis Machine Intelligence, 16(6): 641–647, Jun 1994.
15. Harikrishna Rai G.N, T. R. Gopalakrishnan Nair, "Gradient Based Seeded Region Grow method for CT Angiographic Image Segmentation".
16. Manisha Sharma, Vandana Chouhan,"Objective Evaluation Parameters of Image Segmentation Algorithms", International Journal of Engineering and Advanced Technology (IJEAT) ISSN: 2249 – 8958, Volume-2, Issue-2, December 2012.

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Review on Motion Capture Technology

By Rahul M

Abstract- In this paper we provide the reader with a overview of what is motion capture, its history and evolution so far and processes used in acquiring the tri-dimensional data of the recorded scene, take or animation. A brief look at the "mocap" process's (short for motion capture) structure is given followed by an extensive list of the technologies behind the most popular systems used today. We dive into the inner works of acoustical, mechanical, magnetic and optical mocap systems, also discussing the differences between active, passive and marker less optical systems, since these are the most popular of the above referred. Later on we also provide some insight into facial motion capture, right after we compare the data acquisition systems and quickly overview the generic data file structure. Finally we provide examples of real-world applications and some possible research fields in the area along with our conclusions.

Keywords: *motion capture, movement reconstruction, markerless capture.*

GJCST-F Classification: *I.2.10*

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Review on Motion Capture Technology

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I. Introduction

Animation gave its first steps in the early 20th century, when in 1911, cartoonist Winsor McCay drew a character in multiple sheets of paper with slight changes between these and then sampled them at a constant rate to create the illusion of motion .

Animation processes did not witness considerable innovation until computers started to take place in the process. With the birth of keyframing, which reduced the amount of samples needed to create an animation animators saw their work a lot more simplified. This process was time consuming because, at the time, every artist was forced to individually animate each pose/frame. With the introduction of keyframing the artist specified the initial and ending frames of the animation and the intermediate frames of the movement where automatically generated. However some animations were still impossible to recreate due to their inherent complexity, for example the human walking animation, which is terrifyingly complex due to our articulations.

To speed up the animation process further, motion capture was invented, a means by which we capture the movements of objects in the real world and then insert the data of the captured movement in a tri-dimensional model of the world in a virtual environment. The process first evolved with mechanical systems that were quite cumbersome and limited the amount of freedom the actor could experience, limiting severely the animation spectrum that could be captured. This happened mainly because these were mechanical systems that resorted to very restrictive suits and large amounts of cable that hindered the actor's movements. They include acoustical, mechanical, optical and magnetic systems, further divided in marker and markerless systems.

[1] Today, motion capture is widely used in the gaming, movie and animation industry as a means to provide quick, budget adapting body and/or facial animations in order to animate one or various characters. We provide insight into these methods and processes, and also the data processing and data formats that most systems use. Lastly we introduce some future work and research in motion capture. Research we believe would be highly beneficial and would enable future developments and breakthroughs in the area.

II. Literature Survey

[1] Freedman Y presented a system for person-independent hand posture recognition against complex backgrounds cues. It has a specific color i.e. the color of skin and it moves in the image with a characteristic speed. There are many more high level cues, such as the form, texture or specific trajectory which characterize a moving hand. However, in order to be fast and robust, it sticks with the simplest approach that still does the job.

From the literature survey, it is observed that the reported work motion capture do not perform effectively because motion capture is done inside a room if you want to capture a motion in outdoors it is highly expensive and time consuming because of the climate condition, localization and is less efficient. The background subtraction technique is proposed to enhance the motion tracking and detection. Also, the hardware implementation on STM32 ARM processor is done. The correlation extractor integrates the human motion (video) as input and the correlated output samples are extracted using unsupervised trained weights. The use of Karhumen – Loeve Transform (KLT) is optimal in terms of compactness of representation. However, KLT requires more pre-processing stages and hence, as an alternative Discrete Cosine Transform (DCT) which helps images to transform into parts is preferred in this research. Also, DCT closely approximates KLT in the context of information packing.

[3] Furniss, Maureen, presented human face recognition that do not operate directly on the reflectance of light from a face (i.e. the pixel intensity values). Instead, the primate visual system extracts visual features that are in turn processed clearly. It

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inspired machine object recognition systems, Gabor filters have been used to simulate these human visual features. Similar texture features such as local binary patterns and histograms of orientation gradients serve the same function, but they are more in tune with the discrete nature of digital images.

III. Techniques

There are different techniques in motion capture technology some of the frequently used techniques are Mechanical motion capture, Magnetic motion capture, Magnetic motion capture

a) Mechanical Motion Capture

[3] This technique of motion capture is achieved through the use of an exoskeleton. Each joint is then connected to an angular encoder. The value of movement of each encoder (rotation) is recorded by a computer that by knowing the relative position encoders (joints) can rebuild these movements on the screen using software. An offset is applied to each encoder, because it is very difficult to match exactly their position with that of the real relationship. The below figure describes [3.4].

Fig. 3.1: Mechanical Motion Capture using Exo skeleton

Merits and Demrits of Mechanical Motion Capture

This technique offers high precision and it has the advantage of not being influenced by external factors (such as quality or the number of cameras for Optical MOCAP).

But the catch is limited by mechanical constraints related to the implementation of the encoders and the exoskeleton. It should be noted that the exoskeleton generally use wired connections to connect the encoders to the computer. For example, there is much more difficult to move with a fairly heavy exoskeleton and connected to a large number of simple son with small reflective sphere. The freedom of movement is rather limited.

The accuracy of reproduction of the movement depends on the position encoders and modelling of the skeleton. It must match the size of the exoskeleton at each morphology. The big disadvantage comes from the coders themselves because if they are of great precision between them it cannot move the object to capture in a so true. In effect, then use the method of optical positioning to place the animation in a decor.

b) Magnetic Motion Capture

Magnetic motion capture is done through a field of electro-Magenta is introduced in which sensors are coils of sensors electrics, Les son are represented on a place mark in 3 axes x,y,z. To determine their position on the capture field disturbance created by a son through an antenna then we can know its orientation. The below figure describes [5].

Fig. 3.2: Magnetic Field Transmitter Source

Merits and Demerits of Magnetic Motion Capture

1. The advantage of this method is that data captured is accurate and no further calculations excluding from the calculation of position is useful in handling.
2. But any metal object disturbs the magnetic field and distorts the data.

c) Optical Motion Capture

The capture is based on optical shooting several synchronized cameras, the synthesis of coordinates (x, y) of the same object from different angles allows to deduce the coordinates (x, y, z). This method involves the consideration of complex problems such as optical parallax. Distortion lens used, etc. The signal thus undergoes many interpolations. However a correct calibration of these parameters will help in high accuracy of data collected. To determine their position on the capture field disturbance created by a son through an antenna then we can know its orientation. The above figure describes [3].

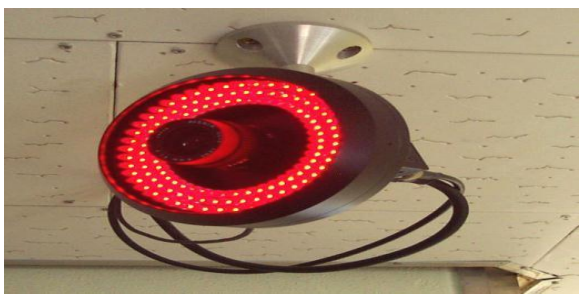

Fig. 3.3: Camera emitting Infrared Radiations

The operating principle is similar to radar: the cameras emit radiation usually infrared, reflected by the markers and then returned to the same cameras. Checking the information of each camera (minimum two cameras) to determine the position of markers in virtual space.

IV. Applications of Motion Capture

a) Advertising

There are many areas that can benefit from the use of motion capture. [1] In 1984, the first animation of a character using this technique was made in a publicity action commissioned by association of the largest producers of canned food of The United States. The animation turned into the ad called Brilliance, or Sexy Robot, which was broadcasted on the Super Bowl Championship, in 1985. The use of this technology, although impressive, even took some time to be used widely in the area of communication, gaining strength in the late 90's, when the technologies were more efficient and accessible.

b) Entertainment

[1] Between the mid to late 80's and early 90's, the technology was being enhanced and applied more often on entertainment projects, being widely used in real-time animations for television — in 1991, a French producer called Media lab, developed for a TV show the character "Mat, the ghost", which was daily broadcasted for more than three years in appearances of a minute. In that same year the Terminator II movie was launched, using the technique to animate the character T-1000, a robot made of liquid metal. Although this would not be the first use of the technique in the film, it was the first use of motion capture in a relevant character. Currently, the cinema is still one of the biggest industries that makes use of this technique. The videogames also had a representative role in using the motion capture. In the 90's this media was responsible for most of the use of motion capture for animation, keeping its current use for entertainment. Even today, many highly qualified technical and artistically games use motion capture, being also employed in digital games consoles such as Nintendo Wii, Xbox and Playstation EyeToy, carrying the players ' movements into the games.

c) Health

[5] This field is a largely benefited by motion capture processes. One of the main areas served by this technology is biomechanical analysis, which can be used to verify the conditions of a person requiring prosthesis. The motion capture can analyze how a person performs his movements and where he exerts more strength in order to identify points in the body where any workload is happening, thus providing data for the construction of custom prostheses for each person and an unprecedented analysis on the progress of rehabilitation work.

d) Sports

The motion capture can be used to analyze the performance of athletes, providing information about the way people move; allowing them to improve their performance by recognizing its gaps. The capture works out in a specific situation, analyzing a certain athlete, and in a general aspect, analyzing the performance data of all athletes involved in a match.

