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Otsu Segmentation Method for American Sign Language Recognition

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Abstract— Sign language recognition is a growing research area in the field of gesture recognition. Research on sign language recognition has been done around the world, using many sign languages. An accurate hand segmentation is the first and important step in sign language recognition systems. This paper proposed Otsu segmentation method that helps to build a better vision based sign language recognition system for its simplicity and efficiency. It is based on thresholding technique. It depends on selecting the optimal threshold value that maximizes the between-class variance of resulting object and background classes. This work is used to segment the signs representing the numbers from one to nine of the American Sign Language (ASL).The Experimental results demonstrate the effectiveness of this proposed method.

Keywords— Sign Language, Image segmentation, American Sign Language, Otsu Segmentation, ASL recognition, Image thresholding, Image processing

1. INTRODUCTION

Sign language (SL) is a visual-gestural language used by deaf and hard-hearing people. They use three dimensional spaces and the hand movements (and other parts of the body) to convey meanings. It has its own vocabulary and syntax which is entirely different from spoken and written languages [1]. Many countries have their own sign languages associated with their own grammars and rules. American Sign Language (ASL), British Sign Language (BSL), French Sign Language (LSF), and Indian Sign Language (ISL) [2]. Sign Language recognition system transfers the communication from human-human to human-computer interaction. The aim of the sign language recognition system is to present an efficient and accurate mechanism to transcribe text or speech, thus the "dialog communication" between the deaf and hearing person will be smooth[3]. Recognition of sign language is one of the major concerns for dump and deaf people. Sign language recognition is a research area involving pattern recognition, computer vision, natural language processing. Sign language recognition is a comprehensive problem because of the complexity of the visual analysis of hand gesture and the highly structured nature of sign language. As well as it is considered as a very important function in many practical communication applications, such as sign language understanding, entertainment, and human computer interaction (HCI) [4]. Hand Segmentation is the part of computer vision based natural human computer interaction. Hand tracking and segmentation are the primary steps for any hand gesture recognition system. Survey and sign language study shows that from various gesture communications modality, the hand gesture is most easy and natural way of communication [5]. An accurate face and hand segmentation is the first and important step in sign language recognition systems. Segmentation and detection of hand and face reduce processing time and increase precision of recognizing postures in sign language recognition systems [1]. Good segmentation process leads to perfect features extraction process and the later play an important role in a successful recognition process [6]. In this paper, an Otsu thresholdindg segmentation method is proposed for ASL gesture recognition. The remainder of this paper is organized as follows. Section 2 highlights the related works. Section 3 introduces American Sign Language concept. Section 4 describes the Otsu Segmentation algorithm. Section 5 presents the proposed method. Section 6 provides the experimental results. Finally, the paper is concluded in section 7.

2.RELATED WORK

Research in sign language recognition started to appear in literature at the beginning of 1990s [7]. **Neha et al.** [8] presented a methodology which recognizes the Indian Sign Language (ISL) and translates into a normal text. Skin color segmentation is performed using k-means clustering method. **Sumaira K. et al.** [9] introduced a fuzzy classifier to recognize Pakistani Sign Language (PSL). Marked color glove has been used to segment hand and then these marks are also used to extract features to be used by the classifier to recognize sign. **Xu Zhang et al**.[10] presented a framework for Chinese Sign Language (CSL)recognition based on the information fusion of a three-axis accelerometer (ACC) and multichannel electromyography (EMG) sensors using the active segments. **Cao Dong, Ming C. Leu**[11] employed a per-pixel classification method that was adapted to segment the hand into parts. The input of this process was the depth image of the hand region, and the output was the classification label of each pixel. **Divya S and Kiruthika** [12] developed a design for a SLR (sign language recognition) system computerizes the work of a sign language translator, the image is segmented using skin colour based on HSV, RGB and YCbCr Colour spaces.

