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Performance Analysis on Hand Gesture Recognition Using Artificial Neural Network

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Abstract:

The communication gap between normal people and hearing impaired people needs to be reduced with the help of advanced technology. Two-way intermediate devices with gestures to words and words to gestures are the best solution for both communities. This paper introduces one-way translation system with gestures to words by combining Artificial Neural Network (ANN) methodology with image processing technology. Human gestures are captured via Laptop Webcam and the system's Graphical User Interface (GUI) translates these gestures into words. Performance analysis for this system is also done. The system is created by using MATLAB environment because it is very easy to manipulate and easy to understand. Gesture recognition is also very important for many other applications such as robotic with artificial intelligent (AI), etc.

Keywords:

Hearing Impaired People, Gestures Recognition, Artificial Neural Network, MATLAB, Artificial Intelligent

1. Introduction

Over 5% of the world's population and 650,000 people of Myanmar's population are suffering from the disability of hearing loss. They have difficulties in teaching and learning. Only 2% of these people hold Bachelor's Degree and 50% don't have access to education. According to this survey, it is obvious that there is isolation between deaf community and normal community. Deaf people are finding difficulties in teaching and learning due to lack of well-communicated system. Some hearing impaired people are becoming psychological problem owing to their thought of being abnormal. One of the bitter truths of today's society is that deaf people can rarely access to the normal working environment because of the lack of skills and knowledge that can't be normally taught in deaf and dumb school [1]. In some areas, they are being discriminated in society both intentionally and non-intentionally as the

ones who are holding big weak points. Sadly, there is no national well planned implementation for deaf and dumb people's life and rights.

To reduce these problems, a system that can act as a bridge between normal people and hearing impaired people and provide a "Dialog Communication" should be implemented. System can be implemented by using different platforms. This system should consider every factor mostly related to deaf people like sign language they have mostly used, the environment they are living, the problems and the conditions they are facing, their intention to communicate well, etc. Analysis and survey about these factors is done before system implementation. It would be better if the system is implemented from the small case like static character recognition and common body signs recognition to the whole sign language including both static and dynamic signs. After the implementation of this system, this should be promoted to be widely used in community.

2. Literature Review

According to the literature survey, Kamal Preet Kour and Dr. Lini Mathew from Electrical & Panjab University presented sign language recognition system by using image processing. In this system, Speed Up Robust Features (SURF) algorithm was used for feature detection and feature extraction of hand gesture with the help of MATLAB environment. Testing and recognizing with 26 alphabets such A, B, etc were done. The main weak point is that SURF algorithm was not robust when different images with different conditions were being used for feature matching [5].

The another literature work is "A Survey on Hand Gesture Recognition Techniques, Methods and Tools" presented by Nidhibahen Patel and Dr. Selena (Jing) He, Kennesaw State University, USA. In this work, two different techniques such as glove based and vision-based approach were discussed. It pointed out that both approaches have their own advantages and limitation [6].

After doing some literature survey, this paper introduces a gesture recognition system by combining Artificial Neural Network (ANN) methodology with image processing technology so that it can be recovered some of the limitations from the literature works.

3. Methodology

The overall system block diagram is shown in Figure 1. The webcam captures the human gestures in front of the computer. After acquiring the images, the following steps are done.

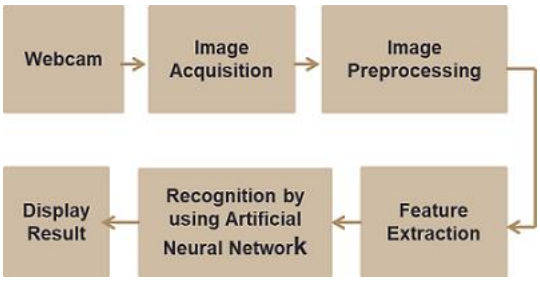

Figure 1. *System Block Diagram.*

3.1. Image Preprocessing

The very important step after image acquisition is preprocessing. This step includes converting RGB images to gray scale images, removing the noises from the images and resizing the images.

3.2. Feature Extraction

Feature extraction is also an important step for a successful recognition process. Features are specific structures in the image data. They are invariant to common image transformations like scaling, rotation, translation and changing the lighting conditions and colors. Examples of features are Edges, Corners/Interest points, Blob/Region of interest points and ridges (elongated objects). Among these types of features, edge is used for feature extraction. Canny Edge Detection Algorithm is used to extract the features. This method calculates the gradient using the derivative of a Gaussian filter. The derivative of a Gaussian filter is done by using equation (1).

$$g \otimes h = \begin{bmatrix} 0.0030 & 0.0133 & 0.0219 & 0.0133 & 0.0030 \\ 0.0133 & 0.0596 & 0.0983 & 0.0596 & 0.0133 \\ 0.0219 & 0.0983 & 0.1621 & 0.0983 & 0.0219 \\ 0.0133 & 0.0596 & 0.0983 & 0.0596 & 0.0133 \\ 0.0030 & 0.0133 & 0.0219 & 0.0133 & 0.0030 \end{bmatrix} \otimes \begin{bmatrix} 1 & -1 \end{bmatrix} \quad (1)$$

3.3. Recognition

Among others recognition methods, Artificial Neural Network (ANN) is the choice for this system. Neural network is a computing model with layered structure resembling the network structure of neurons in the human brain. This is the main point for truly recognition of human gestures. The working principle of artificial neuron is as the following equation (2).

$$net_{output} = F(net_{input}) = F(WX + B) \quad (2)$$

In the above equation, net_{input} is the input for the activation function F and net_{output} is the output of the neuron. X is the input vector and W is the weight vector. B is the bias constant. The activation function used is linear function. In this system, feed forward neural network with two hidden layers is used. The network is trained under a supervised learning scenario. Gradient Descent with Momentum and Adaptive LR Algorithm is used to train the images by calculating Mean Square Error value. It can train 10000Epoches in 41 seconds.