V. Conclusion

Mocap systems, as shown throughout the paper, have evolved from simple, highly restricting, user un-friendly systems (software wise), to very mobile and specialized ones. The types of system discussed clearly all have their optimal case scenarios for deployment. However, optical mocap has evolved much more than its brethren systems. This is, for the most part, due to its ability to adapt very well to the major requirements of the film and videogame industry, which have invested and thus aided in this technology's development. Despite its advantages, there are still improvements that can be done in this field (some of which proposed in the Future Research section). Other than these improvements, some mocap systems are still very limited in terms of the area where they can capture movements, being restricted to adapted warehouses or studios. These systems are also very high budget, which, in some cases, rules them out of question. They could benefit from lower budget versions, more accessible by the public and smaller companies.

a) Direction For Future Work

i. *Captured Movement Modification:* Since every data file represents a limited and closed data set of animations these cannot be manipulated after the caption process. An interesting field of research would be how to modify or derive new movements from an already captured movement. Captured Movement Fusion and Concatenation: As an extension to the research field one could try to create a fusion of any number of movements or concatenate them in order to create new movements from these original ones.

ii. *Improvements in Actual Tracking Techniques:* As discussed, marker occlusion in optical mocap systems is critical. Improved tracking techniques could be developed to eliminate this problem.

iii. *Marker Mapping Techniques for Non-Human Beings:* Sometimes we want to capture movements that don't belong to human beings. Studying how to position the markers in the most effective way in these beings could prove beneficial, especially if the procedure could adapt itself to every object, thus becoming general and optimal.

iv. *Transference of motion captured animations between models:* Although mocap is somewhat

transferable between models there are still a lot of limitations as to which animations can be transferred, given the source and destination model. For example, the animation of a normal person cannot be transferred to a giant, since by physical laws they move in a very different manner, or between models with very different body constitutions.

v. *Improvements in Actual Tracking Techniques:* As previously discussed, marker occlusion in optical mocap systems is critical. Improved tracking techniques could be developed to eliminate this problem.

Contribution

This paper explores the different motion capture techniques which are used in several field for the capture of motion. These techniques provide invisible patterns which can be used for capturing motions.

In the introduction section we are providing the information about what motion capture is, it's origin, history, and how motion capture can be used in different fields. In literature survey we highlight the research work done by various researchers on motion capture technology. We discuss different techniques that are used in motion capture, applications of motion capture and how motion capture is implemented in different fields. Motion capture techniques are effective approach to the latest and indefinite patterns in the data. The motion which is obtained can be used by animators which can be used in different filed to get better results. Finally we conclude various implications and significance and applications of using motion capture technology.

References Références Referencias

1. Freedman, Y., "Is It Real …or Is It Motion Capture? The battle to Redefine Animation in the Age of Digital Performance ", Velvet Light Trap: A Critical Journal of Film & Television, 2012.
2. Kopniak P. Java wrapper for Xsens motion capture system SDK[C].//Human System Interactions (HSI), 2014 7th International Conference on. IEEE, 2014.
3. Furniss, Maureen, "Motion Capture", MIT Communications Forum, 2004.
4. Menache, Alberto, "Understanding motion capture for computer animation and video games", Morgan Kaufmann, 2000.
5. Margaret S. Geroch. Motion capture for the rest of us. J. Comput. Small Coll., 2004.
6. Jessica Hodgins. Animating human motion. Scientific American, 278(3), March 1998.

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Visualization of Multi-Service System Network with D3.Js & Kdb+/q using Websocket

By Ali Asgher Kapadiya

Abstract- Visualization of the complex web of services running in a multi-service system using D3.js as the frontend, Kdb+/q as backend and WebSocket & JSON for communication.

Keywords: *multi-service systems, visualization, Kdb+, q, D3.js, websocket, JSON, SVG.*

GJCST-F Classification: *C.2.1*

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Visualization of Multi-Service System Network with D3.Js & Kdb+/q using Websocket

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I. Introduction

Data visualization is everywhere. In the past decade, the JavaScript world has evolved multiple folds. A lot of JavaScript frameworks provide visualization analytics that brings the information to life. It has moved from the world of bar charts and scatter plots to a lot of other interactive charts which are now used heavily like Gauge charts (dial charts) in risk systems, Spider charts (radar charts) to compare the multivariate data, etc.

One important aspect these JavaScript frameworks provides is the visualization of the relationship between the data. For example, during the investigation of Panama Papers, the ICIJ network used Linkurious.js [1]. This JavaScript library provided a simple and powerful way to visualize the graph database generated by Neo4j from more than 11.5 million documents, representing around 2.6 terabytes of data, enabling the investigators to uncover the potential stories in a short time frame.

There are multiple JavaScript frameworks available for data visualization D3.js, Linkurious.js, Processing.js, Raphael.js to name a few. The comparison of these visualization frameworks is beyond the scope of this paper.

a) Motivation

The idea of this paper is to visualize the complex network of the multi-service system (having 100s of services serving different functionalities) using the WebSocket and JSON for communication. This visualization can help the developers/maintenance team to understand the complexity of the system and analyze the flow of information between the services.

In this paper, we are going to visualize the complex web of Kdb+/q services in a typical financial institution using the D3.js as a visualization tool. However, any system publishing the events to a centralized service supporting the WebSocket and JSON can easily be integrated with the D3.js implementation we are going to discuss in this paper.

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b) D3.js

D3.js (D3 or Data-Driven Documents) created by Mike Bostock [2], is one of the JavaScript frameworks which uses the browser capabilities for producing interactive visualizations. It works perfectly with the DOM (Document Object Model) and is widely used on websites across the world for displaying the data in interactive graphical components.

In general, there are two different ways to create and visualize the graphical components:

- SVG - Remembers the objects in a DOM and enables the event handlers to be associated with objects.
- Canvas - Renders the objects to a picture, but highly performant while handling a large number of objects.

c) Kdb+

Kdb+ is column-oriented, in-memory database known for its high-performance in the financial world. It was created by Arthur Whitney and is now one of the highly suitable databases for real-time time-series data analytics and is capable of handling millions of records effectively. The 32-bit version is free to download and use from https://kx.com/.

Kdb+ is used for tick data and analytics platform in investments banks, hedge funds, etc. for various real-time analytics, P&L, risk assessment, best execution and regulatory purpose. It is slowly making its way to other fields like life-sciences, gaming, space, etc [3]. A typical Kdb+ platform has evolved to hundreds of q services serving a different functionality like data capture, in-memory database, historical database, real-time calculation, user query gateways, etc.

II. Process Visualizer

There are two main components we are going to discuss in this paper. We will be using the term Process and Service interchangeably in this paper.

a) Monitor process

It is a centralized service containing the information of all the processes and connections among those processes. In this paper, it has been implemented in Kdb+ however it can be implemented in any other programming language and for any system having the complex web of connections.

b) D3 Process visualizer

Implemented using D3.js framework for the visualizing the service network.

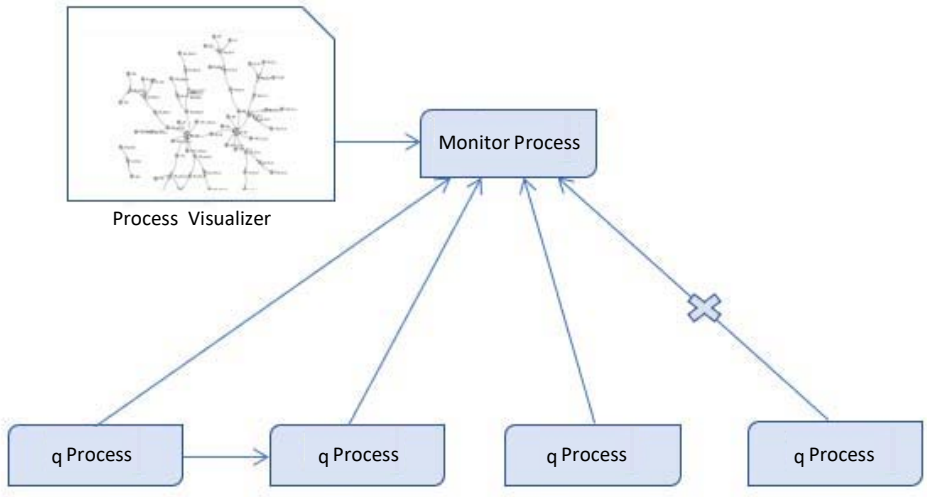

Fig. 1: High-level diagram

III. Data Structure

Following are the data structures we are going to use in this paper.

Node: A node is a point in the network that holds some properties. In our example, we are going to represent each Kdb+ service as a node in the network with two attributes 'prc' (process name) and 'grp' (process group).

Link: An edge or a link represents a connection between two nodes. In our case, a link is representing a q/Kdb+ process connection to another q/Kdb+ process.

IV. Monitor Process

A Kdb/q process that acts as centralized service and has information of all the q processes running in the system and the connection between these q processes or to the users or the third-party apps. The appendix contains the full code for the monitor process. There are three main functionalities of a q monitor service.