3. AMERICAN SIGN LANGUAGE

ASL is a complete, complex language that employs signs made with the hands and other movements, including facial expressions and postures of the body. It is the first language of many deaf North Americans, and one of several communication options available to deaf people. ASL is said to be the fourth most commonly used language. American Sign Language is a unique system of communication because it is both a visual language and manual language. Instead of expressing himself through sound, a speaker using ASL employs a combination of facial expressions, body language, gestures, palm orientations, and hand shapes.[13] ASL consists of about 6,000 signs for representing the commonly used words, most of signs in ASL could be considered as a combination of 36 basic hand shapes. These 36 hand shapes include most of ASL alphabets and their variations. Therefore, the recognition of ASL alphabets is not only important for spelling a person's name and the words which are not in the ASL vocabulary, but vital for further research on word and sentence recognition[7]. Figure (1) show an example of ASL alphabets:

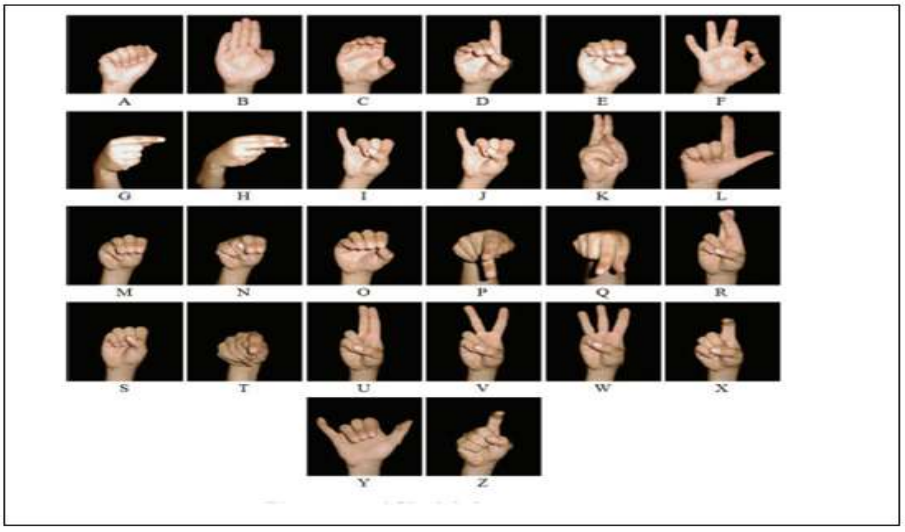


Figure (1): American sign language alphabets.

4. OTSU SEGMENTATION ALGORITHM

Image segmentation is one of the most fundamental and difficult problems in image analysis. Image segmentation is an important part in image processing. In computer vision, image segmentation is the process of partitioning an image into meaningful regions or objects[14]. Among all the segmentation methods, Otsu method is one of the most successful methods for image thresholding because of its simple calculation. Otsu's method [15] is one of the most popular methods for its simplicity and efficiency. It is based in thresholding technique. It depends on selecting the optimal threshold value that maximizes the between-class variance of resulting object and background classes. The search for the optimal threshold done sequentially until finding a value that makes variance between two classes or more maximum[16]. Otsu method is type of global thresholding in which it depend only gray value of the image. Otsu method is global thresholding selection method, which is widely used because it is simple and effective . Otsu is an

automatic threshold selection region based segmentation method .The Otsu method requires computing a gray level histogram before running [14]. Otsu's thresholding method based on a simple idea. Find the threshold that minimizes the weighted within-class variance. This turns out to be the same as maximizing the between-class variance. Assumptions for OTSU's method:

• Histogram (and the image) is bimodal.
• No usage of spatial coherence, nor other notion of object structure.
• Assumes stationary statistics, but can be altered to be locally adaptive.[17]

Suppose the intensity of a gray level image be expressed in L gray levels [1,2,...,L] the number of points with gray level at i is denoted by x_i and the entire number of points can be expressed as $X = x_1 + x_2 + \cdots + x_L$. The histogram of this gray –level image is regarded as a occurrence distribution of probability :

$p(i) = \frac{x_i}{X}$, $x_i \geq 0$, $\sum_{i=1}^{L} x_i = 1$ ……(1)

The image pixels are divided into two parts C0 and C1 , i.e. foreground and background by a threshold t. Where C0 represents pixels within levels [1,2,...,t] , and C 1 denotes pixels within levels [t+1,..., L].The occurrence probabilities of this class and average can be expressed as respectively[16] :

$w_0 = w(t) = \sum_{i=1}^{t} p(i)$ ……..(2)

$w_1 = 1 - w(t) = \sum_{i=t+1}^{L} p(i)$ ……(3)