4. Test and Results

There are two categories of hand gestures: static gestures and dynamic gestures. The recognition of static images is only implemented in this system.

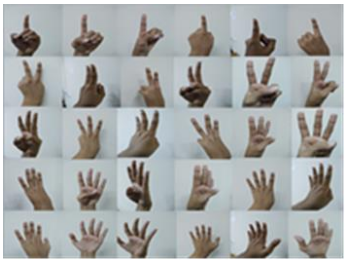

Figure 2. *Training Images in Dataset (Numbers).*

Static gestures for five numbers such as 1, 2, 3, 4, 5 and five characters such as A, B, C, D, E are used and tested. Figure 2 shows the training images for numbers and

Figure 3 shows the edge features for the training dataset. Figure 4 shows the training images for characters and Figure 5 shows the edge features for the training dataset.

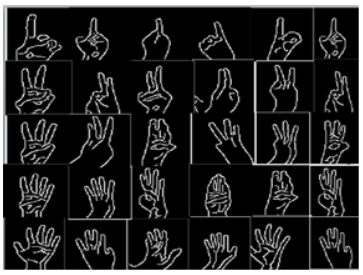

Figure 3. *Edge Features for Training Dataset (Numbers).*

Figure 4. *Training Images in Dataset (Characters).*

Figure 5. *Edge Features for Training Dataset (Characters).*

Figure 6. *Testing Result for Number '2'.*

After the training process is done and satisfied, gestures for numbers and characters are tested with various conditions of background and noises in several times. Figure 6 shows testing result for number '2'. Figure 7 shows testing result for number '3' by adding speckle noise with variance 0.04, but the result shows the number '3' as the number '5' wrongly.

Figure 7. *Testing Result for Number '3' with Speckle Noise with Variance 0.04.*

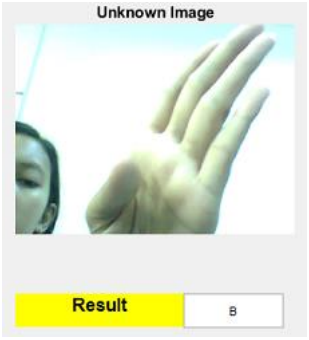

Figure 8. *Testing Result for Character 'B' with Bright Background.*

Figure 9. *Testing Result for Character 'C' with Gaussian Noise with Variance 0.03.*

Figure 8 shows the testing result for character 'B' with bright background. It gives the true result as character 'B'. However, it gives the wrong result as character 'A' instead of character 'C' in Figure 9, with the condition of adding Gaussian noise of variance 0.03. Figure 10 shows the accuracy testing in preprocessing step of character 'A', 'C' and number '3'. The accuracy of the system is calculated as the following equation (3).

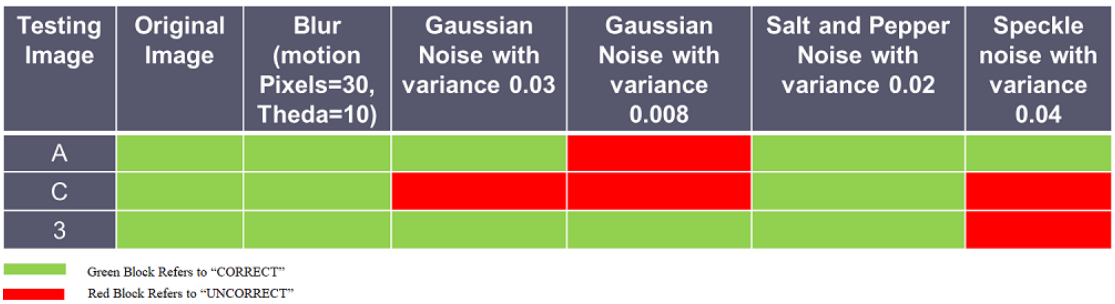

Figure 10. *Accuracy Testing With Various Noises*

$$Accuracy\% = \frac{Number\ of\ correct\ result}{Total\ number\ of\ testing\ times} \times 100\% \quad (3)$$

According to Figure 10, the gesture recognition system gives 83% of accuracy for character 'A', 50% of accuracy for character 'C' and 83% of accuracy for number '3', in various noise conditions. Moreover, the real time accuracy testings' result is shown in Table 1.

Table 1. *Real Time Accuracy Testings' Result.*

Hand Gesture	Number of Matches (Out of 10)
1	10
2	9
3	8
4	8
5	9
A	8
B	8
C	6
D	7
E	7
Total Matches	80 Matches
Average	80 Matches/100Trials
Total Accuracy%	80%
Error %	100% - total accuracy% = 100% - 80% = 20%

Hundred trials are done for gesture testing in real time. Table II lists the number of matches for numbers and characters gestures. Out of 100 trials, 80 matches were occurred. Therefore, the system accuracy is 80% and the error percent for this system is 20.

5. Conclusion

In this paper, performance analysis and accuracy testing on Hand Gesture Recognition System are done. Artificial Neural Network (ANN) is used for improving recognition accuracy. The system is implemented for five numbers such as 1, 2, 3, 4, 5 and five characters such as A, B, C, D, E. Real time accuracy for this system is 80%. Neural network approach still needs to attempt to obtain 100% accuracy. To obtain 100% accuracy, the images in the dataset must be considered and trained with several kinds of conditions like lightening, noise, blurring, etc. The more the images to train, the more reliable the result and the more the time ANN take for processing in MATLAB. In this system, the amounts of training images are reduced to avoid the long processing time.

Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this article.

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