- Monitoring - Listening all process/connection events
- Subscriptions - Maintaining the list of subscribers
- Notification - Notifying the subscriber about any addition/deletion of process/connections

a) Monitoring functionality

Following are the functions through which the Monitor service cab be notified about any process/connection addition/drop.

- Add Prcocess

Any service when it comes up needs to notify the monitor process about its name and meta using this function.

- Add Connection

When a process is requested for a connection from some other process, user or third-party app, the process can inform the monitor service using the add Connection method.

- Drop Process

This function can either be called from a process which is gracefully shutting down or can be called by monitor process connection handler after detecting the disconnection.

- Drop Connection

This function will be called when a q process drops a connection to some other process either gracefully or detecting a disconnection by connection close handler.

b) Subscription Functionality

The subscription functionality maintains a list of subscribers who are interested in process/connection events. The browser while loading the page will connect to Monitor service for any event updates.

c) Notification functionality

The monitor process will publish the following event to all the subscribers in case of any events along with the process/connection details. The web component needs to implement/handle these events and render the changes accordingly on the screen.

- add_prc_event
- add_conn_event
- remove_prc_event
- remove_conn_event

V. Web Component

It's an HTML & JavaScript component which contains the d3 visualization code and JavaScript functions for:

- WebSocket connection to Monitor service and subscribing itself for any event updates
- Call-back functions to listen and process the process/connection updates.
- Rendering the nodes (processes) and links (connections) on D3 SVG.

a) Connection to Monitor service

The following JavaScript code is connecting to the Monitor service using the browser WebSocket functionality and implementing the standard call-back methods of WebSocket.

```
function connect() {
    if ("WebSocket" in window) {
        connWS = new
WebSocket("ws://localhost:5555/");
        console.log("INFO : Requesting WebSocket
connection to q process");
        connWS.onopen = function(obj) {
console.log("INFO : WebSocket connection successful");
}
        connWS.onclose = function(obj) {
            console.log("INFO : WebSocket connection
dropped");
            connWS.close();
        }
        connWS.onmessage = function(obj) {
            var res = JSON.parse(obj.data);
            if (null !== res) {
                var funcName = res.shift();
                var params = res[0];
                window[funcName](params);
            }
        }
        connWS.onerror = function(obj) {
console.log(obj.data); }
    } else alert("WebSockets not supported in this
Browser");
}
```

b) Monitor Event call-back methods implementation

Implementation of the monitor process call-backs methods and then delegating the calls for displaying the process/connection updates using d3.js.

```
    function add_prc_event(nodeObj) {
        addNode(nodeObj.prc, nodeObj.grp);
    }

    function add_conn_event(linkObj) {
        addLink(linkObj.prc, linkObj.target);
    }

    function remove_prc_event(nodeObj) {
        removeNode(nodeObj.prc);
    }

    function remove_conn_event(linkObj) {
        removeLink(linkObj.prc)
    }
```

c) Initializing the D3 SVG object

```
var force = d3.layout.force().size([sWidth, sHeight])

.nodes(nNodes).links(nLinks).linkDistance(50).charge(-
200)
    .on("tick", tick);

var svg =
d3.select("body").append("svg").attr("width",
sWidth).attr("height", sHeight);

var arrows =
svg.append("svg:defs").selectAll("marker")
    .data(["arrow"])
    .enter()
    .append("svg:marker")
    .attr("id", String).attr("viewBox", "0 -5 10 10")
    .attr("refX", 10).attr("refY", -1)
    .attr("markerWidth", 4).attr("markerHeight", 4)
    .attr("orient",
"auto").append("svg:path").attr("d", "M0,-
5L10,0L0,5");

svg.append("rect").attr("width",
sWidth).attr("height", sHeight);

var nNodes = force.nodes(),
    nLinks = force.links(),
    node = svg.selectAll(".node"),
    link = svg.selectAll(".link");
```

d) Refreshing the nodes and links

The 'refresh' function contains the code to refresh the SVG after each node/link addition/removal update.

```
function refresh() {
    link = link.data(nLinks);
    link.enter().append("path").attr("class", "link")
        .attr("marker-end", "url(#arrow)");
    link.exit().remove();

    node = node.data(nNodes);
    var nodeEnter = node.enter()
        .insert("g").attr("class",
"node").call(force.drag);

    nodeEnter.append("image")
        .attr("xlink:href",
"https://image.ibb.co/dzEqFe/process.png")
        .attr("x", -8).attr("y", -8)
        .attr("width", 16).attr("height", 16);
    nodeEnter
        .append("text").attr("dx", 12).attr("dy",
".35em");
```

VI. D3.Js in Action

The appendix below contains the full code for creating and displaying the process network.

a) Steps to Run

1) Download 32bit version of KDB+/q from https://kx.com/download/
2) Extract the zip file to 'C:\'; it will produce a folder 'C:\q' [4].
3) Save the `monitor.q`, `Visualizer.html` and `simulator.q` files to the `C:\q\w32` directory.
4) Open a command prompt, go to the `C:\q\w32` directory and run the `monitor.q` file

C:\q\w32>q monitor.q -p 5555

Now the monitor service is ready to listen to any service/connection events.

5) Open the `Visualizer.html` in any browser supporting the WebSocket. The page will connect via WebSocket to the monitor service running on port 5555. Now the Visualizer is ready to display and service/connection updates.

C:\q\w32>Visualizer.html

6) We will run a simulator to span some dummy services and connections.

C:\q\w32>q simulator.q

7) Now check the Visualizer page, you will see the simulated network updating real-time.

To stop the continuously running simulation, type the command loop:0b on the simulator service console.

b) Simulated Network Visualization

Here is a sample graph generated by D3.js using the simulated process network implemented in q/Kdb+.

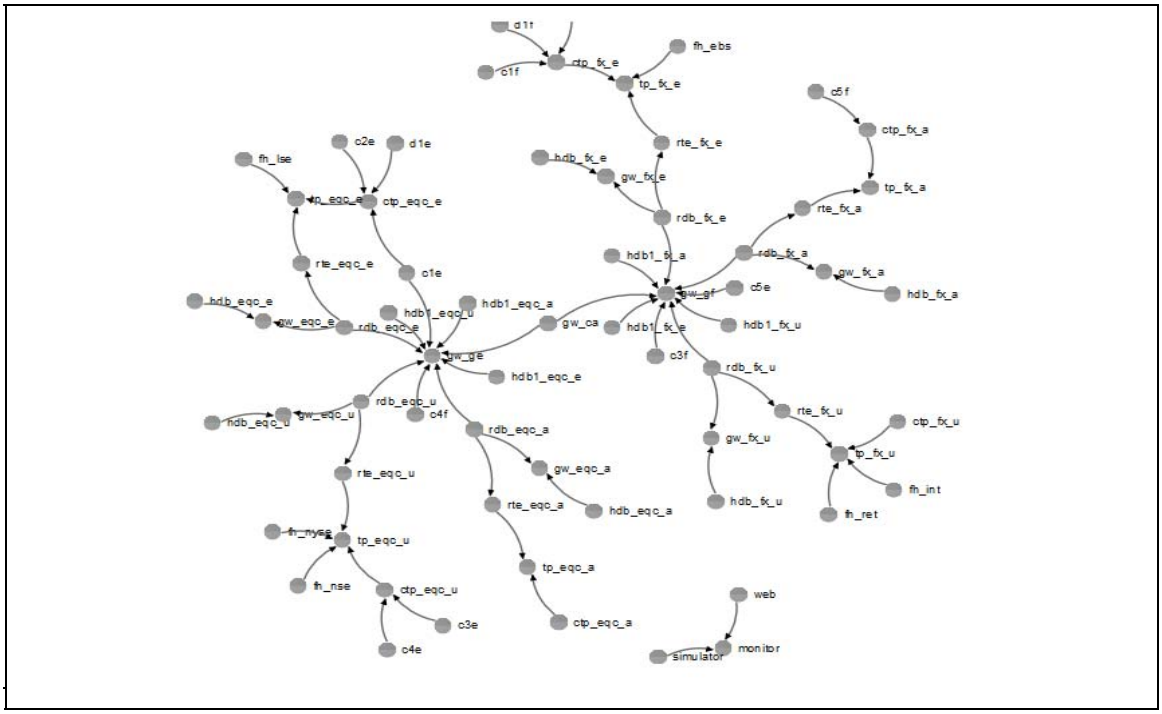

Fig. 2: Service Network

VII. Conclusion

The whitepaper demonstrated how the visualization platform could connect to a centralized service supporting the JSON and WebSocket and display the network of services interfacing with each other.

The service-network visualization example discussed in this paper could be useful for developers and support to visualize the health of the system for monitoring purpose. The code is not production-ready and has been kept concise for simplicity.

Appendix below contains the complete implementation of the example in q, JavaScript and HTML.

The example needs Kdb+ 3.0 or above.