$\mu_0 = \sum_{i=1}^{t} \frac{i.p(i)}{w_0} = \frac{1}{w(t)} \sum_{i=}^{t} i.p(i)$ ……(4)

$\mu_1 = \sum_{i=t+1}^{L} \frac{i.p(i)}{w_1} = \frac{1}{1-w(t)} \sum_{i=t+1}^{L} i.p(i)$ …… (5)

Total mean can be written as :

$\mu_T = \sum_{i=1}^{L} i.p(i)$ ……..(6)

And then :

$\mu_T = w_0 \mu_0 + w_1 \mu_1$ ……..(7)

Where w_0 and w_1 denote probabilities of foreground part and background part .Besides, μ_0 , μ_1 refer to the mean in gray levels of the foreground of the gray image, the background of the gray image and the entire gray of level image.The between-class variance σ_B^2 of the C0 and C1 is given by :

$\sigma_B^2 = w_0 (\mu_0 - \mu_T)^2 + w_1 (\mu_1 - \mu_T)^2$ .... (8)

The separable degree η of the class, in the discrimination analysis , is

$\eta = \max_{1 \leq t \leq L} \sigma_B^2$ ……(9)

Finally, maximizing σ_B^2 to choose the optimal threshold t^*

$t^* = \arg \max_{1 \leq t \leq L} \sigma_B^2$ …….. (10)

5. PROPOSED METHOD

The proposed method consists of four stages which include reading image from the database that contains some of ASL signs, image resizing, color space conversion, and then applying Otsu algorithm. The general architecture of the proposed Otsu segmentation method is shown below in figure(2):

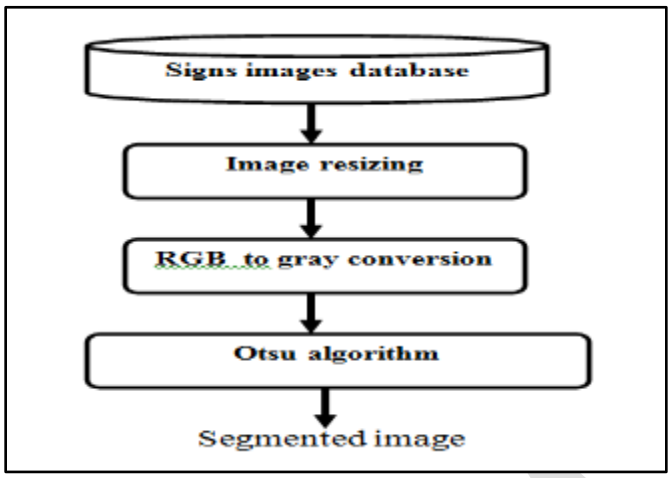


Figure (2): Architecture of the proposed method

5.1 IMAGE DATABASE

In this work, the ASL signs were used for image segmentation purpose. The database consists of nine RGB images for ASL signs that representing the numbers from one to nine which is collect from the web. The images with the same size have the dimensions (320 x320) pixels. Figure (3) show the database images:

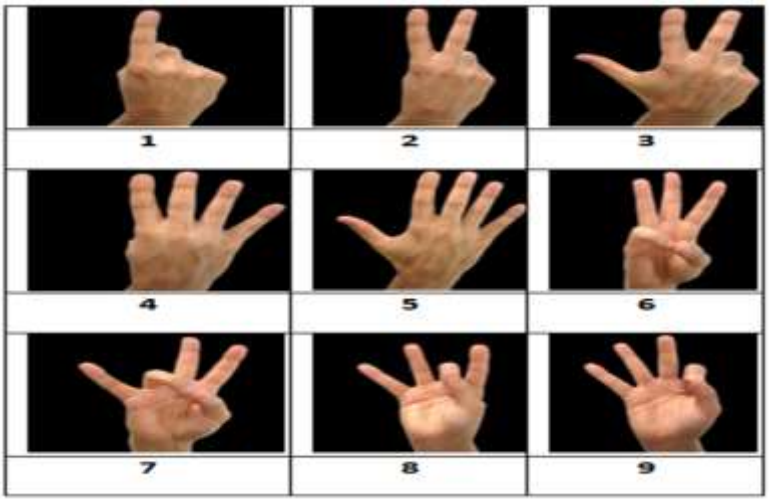


Figure (3): ASL numbers from one to nine.