Appendix

a) Monitor.q

```
/Publish-Subscribe
.ps.subs:([h:()];u:());
.ps.sub:{[ch;u] `.ps.subs upsert (ch;u)};
.ps.pub:{[msg]  .ws.pub[;msg] each exec h from
.ps.subs };
.ps.unsub:{[ch] delete from `.ps.subs where h=ch};

/Webscoket
.ws.pub:{neg[x].j.j y};
.z.ws:{.log.info["WebSocket Request : ",.Q.s1
x];.ws.pub[.z.w] .debug.r:@[value;x;{`$x}]};
//Send intial process & connection list
.z.wo:{.log.info["WebSocket Connection open : ",
string x];.ps.sub[x;.z.h]  ;
{.ws.pub[x;(`add_prc_event;y)] }[x]each value
.pm.prclist; ; {.ws.pub[x;(`add_conn_event;y)]
}[x]each delete h from .pm.conlist};
.z.wc:{.log.info["WebSocket Connection close :
",string x];.ps.unsub[x]};

/Process Monitor
.pm.prclist:([h:()] prc:(); grp:());
.pm.conlist:( [] h:() ;prc:() ; target:());
```

```
addprc :{[prc] .log.info(`addprc ;prc); `.pm.prclist
upsert (.z.w;prc`prc;prc`grp);    .ps.pub
(`add_prc_event ;prc) };
addcon :{[con] .log.info(`addcon ;con); `.pm.conlist
upsert (.z.w;con`prc;con`target); .ps.pub
(`add_conn_event;con) };
dropprc:{[prc] .log.info(`dropprc;prc);  .ps.pub
(`remove_prc_event ;prc)};
dropcon:{[con] .log.info(`dropcon;con);  .ps.pub
(`remove_conn_event;con)};

.log.info:{show x};

//Process handlers
.z.po:{[x] .log.info (.z.h;.z.u)};
.z.pc:{
    .d.p:prc:.pm.prclist[x];
    show "Stopping the process : ", string prc`prc;
    c:select from .pm.conlist where h=x ;
    delete from `.pm.prclist where h=x;
    delete from `.pm.conlist where h=x;
    dropprc[prc] ;
    dropcon each c
 };
```

b) *Visualizer.html*

```
<!DOCTYPE html>
<meta charset="utf-8">
<html>
<title>Service Network Visualizer</title>
<body onload="connect();">
    <script
src="https://d3js.org/d3.v3.min.js"></script>
    <script>
    var connWS;
    var nLinks = [];
    var nNodes = [];
    var sWidth = 900, sHeight = 600, radius = 8;
    var nodeIdMap = {} ,nodeCount = 0;

    function connect() {
        if ("WebSocket" in window) {
            connWS = new
WebSocket("ws://localhost:5555/");
            console.log("INFO : Requesting WebSocket
connection to q process");
            connWS.onopen = function(obj) {
console.log("INFO : WebSocket connection successful");
}
            connWS.onclose = function(obj) {
                console.log("INFO : WebSocket
connection dropped");
                connWS.close();
            }
            connWS.onmessage = function(obj) {
                var res = JSON.parse(obj.data);
                if (null !== res) {
                    var funcName = res.shift();
                    var params = res[0];
                    window[funcName](params);
                }
            }
            connWS.onerror = function(obj) {
console.log(obj.data); }
        } else alert("WebSockets not supported in this
Browser");
    }

    function ack(msg) { console.log('Ack -> ' + msg);
}

    function add_prc_event(nodeObj) {
addNode(nodeObj.prc, nodeObj.grp); }
    function add_conn_event(linkObj) {
addLink(linkObj.prc, linkObj.target); }
    function remove_prc_event(nodeObj) {
removeNode(nodeObj.prc); }
    function remove_conn_event(linkObj) {
removeLink(linkObj.prc) }
```

```
    function initMap() {
        nodeIdMap = {};
        nodeCount = 0;
        nNodes.forEach(function(d, i) {
nodeIdMap[d.id] = nodeCount++; })
    }
    function addNode(nodeName, g) {
        var node = { x: sWidth, y: sHeight, id:
nodeName, grp: g };
        var n = nNodes.push(node);
        nodeIdMap[nodeName] = nodeCount++;
        refresh();
    }
    function addLink(srcId, targetId) {
        if (srcId != targetId) {
            var s = {}, t = {};
            nNodes.forEach(function(curNode) {
                if (typeof curNode.id != "undefined")
{
                    if (curNode.id == srcId) { s =
curNode; }
                    if (curNode.id == targetId) { t =
curNode; }
                }
            });
            nLinks.push({ source: s, target: t });
        };
        refresh();
    }
    function removeNode(nodeName) {
        if (nodeName == "") return;
        nLinks = nLinks.filter(function(curLink) {
            return curLink.source.id !== nodeName &&
curLink.target.id !== nodeName;
        });
        force.links(nLinks);
        var i = nodeIdMap[nodeName];
        if (typeof i != "undefined") {
nNodes.splice(i, 1); }
        initMap();
        refresh();
    }


    function removeLink(linkObj) {
        nLinks = nLinks.filter(function(l) { return
!(l.source.id == linkObj.prc && l.target.id ==
linkObj.target); });
        force.links(nLinks);
        initMap();
    }

    initMap();

    var force = d3.layout.force().size([sWidth,
sHeight])

.nodes(nNodes).links(nLinks).linkDistance(50).charge(-
200)
        .on("tick", tick);

    var svg =
d3.select("body").append("svg").attr("width",
sWidth).attr("height", sHeight);

    var arrows =
svg.append("svg:defs").selectAll("marker")
        .data(["arrow"])
        .enter()
        .append("svg:marker")
        .attr("id", String).attr("viewBox", "0 -5 10
10")
        .attr("refX", 10).attr("refY", -1)
        .attr("markerWidth", 4).attr("markerHeight",
4)
        .attr("orient",
"auto").append("svg:path").attr("d", "M0,-
5L10,0L0,5");

    svg.append("rect").attr("width",
sWidth).attr("height", sHeight);
```

```
    var nNodes = force.nodes(),
        nLinks = force.links(),
        node = svg.selectAll(".node"),
        link = svg.selectAll(".link");

    refresh();

    function tick() {
        link.attr("d", function(d) {
            var dx = d.target.x - d.source.x, dy =
d.target.y - d.source.y;
            var angle = Math.atan2(dy, dx);
            var offsetX = radius * Math.cos(angle);
            var offsetY = radius * Math.sin(angle);
            dr = Math.sqrt(dx * dx + dy * dy);
            return ("M" + (d.source.x + offsetX) + ","
+ (d.source.y + offsetY) +
                "A" + dr + "," + dr + " 0 0,1 " +
                (d.target.x - offsetX) + "," +
(d.target.y - offsetY)
            );
        });
        node.attr("transform", function(d) { return
"translate(" + d.x + "," + d.y + ")"; });
    }

    function refresh() {
        link = link.data(nLinks);
        link.enter().append("path").attr("class",
"link")
            .attr("marker-end", "url(#arrow)");
        link.exit().remove();

        node = node.data(nNodes);
        var nodeEnter = node.enter()
            .insert("g").attr("class",
"node").call(force.drag);

        nodeEnter.append("image")
            .attr("xlink:href",
"https://image.ibb.co/dzEqFe/process.png")
            .attr("x", -8).attr("y", -8)
            .attr("width", 16).attr("height", 16);
        nodeEnter
            .append("text").attr("dx", 12).attr("dy",
".35em");

        node.select('text').text(function(d) { return
d.id; });
        node.exit().on('mousedown.drag',
null).remove();
        force.start();
    }


    </script>
</body>

</html>
<style>
rect {
    fill: none;
    pointer-events: all;
}
.node {
    fill: #000;
}
.link {
    stroke: #999;
}
.node text {
    pointer-events: none;
    font: 10px sans-serif;
}
path.link {
    fill: none;
    stroke: #666;
    stroke-width: 1.5px;
}
</style>
```

c) *Simulator.q*

```
.sim.prcsall:update id:i from ungroup update
`$prc,`$grp ,`$"|"vs/:target from
`prc`grp`target!/:(("tp_fx_a";"tp";"");("tp_eqc_a";"tp
";"");("tp_fx_e";"tp";"");("tp_eqc_e";"tp";"");("tp_fx
_u";"tp";"");("tp_eqc_u";"tp";"");("ctp_fx_a";"ctp";"t
p_fx_a");("ctp_eqc_a";"ctp";"tp_eqc_a");("ctp_fx_e";"c
tp";"tp_fx_e");("ctp_eqc_e";"ctp";"tp_eqc_e");("ctp_fx
_u";"ctp";"tp_fx_u");("ctp_eqc_u";"ctp";"tp_eqc_u");("
rte_fx_a";"rte";"tp_fx_a");("rte_eqc_a";"rte";"tp_eqc_
a");("rte_fx_e";"rte";"tp_fx_e");("rte_eqc_e";"rte";"t
p_eqc_e");("rte_fx_u";"rte";"tp_fx_u");("rte_eqc_u";"r
te";"tp_eqc_u");("rdb_fx_a";"rdb";"rte_fx_a|gw_fx_a|gw
_gf");("rdb_eqc_a";"rdb";"rte_eqc_a|gw_eqc_a|gw_ge");(
"rdb_fx_e";"rdb";"rte_fx_e|gw_fx_e|gw_gf");("rdb_eqc_e
";"rdb";"rte_eqc_e|gw_eqc_e|gw_ge");("rdb_fx_u";"rdb";
"rte_fx_u|gw_fx_u|gw_gf");("rdb_eqc_u";"rdb";"rte_eqc_
u|gw_eqc_u|gw_ge");("hdb1_fx_a";"hdb1";"gw_gf");("hdb1
_eqc_a";"hdb1";"gw_ge");("hdb1_fx_e";"hdb1";"gw_gf");(
"hdb1_eqc_e";"hdb1";"gw_ge");("hdb1_fx_u";"hdb1";"gw_g
f");("hdb1_eqc_u";"hdb1";"gw_ge");("hdb_fx_a";"hdb";"g
w_fx_a");("hdb_eqc_a";"hdb";"gw_eqc_a");("hdb_fx_e";"h
db";"gw_fx_e");("hdb_eqc_e";"hdb";"gw_eqc_e");("hdb_fx
_u";"hdb";"gw_fx_u");("hdb_eqc_u";"hdb";"gw_eqc_u");("
gw_fx_a";"gw";"");("gw_eqc_a";"gw";"");("gw_fx_e";"gw"
;"");("gw_eqc_e";"gw";"");("gw_fx_u";"gw";"");("gw_eqc
_u";"gw";"");("gw_ge";"gw";"");("gw_gf";"gw";"");("fh_
lse";"fh";"tp_eqc_e");("fh_nyse";"fh";"tp_eqc_u");("fh
_nse";"fh";"tp_eqc_u");("fh_ret";"fh";"tp_fx_u");("fh_
ebs";"fh";"tp_fx_e");("fh_int";"fh";"tp_fx_u");("c1e";
"c";"ctp_eqc_e|gw_ge");("c2e";"c";"ctp_eqc_e");("c3e";
"c";"ctp_eqc_u");("c4e";"c";"ctp_eqc_u");("c5e";"c";"g
w_gf");("d1e";"d";"ctp_eqc_e");("c1f";"c";"ctp_fx_e");
("c2f";"c";"ctp_fx_e");("c3f";"c";"gw_gf");("c4f";"c";
"gw_ge");("c5f";"c";"ctp_fx_a");("d1f";"d";"ctp_fx_e")
;("gw_ca";"gw";"gw_gf|gw_ge"));
.sim.prcs:delete from .sim.prcsall where null target;

.sim.conMap:()!();
resetVars:{show "reset called";.sim.cnt:count
.sim.prcs;.sim.pubNodes:()};
newPrc:{[prc] h:hopen 5555 ;.sim.conMap[prc`prc]:h;
neg[h] (`addprc;prc) ;h""};
newCon:{[c] h:.sim.conMap[c`prc]; neg[h]@(`addcon;c);
h""; };

loop:1b; //To continuously run the simulation
//loop:0b;   //To stop the simulation after adding the
nodes

reset:{ if[not loop;:()];
    $[0<count .sim.pubNodes;
        [   prc:first .sim.pubNodes ;
            .sim.pubNodes:1_.sim.pubNodes;
            if[prc in key .sim.conMap  ; hclose
.sim.conMap[prc]  ]
        ];
        resetVars[]
    ]};

pubNetwork:{
    .sim.cnt-:1;     n:();
    con:.sim.prcs[.sim.cnt];
    if[not con[`prc] in .sim.pubNodes; n,:con`prc;
.sim.pubNodes,:con`prc  ];
    if[not con[`target] in .sim.pubNodes;
n,:con`target; .sim.pubNodes,:con`target];
    nodes:distinct select prc, grp from .sim.prcsall
where prc in n;
    if[count nodes;newPrc  each nodes] ;
    newCon con };

simulation:{$[.sim.cnt>0;pubNetwork[];reset[]]};

resetVars[];
.sim.monh:hopen 5555;  //Connection to Monitor process

.z.ts:simulation;
.z.pc:{show "Connection dropped"};

value "\\t 1000";
```

References Références Referencias

1. https://linkurio.us/blog/panama-papers-how-linkurious-enables-icij-to-investigate-the-massive-mossack-fonseca-leaks/
2. D3.js https://d3js.org/
3. https://kx.com/solutions/
4. https://code.kx.com/q/tutorials/install/#microsoft-windows

Global Journal of Computer Science and Technology: F
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New Algorithm for Detection of Spinal Cord Tumor using OpenCV

By Raihan Uddin Ahmed, Tanvir Ahmed Chowdhury & A. S. M Mahmudul Hasan

The International University of Scholars

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GJCST-F Classification: *I.3.3*

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New Algorithm for Detection of Spinal Cord Tumor using OpenCV

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I. Introduction

Spinal cord [1] resides inside the spine of a human body (Fig. 1). The Central Nervous System consists of the brain and the spinal cord [2]. The role of the central nervous system is to control the majority of the functions of both the body and the mind. The spinal cord has tubular bundle of long and thin nervous tissue. It also have other support cells which extends to the lumbar region of the vertebral column from the medulla. It's around 45 cm (18 inches) in men and approximately 43 cm (17 inches) long in women. Thirty one pairs of spinal nerves rise because of that [7].

Fig. 1: The spine of a human body

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a) Spinal Cord Tumor

A spinal cord tumor [3] is an abnormal mass of tissue within or on the surface of the spinal cord or spinal column (Fig. 2). Spinal cord tumors generally develop slowly and worsen over time. But the symptoms are visible at a very early stage because spinal cord controls the many functions of the body like movements and senses. In most cases, an affected spinal cord becomes bent or distorted, that causes loss of bodily functions. It is essential to detect spinal cord tumors at an early stage. An automated system for this purpose can reduce the time and effort required to diagnose the tumors and thus help the treatment process.

Following are some facts [6] about spinal cord tumors around the world:

- 0.74 of the population in 100,000 are affected per year by spinal cord tumors.
- This rate becomes 1.80 for the 75-84 age group.
- Only 64% among these people survives for ten years if they are able to detect spinal cord tumors at a primary stage.

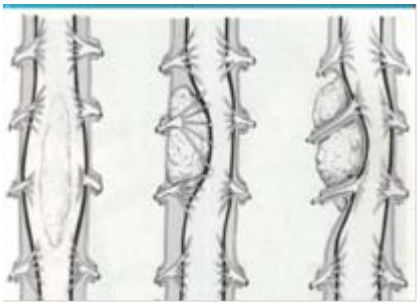

Fig. 2: Spinal cord tumor

The spinal cord tumors can be either cancerous or non-cancerous. Another classification can be as follows:

- Extradural - outside the dura mater lining (most common)
- Intradural - part of the dura
- Intramedullary - inside the spinal cord
- Extramedullary- inside the dura, but outside the spinal cord

Spinal tumors may occur in the areas like cervical, thoracic, lumbar, and sacrum.

b) Spinal Cord Tumor Diagnostics: MRI

One of the most common diagnosis processes for Spinal Cord tumor is MRI. The full form of MRI [8] is –

"Magnetic Resonance Imaging." It is considered to be a better diagnostics method than X-ray, ultrasound, or computerized tomography (CT) scan because it gives more information about the structures of the body. According to Wikipedia, there are many medical imaging techniques like MRI (Magnetic Resonance Imaging), NMRI (Nuclear Magnetic Resonance Imaging), or MRT (Magnetic Resonance Tomography) to visualize the structure and the physiological processes of the body. Using strong magnetic fields, radio waves, and field gradients, MRI scanners form the images of the body.

Use of MRI images (Fig. 3) in the detection process of spinal tumors gives better results in terms of accuracy. That is why, in this research, MRI scans of the spinal cord are used to detect the anomaly.

Fig. 3: MRI image of the cervical spine

c) Medical Image Processing

Medical Image Processing is an extended version of image processing. By using medical images, it is possible to diagnosis the human organs automatically. The main challenge behind medical image processing is that the images need to have a very high level of accuracy along with sufficient details in each case of use, as it is directly related to human health. Medical image processing techniques are improving rapidly day by day, and many automated applications are being available in medical diagnostics. These are reducing the time required for finding diseases and batch processing of images and thus accelerating the treatment process along with the chances of survival.

II. Related Works

In the paper titled "Diagnosis of Disc Herniation Based on Classifiers and Features Generated from Spine MR Images"[10], Jaehan Koh, Vipin Chaudhary, and Gurmeet Dhillon discussed using perceptron, SVM, and Least-mean-square after segmentation and feature generation of lumbar vertebrae to identify disk herniation. They gained 97% accuracy.

E. Lopez Arce-Vivas, Francisco Javier Cisneros, Rq Fuentes, Alejandro García-González, J. Gonzalez-Cruz, and Jose Maria Jiménez-Avila also worked on disk herniation using semiautomatic approach. But their accuracy rate was low. They published their word with the title- "Application of a semiautomatic classifier for Modic and disk hernia changes in magnetic resonance"[11]. It is not that much effective to use for clinical diagnosis. The outcome of the research shows that it has only 60-65% and 58-61% certainty for the MODIC classification and herniated discs respectively as compared with clinical experience. This inspired us to develop a semiautomatic classifier with effectiveness of diagnostic reliability as doctors.

In their paper "Computer-Aided Diagnosis of Lumbar Disc Herniation"[12], Khaled Alawneh, Mays Al-dwiekat, Mohammad Alsmirat and Mahmoud Al-Ayyoub proposed methods based on ROI Extraction, ROI Enhancement, Feature Extraction, Classification Algorithms or Classifiers to auto-diagnose lumbar disk herniation. Their method shows 100 % accuracy rate.

B. Karlık and S. Kul show 95% accuracy in the detection of disk herniation using Artificial Neural Net. They described their work in the paper "Diagnosis of Lumbar Disc Hernia Using Wavelet Transform and Neural Network" [13].