5.2 IMAGE RESIZING

The input image is first resized into the size of (200 x 200) pixels. Image resizing is done to reduce the processing time by the computer and allowing algorithm for better performance.

5.3 COLOR SPACE CONVERSION

The images are converted to gray scale image thus removing all color
information, leaving only the luminance of each pixel using equation (11). The gray scale image has the gray level intensity ranging from 0 to 255.

$$y = 0.2989 * R + 0.5870 * G + 0.1140 * B \quad \ldots\ldots\ldots\ldots\ldots\ldots(11)$$

5.4 OTSU ALGORITHM

The steps of the OTSU algorithm: For each potential threshold T,

1. Separate the pixels into two clusters according to the threshold.
2. Find the mean of each cluster.
3. Square the difference between the means.
4. Multiply by the number of pixels in one cluster times the number in the other.[18].

6. EXPERIMENTAL RESULTS

The experiments of the proposed Otsu segmentation method are implemented on Intel Core i7-2330M CPU, 2.20 GHz with 2 GB RAM under Matlab environment and a Windows 8 platform. At first the color sign image is reading from the database then it resized .The RGB resizing image is converted to grayscale as shown in figure (4):

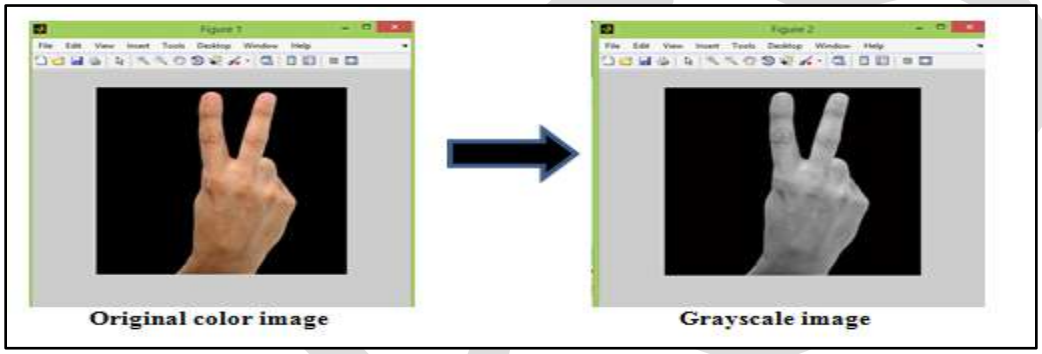


Figure (4): Colored Image conversion.

Then the Otsu segmentation algorithm is applied on grayscale image to obtain the segmented image as show in figure (5):