In the paper titled "Computer-Aided Detection of Brain Tumor in Magnetic Resonance Images"[14], Abhishek Raj, Alankrita, Akansha Srivastava and Vikrant Bhateja worked on the automated diagnosis of brain tumor using Wavelet Transform, Multi-scale Analysis, Morphological filtering, Wavelet-Based Sub-band Coding, Non-linear Enhancement Operator.

None of these scholarly works try to identify spinal cord tumor from MRI images. They mostly deal with a brain tumor or herniation of protective disks in the spinal column.

III. Proposed System

The proposed system has three major modules. The first module involves image retrieval of images and their normalization to make all images of the same width (Fig. 4). The second module enhances the images by blurring noises, detects edges for finding out the ROI (Region of Interest) and then applies segmentation to isolate the ROIs. The final module analyzes the ROIs and makes a final decision based on the novel Simple Average Deviation (SAD) algorithm.

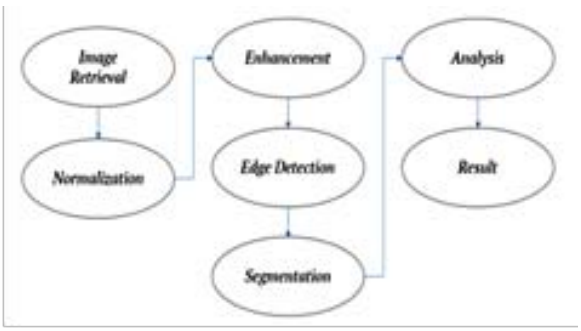

Fig. 4: System Processes for Spinal Tumor Detection System

a) Image Retrieval

The first step in image processing is the retrieval of images. We have implemented the retrieval process for a single picture only.

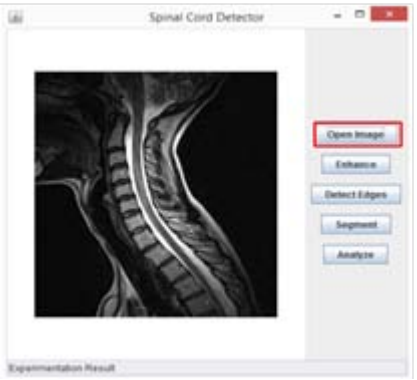

Fig. 5: The image retrieval and normalization

The retrieved images are converted to grayscale to simplify the processing with only two colors – black and white. It also makes it easier to generate binary images later on or analyze the color histogram. The picture also normalized so that all have a standard width of 294 pixels. To reshape the image and calculate the area based on the width only, we keep the height of the pictures relative to the original aspect ratio. This approach gives the optimum result in an application.

b) Image Enhancements

In the enhancement stage, a blurring filter is applied to reduce noises in the image. We have used the Gaussian filter [17] for this purpose.

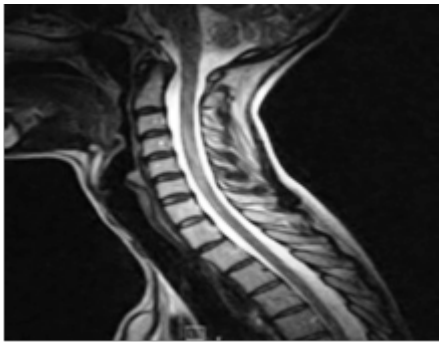

Fig. 6: Image before enhancement

To implement the Gaussian blur (mainly used as a smoothing operator) needs to be careful.

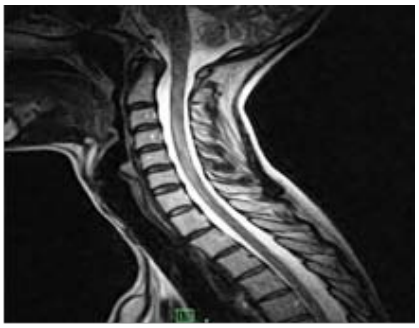

Fig. 7: Image after enhancement

As it can hide some crucial details of the image in the process of blurring noises from the image (Fig. 6 and Fig. 7).

c) Thresholding

A thresholding process usually applies a fixed level threshold to the whole image. It takes a threshold pixel range through its parameters and creates a binary version of the image (black and white) depending on the threshold.

Fig. 8: An MRI image after thresholding

In our system, we have used the Adaptive Threshold [19] technique, which is a better version of the original threshold.

d) ROI and Edge Detection

In this stage Region of Interest (ROI), the spinal cord is determined. Another reason for indentifying ROI is that some parts of the spinal cord lie in line with the boundary edges. It makes the edge detection difficult. On the other hand, grabbing the ROI helps us to get a fixed height of the spinal cord, which is very useful in the segmentation of a spinal cord (Fig. 9).

After determining the ROI, the Canny algorithm for edge detection is used to find the connected spinal cord.

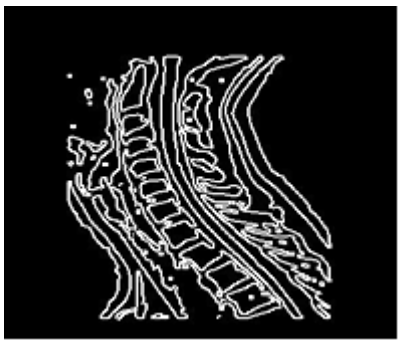

Figure 9: Image after edge detection

The Canny algorithm has less error rate and has a localization meaning that the distance between edge pixels are easily detected. It works best in our system as we compared it to other edge detection methods like Sobel [20].

e) Segmentation

After detecting edges for the connected regions, segments were separated (Figure 10) by filtering them according to their area and height.

Fig. 10: Segmentation result of a spinal MRI image

Then the whole connected region was calculated, and we preserved the X and Y coordinated of the spinal column for later use by the tumor detection algorithm called Simple Average Deviation (SAD) algorithm.

f) The SAD Algorithm

The Simple Average Deviation (SAD) algorithm is the contribution of this paper. It's developed to find any irregular deviation of the curves in the spinal cord boundary. We have applied a prototype of the algorithm which can determine whether a spinal cord is normal or not. If a spinal cord doesn't exist in the list of contours found in the segmentation stage, then we can say that the spinal cord has tumors or another type of abnormalities. Our prototype can also detect tumors at a primary stage if they are present at the edge of the spinal cord itself. The technical specification of this algorithm is as follows-

The spinal cord has two balanced curves on both sides. By those, we mean the curves that don't have small waves having wavelength less than a threshold. There will have small waves if the body of the spinal cord has tumors attached to it. We have implemented the algorithm by a simple function named simple Average Deviation (). This function needs some values captured at the segmentation stage. We have saved the coordinates of the edges from the respective region which we got by filtering them. Then we have passed the dynamic array of X coordinates, the minimum value among the Y indexes, and the maximum value among the Y indexes. The minimum and maximum Y index value is required to ensure top to bottom traversing of the coordinate values and also to analyze both sides of the spinal cord.

In the core of the implementation, we divide the X coordinates into different sequential blocks of 10 values each.

- Let, denote the first block of 10 coordinates = block1
- Let, the total number of blocks = n
- Let, the first value among the X coordinates inside block1 = x1

As there are ten coordinates in each block, we can represent the sum of X coordinates inside block1 as x1+x2+……+x10. So, the equation will be,

- sumBlock1 = x1 + x2 + …… + x10, where sumBlock1 is the sum of all values inside block1.

Now we can say,

- avgBlock1 = sumBlock1 / 10, where avgBlock1 is the average of all x coordinates inside block1.

Similarly, sumBlock2 and avgBlock2 are representing the sum and the average of all values inside block2 respectively. The respective equations can be represented as,

- sumblock2 = x11 + x12 + …… + x20
- avgBlock2 = sumBlock2 / 10

Once we have all the averages, we can easily find the differences among them. We can then consider these differences as the deviations and compare against a threshold. We figured out that it can find abnormalities if the threshold is ranging from -16 (minus 16) to 16.5. The reason behind setting a positive and a negative limit for the range is that the waves caused by tumors can deviate either on the left edge or the right edge of the spinal cord or even both. We also found out that a single instance of abnormally didn't point out to the existence of tumors in any of our test cases. It might simply indicate that the segment we are dealing with isn't smooth in all edge points. So, we can presume that there have to be at least two instances where we find average differences not following the thresholds as mentioned above.

Let, the positive threshold limit = p_t, the negative threshold = n_t and the difference between the first block average and the second block average = diff1.

Then, diff1 = avgBlock1 - avgBlock2

Similarly, diff2 = avgBlock2 - avgBlock3 and so on.

According to the findings above, if diff1 $< n_t$ or diff1 $> p_t$ then we can say that the first abnormal deviation, abn1 resides in either block1 or block2 (the first two blocks) or both.

If we find another abnormal deviation for the average values then we can assume that a tumor might be present in the current segment. Otherwise, we can assume that there are none in this segment.

We have used the Y coordinate values in the actual implementation from the contours for distinguishing between the left edge and the right edge separately as that increases the \chance of proper detection of tumors.

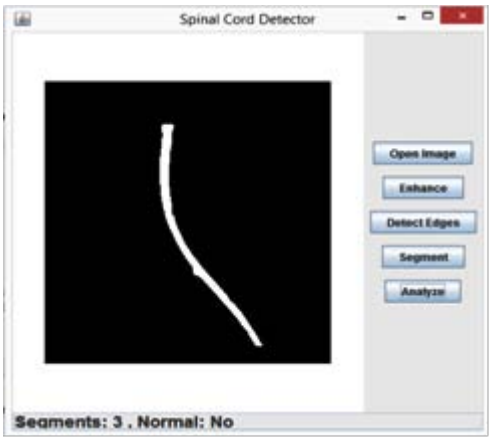

Fig. 11: The spinal tumor detection result

IV. Experimentation Methods Overview

Here, we used a data set of 33 cervical MRI images. We collected those from different medical archives and via google search. The images are of different dimensions. One common aspect of those is that all of them consist of a part of the spinal cord, which is directly attached to the brain. Ten of those images are of spinal cords with no abnormality, which means that there is no tumor visible on them. The other 23 either have tumors or have another type of abnormalities like distortion, too many noises, a very few details and so on. Images were used for academic purpose only as permitted by the authors. Thus, they preserve the copyrights.

We gather the images in a single folder from the dataset. Each of these images was opened one by one and tested using the system. Fig. 12 shows the results collected from these tests.

	data name	Original condition	Test Result	Result type	Type color	Type name
2	test1	Normal	Normal			Accurate
3	test2	Normal	Normal			Wrong
4	test3	Abnormal	Abnormal			
5	test4	Abnormal	Abnormal			
6	test5	Abnormal	Abnormal			
7	test6	Abnormal	Abnormal			
8	test7	Abnormal	Abnormal			
9	test8	Abnormal	Abnormal			
10	test9	Abnormal	Abnormal			
11	test10	Abnormal	Abnormal			

Fig. 12: The spreadsheet for collecting experimentation results

Here in Fig.12, the spreadsheet has some labels that we used for different purposes. We used the "data name" label for storing test image names. The "Original Condition" label for storing the information about those test images whether they have a spinal tumor in or not. The "Test Result" label for storing the feedback from our application prototype (whether the system found out tumor or not). The "Result type" label for storing a single color for each image- either green or red. 'Green' specifies an accurate identification and 'red' specifies a wrong indication by the application etc. the labels named "Type color" and "Type name" describe the result types.

V. Results and Discussions

Our system identifies a spinal cord as normal if and only if it finds a single instance of the spinal cord after applying the SAD algorithm. We used a dataset consisting of 33 cervical MRI images (10 without abnormality and 23 affected with tumors or distorted), and our system acquired up to 90.91% accuracy.

a) True Positives

We have used the term "true positive" whenever we found the case where the original image has a spinal cord without abnormality and the application also states it as the same. We have found out eight true positives in total from the experiment.

b) True Negatives

We have used the term "true negative" whenever we found the case where the original image has a spinal cord with some abnormalities or tumors associated with it, and the application also states that the spinal cord is not normal. By the end of the experiment, we have found out twenty two such cases.

c) False Positives

We have used the term "false positive" whenever we found the case that the original image has an abnormal spinal cord, but our application says that the spinal cord is normal. We found one false positive in our experiment.

d) False Negatives

We have used the term "false negatives" whenever we found the case that the original image represents the spinal cord as normal, but the application denotes that it has an abnormal or defective spinal cord. We found two false negatives in our experiment.

e) Result Analysis

The "true positives" and the "true negatives" yield the total number of accurate detection, which is 30 in total and 90.91 in percentage. The "false positives" and the "false negatives" shows the total number of errors in the detection process, which is 3 in total and 9.09%. We can conclude that our system has 90.91% accuracy, which is a decent one as the research topic is unique. The following Figure (Fig. 13) shows the result statistics-

Total Images	True Positives	True Negatives	Total Accuracy
33	8	22	30 (90.91%)

Total Images	False Positives	False Negatives	Total Error
33	1	2	3 (9.09%)

Fig. 13: The Statistics of the Result Derived from the Experimentation

VI. Limitations of the System

The proposed system has the following weaknesses:

- Unable to detect tumors adjacent to the spinal canal wall.
- Unable to detect if there is too much noise around the spinal cord.
- The system was tested only on the sagittal view of the cervical spine region as generated by an MRI scan.
- The accuracy level (90.91%) needs to be improved.

The system can't identify any characteristics of the tumor other than its location; it can't distinguish between a malignant and a benign tumor.

VII. Conclusion

The main objective of this research was to develop an automated way of finding tumors in Spinal Cords by computer vision tools like OpenCV and using various image processing techniques. We have developed an algorithm (Simple Average Deviation or SAD) to find irregularities in the shape of the Spinal Cord. The algorithm shows 90.91% accuracy in detecting tumor/abnormalities. Currently, the algorithm only works on sagittal MRI images and also suffers several other limitations. We will work on those in the future.

References Références Referencias

1. Wikipedia, (2015). Spinal cord. [online] Available at: https://en.wikipedia.org/wiki/Spinal_cord [Accessed Mar. 2019].
2. Wikipedia, (2015). Central nervous system. [online] Available at: https://en.wikipedia.org/wiki/Central_nervous_system [Accessed Mar. 2019].
3. Mayoclinic.org, (2015). Overview - Spinal cord tumor - Mayo Clinic. [online] Available at: http://www.mayoclinic.org/diseases-conditions/spinal-cord-tumor/home/ovc-20117315 [Accessed Mar. 2019].
4. Wikipedia, (2015). OpenCV. [online] Available at: https://en.wikipedia.org/wiki/OpenCV [Accessed Mar. 2019].
5. Schellinger KA, et al. (2008). Descriptive epidemiology of primary spinal cord tumors. PubMed - NCBI. [online] Ncbi.nlm.nih.gov. Available at: http://www.ncbi.nlm.nih.gov/pubmed/18084720 [Accessed Mar. 2019].
6. Cancer.org, (2015). Survival rates for selected adult brain and spinal cord tumors. [online] Available at: http://www.cancer.org/cancer/braincnstumorsinadults/detailedguide/brain-and-spinal-cord-tumors-in-adults-survival-rates [Accessed Mar. 2019].
7. InnerBody, (2015). Spine. [online] Available at: https://www.innerbody.com/image/skel05.html [Accessed Mar. 2019].
8. Wikipedia, (2015). Magnetic resonance imaging. [online] Available at: https://en.wikipedia.org/wiki/Magnetic_resonance_imaging [Accessed Mar. 2019].
9. Thakkar, K. (2012). What is OpenCV? OpenCV vs. MATLAB — An insight. [online] Karan Jitendra Thakkar. Available at: https://karanjthakkar.wordpress.com/2012/11/21/what-is-opencv-opencv-vs-matlab/ [Accessed Mar. 2019].
10. Koh, J., Chaudhary, V. and Dhillon, G. (2010). Diagnosis of disc herniation based on classifiers and features generated from spine MR images. Medical Imaging 2010: Computer-Aided Diagnosis, [online] 7624(6243O), pp.1-8. Available at: https://www.researchgate.net/publication/228486369_Diagnosis_of_Disc_Herniation_Based_on_Classifiers_and_Features_Generated_from_Spine_MR_Images [Accessed Mar. 2019].
11. Vivas, E., Oliva, F., Aguilar, R., González, A., Cruz, J. and Ávila, J. (2015). Application of a semiautomatic classifier for modic and disk hernia changes in magnetic resonance. Coluna/Columna, [online] 14(1), pp.18-22. Available at: https://www.researchgate.net/publication/273483437_Application_of_a_semiautomatic_classifier_for_modic_and_disk_hernia_changes_in_magnetic_resonance [Accessed Mar. 2019].
12. Alawneh, K., Al-dwiekat, M., Alsmirat, M. and Al-Ayyoub, M. (2015). Computer-aided diagnosis of lumbar disc herniation. 2015 6th International Conference on Information and Communication Systems (ICICS). [online] Available at: https://www.researchgate.net/publication/280036522_Computer-Aided_Diagnosis_of_Lumbar_Disc_Herniation [Accessed Mar. 2019].
13. Karlık, B. and Kul, S. (2009). Diagnosis of Lumbar Disc Hernia Using Wavelet Transform and Neural Network. [online] ResearchGate. Available at: https://www.researchgate.net/publication/228505730_Diagnosis_of_Lumbar_Disc_Hernia_Using_Wavelet_Transform_and_Neural_Network [Accessed Mar. 2019].
14. Raj, A., Alankrita, Srivastava, A. and Bhateja, V. (2011). Computer Aided Detection of Brain Tumor in

Magnetic Resonance Images. IJET, 3(5), pp. 523-532.
15. Docs.opencv.org, (2015). Reading and Writing Images and Video — OpenCV 2.4.12.0 documentation. [online] Available at: http://docs.opencv.org/2.4/modules/highgui/doc/reading_and_writing_images_and_video.html?highlight=imread [Accessed Mar. 2019].
16. Docs.opencv.org, (2015). Geometric Image Transformations - OpenCV 2.4.12.0 documentation. [online] Available at: http://docs.opencv.org/2.4/modules/imgproc/doc/geometric_transformations.html#resize [Accessed Mar. 2019].
17. Wikipedia, (2015). Gaussian filter. [online] Available at: https://en.wikipedia.org/wiki/Gaussian_filter [Accessed Mar. 2019].
18. Docs.opencv.org, (2015). Image Filtering - OpenCV 2.4.12.0 documentation. [online] Available at: http://docs.opencv.org/2.4/modules/imgproc/doc/filtering.html#gaussianblur [Accessed Mar. 2019].
19. Docs.opencv.org, (2015). Miscellaneous Image Transformations - OpenCV 2.4.12.0 documentation. [online] Available at: http://docs.opencv.org/2.4/modules/imgproc/doc/miscellaneous_transformations.html#adaptivethreshold [Accessed Mar. 2019].
20. Docs.opencv.org, (2015). Image Filtering - OpenCV 2.4.12.0 documentation. [online] Available at: http://docs.opencv.org/2.4/modules/gpu/doc/image_filtering.html?highlight=sobel#gpu-sobel [Accessed Mar. 2019].