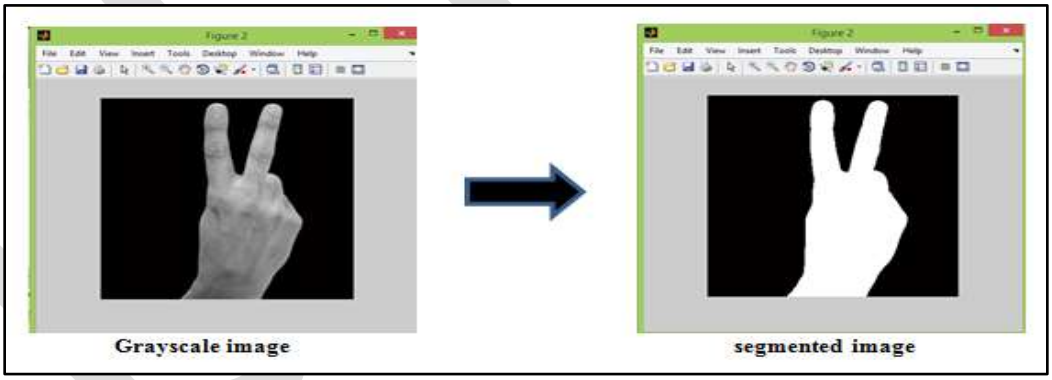
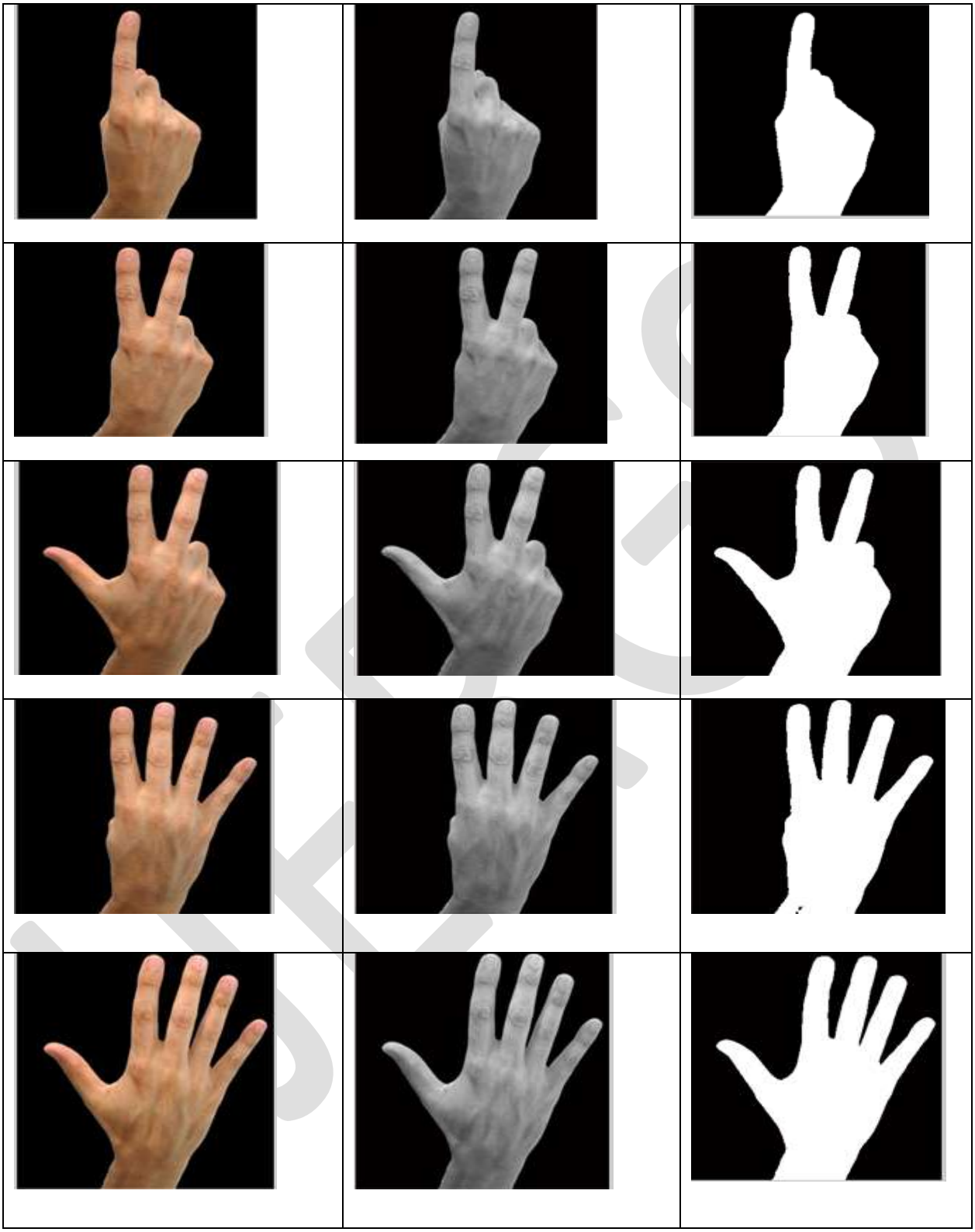