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The ' MARSS ' title is accorded to a selected professional after the approval of the Editor-in-Chief / Editorial Board Members/Dean.

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MARSS designated members are entitled to avail a 25% discount while publishing their research papers (of a single author) in Global Journals Inc., if the same is accepted by our Editorial Board and Peer Reviewers. If you are a main author or co-author of a group of authors, you will get discount of 10%.

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We shall provide you intimation regarding launching of e-version of journal of your stream time to time. This may be utilized in your library for the enrichment of knowledge of your students as well as it can also be helpful for the concerned faculty members.

The MARSC member can apply for approval, grading and certification of standards of their educational and Institutional Degrees to Open Association of Research, Society U.S.A.

Once you are designated as MARSC, you may send us a scanned copy of all of your credentials. OARS will verify, grade and certify them. This will be based on your academic records, quality of research papers published by you, and some more criteria.

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AUXILIARY MEMBERSHIPS

Institutional Fellow of Open Association of Research Society (USA)-OARS (USA)

Global Journals Incorporation (USA) is accredited by Open Association of Research Society, U.S.A (OARS) and in turn, affiliates research institutions as "Institutional Fellow of Open Association of Research Society" (IFOARS).

The "FARSC" is a dignified title which is accorded to a person's name viz. Dr. John E. Hall, Ph.D., FARSC or William Walldroff, M.S., FARSC.

The IFOARS institution is entitled to form a Board comprised of one Chairperson and three to five board members preferably from different streams. The Board will be recognized as "Institutional Board of Open Association of Research Society"-(IBOARS).

The Institute will be entitled to following benefits:

The IBOARS can initially review research papers of their institute and recommend them to publish with respective journal of Global Journals. It can also review the papers of other institutions after obtaining our consent. The second review will be done by peer reviewer of Global Journals Incorporation (USA) The Board is at liberty to appoint a peer reviewer with the approval of chairperson after consulting us.

The author fees of such paper may be waived off up to 40%.

The Global Journals Incorporation (USA) at its discretion can also refer double blind peer reviewed paper at their end to the board for the verification and to get recommendation for final stage of acceptance of publication.

The IBOARS can organize symposium/seminar/conference in their country on behalf of Global Journals Incorporation (USA)-OARS (USA). The terms and conditions can be discussed separately.

The Board can also play vital role by exploring and giving valuable suggestions regarding the Standards of "Open Association of Research Society, U.S.A (OARS)" so that proper amendment can take place for the benefit of entire research community. We shall provide details of particular standard only on receipt of request from the Board.

The board members can also join us as Individual Fellow with 40% discount on total fees applicable to Individual Fellow. They will be entitled to avail all the benefits as declared. Please visit Individual Fellow-sub menu of GlobalJournals.org to have more relevant details.

We shall provide you intimation regarding launching of e-version of journal of your stream time to time. This may be utilized in your library for the enrichment of knowledge of your students as well as it can also be helpful for the concerned faculty members.

After nomination of your institution as "Institutional Fellow" and constantly functioning successfully for one year, we can consider giving recognition to your institute to function as Regional/Zonal office on our behalf.
The board can also take up the additional allied activities for betterment after our consultation.

The following entitlements are applicable to individual Fellows:

Open Association of Research Society, U.S.A (OARS) By-laws states that an individual Fellow may use the designations as applicable, or the corresponding initials. The Credentials of individual Fellow and Associate designations signify that the individual has gained knowledge of the fundamental concepts. One is magnanimous and proficient in an expertise course covering the professional code of conduct, and follows recognized standards of practice.

Open Association of Research Society (US)/ Global Journals Incorporation (USA), as described in Corporate Statements, are educational, research publishing and professional membership organizations. Achieving our individual Fellow or Associate status is based mainly on meeting stated educational research requirements.

Disbursement of 40% Royalty earned through Global Journals : Researcher = 50%, Peer Reviewer = 37.50%, Institution = 12.50% E.g. Out of 40%, the 20% benefit should be passed on to researcher, 15 % benefit towards remuneration should be given to a reviewer and remaining 5% is to be retained by the institution.

We shall provide print version of 12 issues of any three journals [as per your requirement] out of our 38 journals worth $ 2376 USD.

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The individual Fellow and Associate designations accredited by Open Association of Research Society (US) credentials signify guarantees following achievements:

- The professional accredited with Fellow honor, is entitled to various benefits viz. name, fame, honor, regular flow of income, secured bright future, social status etc.

- In addition to above, if one is single author, then entitled to 40% discount on publishing research paper and can get 10%discount if one is co-author or main author among group of authors.
- The Fellow can organize symposium/seminar/conference on behalf of Global Journals Incorporation (USA) and he/she can also attend the same organized by other institutes on behalf of Global Journals.
- The Fellow can become member of Editorial Board Member after completing 3yrs.
- The Fellow can earn 60% of sales proceeds from the sale of reference/review books/literature/publishing of research paper.
- Fellow can also join as paid peer reviewer and earn 15% remuneration of author charges and can also get an opportunity to join as member of the Editorial Board of Global Journals Incorporation (USA)
- • This individual has learned the basic methods of applying those concepts and techniques to common challenging situations. This individual has further demonstrated an in–depth understanding of the application of suitable techniques to a particular area of research practice.

Note :

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- In future, if the board feels the necessity to change any board member, the same can be done with the consent of the chairperson along with anyone board member without our approval.
- In case, the chairperson needs to be replaced then consent of 2/3rd board members are required and they are also required to jointly pass the resolution copy of which should be sent to us. In such case, it will be compulsory to obtain our approval before replacement.
- In case of "Difference of Opinion [if any]" among the Board members, our decision will be final and binding to everyone.

"

Preferred Author Guidelines

We accept the manuscript submissions in any standard (generic) format.

We typeset manuscripts using advanced typesetting tools like Adobe In Design, CorelDraw, TeXnicCenter, and TeXStudio. We usually recommend authors submit their research using any standard format they are comfortable with, and let Global Journals do the rest.

Alternatively, you can download our basic template from https://globaljournals.org/Template.zip

Authors should submit their complete paper/article, including text illustrations, graphics, conclusions, artwork, and tables. Authors who are not able to submit manuscript using the form above can email the manuscript department at submit@globaljournals.org or get in touch with chiefeditor@globaljournals.org if they wish to send the abstract before submission.

Before and during Submission

Authors must ensure the information provided during the submission of a paper is authentic. Please go through the following checklist before submitting:

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2. Authors must accept the privacy policy, terms, and conditions of Global Journals.
3. Ensure corresponding author's email address and postal address are accurate and reachable.
4. Manuscript to be submitted must include keywords, an abstract, a paper title, co-author(s') names and details (email address, name, phone number, and institution), figures and illustrations in vector format including appropriate captions, tables, including titles and footnotes, a conclusion, results, acknowledgments and references.
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7. Manuscript submitted *must not have been submitted or published elsewhere* and all authors must be aware of the submission.

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

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

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- Findings
- Writings
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- Graphs
- Illustrations
- Lectures

- Printed material
- Graphic representations
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- Electronic material
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2. Drafting the paper and revising it critically regarding important academic content.
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The corresponding author should mention the name and complete details of all co-authors during submission and in manuscript. We support addition, rearrangement, manipulation, and deletions in authors list till the early view publication of the journal. We expect that corresponding author will notify all co-authors of submission. We follow COPE guidelines for changes in authorship.

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

Acknowledgments

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

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

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

Manuscript Style Instruction (Optional)

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

Structure and Format of Manuscript

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

A research paper must include:

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

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

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

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

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

Format Structure

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

All manuscripts submitted to Global Journals should include:

Title

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

Author details

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

Abstract

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

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

Keywords

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

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

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

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

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

Numerical Methods

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

Abbreviations

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

Formulas and equations

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

Tables, Figures, and Figure Legends

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

Figures

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

Preparation of Eletronic Figures for Publication

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

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Tips for writing a good quality Computer Science Research Paper

Techniques for writing a good quality computer science research paper:

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Informal Guidelines of Research Paper Writing

Key points to remember:

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

Final points:

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

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

The discussion section:

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

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

General style:

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

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

Mistakes to avoid:

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

Title page:

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

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

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

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

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

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

Approach:

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

Introduction:

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

The following approach can create a valuable beginning:

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

Approach:

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

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

Procedures (methods and materials):

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

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

Materials:

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

Methods:

- Report the method and not the 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—detail how procedures were completed, not how they were performed on a particular day.
- If well-known procedures were used, account for the procedure by name, possibly with a reference, and that's all.

Approach:

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

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

What to keep away from:

- 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 as entirely objective details of the outcome, and save all understanding for the discussion.

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

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

Content:

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

What to stay away from:

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

Approach:

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

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

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

Figures and tables:

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

Discussion:

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

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

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

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

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

Approach:

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

Describe generally acknowledged facts and main beliefs in present tense.

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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

INDEX

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