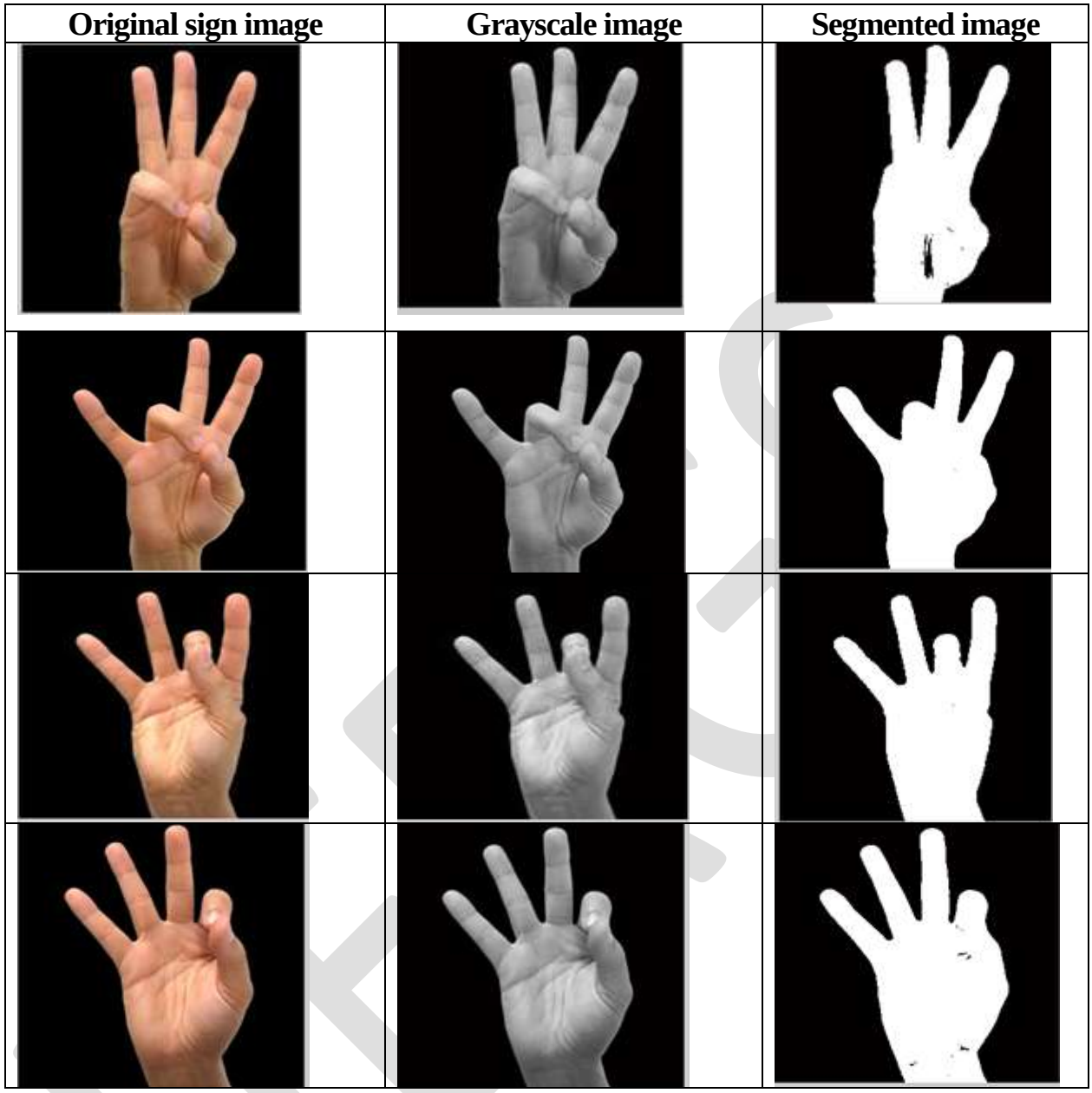
Figure (5): Otsu segmentation algorithm result

The same steps applied for the rest images given the result as shown in figure (6):

Original sign image	Grayscale image	Segmented image



Figure(6): Results of Otsu segmented algorithm for signs numbers from one to five.



Figure(6): continued -Results of Otsu segmented algorithm for signs numbers from six to nine

7. CONCLUSION

Image segmentation is often used to distinguish the foreground from the background. In this paper, the Otsu thresholding method has been proposed for ASL sign image segmentation. This method is robust, fast and very easy to implement and produces suitable binary images, which can be used in further processing stages such as feature extraction and recognition. The Otsu method is very efficient method to threshold the gray images. The experimental results show that the proposed Otsu threshold method can be obtained easily with a better result of image segmentation.

REFERENCES:

[1] Madhuri Sharma, Ranjna Pal and Ashok Kumar Sahoo, "Indian Sign Language Recognition using Neural Network and KNN Classifiers", ARPN Journal of Engineering and Applied Sciences , vol. 9, No. 8, August 2014.

[2] Rohit Sharma, Yash Nemani, Sumit Kumar, Lalit Kane, Pritee Khanna,Member,IAENG,"Recognition of Single Handed Sign Language Gestures using Contour Tracing Descriptor" , Proceedings of the World Congress on Engineering Vol II, July , 2013.

[3] Neha S. Chourasia, Kanchan Dhote, Supratim Saha , "Analysis on Hand Gesture Spotting using Sign Language through Computer Interfacing", International Journal of Engineering Science and Innovative Technology (IJESIT) Volume 3, Issue 3, May 2014.

[4] Jayashree R. Pansare, Shravan H. Gawande, Maya Ingle ," Real-Time Static Hand Gesture Recognition for American Sign Language (ASL) in Complex Background",Journal of Signal and Information Processing, 2012.

[5] Sunita Patidar, Dr. C.S.Satsangi, "Hand Segmentation and Tracking Technique using Color Models", International Journal of Software & Hardware Research in Engineerin Volume(1)Issue(2),October ,2013.

[6] Neha V. Tavari, Prof. A. V. Deorankar, "Indian Sign Language Recognition based on Histograms of Oriented Gradient", International Journal of Computer Science and Information Technologies, Vol. 5 , 2014.

[7] Honggang Wang, Ming. Leu and Cemil OZ, "American Sign Language Recognition Using Multi-dimensional Hidden Markov Models*", Journal of Information Science and EngineeringG , (2006) .

[8] Neha S. Chourasia, Kanchan Dhote, Supratim Saha ,"Analysis on Hand Gesture Spotting using Sign Language through Computer Interfacing", International Journal of Engineering Science and Innovative Technology (IJESIT) Volume 3, Issue 3, May 2014.

[9] S. Kausar, M. Y. Javed, and S. Sohail, "Recognition of Gestures in Pakistani Sign Language using Fuzzy Classifier," in Proc. the 8th International Conference on Signal Processing, Computational Geometry and Artificial Vision, Greece, 2008.

[10] Xu Zhang, Xiang Chen, Associate Member, IEEE, Yun Li, Vuokko Lantz, Kongqiao Wang, and Jihai Yang, "A Framework for Hand Gesture Recognition Based on Accelerometer and EMG Sensors",IEEE Transactions On Systems, Man, And Cybernetics ,PART A: Systems and Humans, Vol. 41, No. 6, November, 2011.

[11] Cao Dong, Ming C. Leu and Zhaozheng Yin, "American Sign Language Alphabet Recognition Using Microsoft Kinect", IEEE,Computer Vision Foundation , 2015.

[12] Divya S , Kiruthika ,S Nivin Anton A L and Padmavathi S," Segmentation, Tracking And Feature ExtractionFor Indian Sign Language Recognition", International Journal on Computational Sciences & Applications (IJCSA) Vol.4, No.2, April 2014.

[13] Prof.Sayyad T.J. "Recognition of ASL using Hand Gestures", International Journal of Emerging Trends & Technology in Computer Science (IJETTCS), Volume 2, Issue 5, September – October ,2013.

[14] Miss Hetal J. Vala, Prof. Astha Baxi " A Review on Otsu Image Segmentation Algorithm", International Journal of Advanced Research in Computer Engineering & Technology (IJARCET) Volume 2, Issue 2, February 2013.

[15] Otsu N., "A threshold selection method from gray-level histogram," IEEE Trans. On System Man Cybernetics, 1979, Vol. 9, No. 1, pp. 62- 66.

[16] Ali El-Zaart and Ali A.Ghosn, " MRI Images Thresholding For Alzheimer Detection",", International Journal of Computer Science & Information Technology (CS & IT),2013.

[17] D. Palani , K. Venkatalakshmi,E. Venkatraman," Implementation & Comparison Of Different Segmentation Algorithms For Medical Imaging" , International Journal of Innovative Research in Science, Engineering and Technology Volume 3, Special Issue 3, March 2014.

[18] Y.Ramadevi, T.Sridevi, B.Poornima, B.Kalyani, " Segmentation and Object Recognition Using Edge Detection Techniques", International Journal of Computer Science & Information Technology (IJCSIT), Vol 2, No 6, December 2010.