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Novel Feature Extraction Technique for Indian Sign Language Recognition using Energy Compaction of Cosine Transform

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ABSTRACT
Sign language is the basic medium of communication for the deaf and dumb people. It has evolved as one of the major areas of research and study in Computer Vision. In this paper we display the importance of Indian Sign Language and proposed techniques for feature extraction and their efficient results. Indian Sign Language has a total of 26 alphabets using either one hand or both hands to show the sign. With the help of energy compaction using discrete cosine transform, maximum energy is packed into lows frequency region. In order to ensure efficient feature extraction and enabling feature vector size to be as small as possible, this paper proposes a novel technique to perform feature extraction and obtain high efficiency. Two techniques have been proposed with regard to reduced complexity and give better efficiency out of which the second approach of considering a feature vector of size 3 has been proved to be the best. It results in least computational complexity in query optimization and further gives 84.61% accuracy in detection of signs.

This paper presents the comparison among various transforms for feature extraction from hand sign images. The proposed techniques for feature extraction are executed on a dataset of 260 images (consisting of 10 images of each alphabet).

Keywords
Feature extraction, DCT, Energy compaction, Feature vector.

1. INTRODUCTION
Sign language is basically a language which uses manual communication and body language to convey meaning. This can involve combining hand shapes, orientation and movement of hands. It can be considered to be a replacement of speech for hearing and visually impaired people. Thus, because of which it has attracted many researchers in this field since long. Many researchers have been working on different sign languages like American Sign Language, British Sign Language and others but less work has been carried on in Indian Sign Language.

To build an application for the deaf and dumb community has become of utmost importance today. With the changing world in terms of technology innovations and education opening new arenas of opportunities, it becomes necessary for everyone to be ahead of the others in this race. In order to enable the deaf and dumb community to create a recognition and also to give them a standard platform to communicate and express their opinions with every other individual, this application is being created.

A sign language uses hand gestures in order to communicate with the other end. On the other end, it could be either a deaf and dumb person wishing to communicate or a normal person. In order to bridge the gap between the visually challenged and hearing impaired people with the others, the application which would be built would work as a translator to translate American sign language to Indian and vice versa. It would also convert text to either of the sign languages and back. This would make communication among all people easier and convenient. With an initiative to build a unified interface between the two, this paper focuses on the stage of efficient feature extraction to provide ease to the translation of sign languages. [10][11]

2. INDIAN SIGN LANGUAGE
Indian Sign Language [2] was developed so that the deaf people in the society can interact with the normal people without any difficulties. In this paper, we have considered the alphabets of ISL which involves the use of either single hand or both hands. A total of 26 alphabets were considered which is shown in Figure 1.ISL comprises of around 3000 gestures and other common words. The common words are shown with some specific gesture or spelling with the help of 26 hand gestures indicating 26 alphabets of ISL. This application initiates to focus on the importance to be given to ISL neglecting the limitations widely known.

Fig 1: 26 alphabets of Indian Sign Language

3. FEATURE EXTRACTION
Feature extraction involves simplifying the amount of features required to describe a large image accurately. When performing analysis of a large image, which involves innumerable features, one of the major problem that stems out is the number of feature vectors involved. Analysis with large number of features generally requires a large amount of memory and computation power. So in order to reduce the amount of time taken to perform this complex computation, a novel technique is to be proposed which extracts the minimum required feature vectors to process and obtain output efficiently.

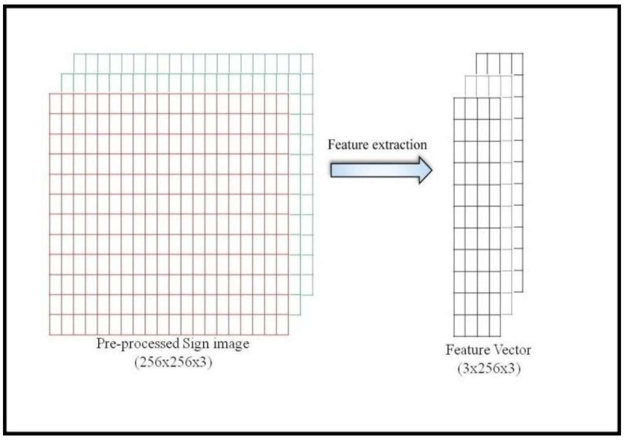


Fig 2: Extracting feature vector of size 3

4. DISCRETE COSINE TRANSFORM (DCT)

A discrete cosine transform (DCT) [13] expresses a sequence of finitely many data points in terms of a sum of cosine functions oscillating at different frequencies. It is a technique of converting a signal into elementary frequency components. In particular, a DCT [3] is a Fourier-related transform similar to the discrete Fourier transform (DFT), but using only real numbers. DCTs are equivalent to DFTs of roughly twice the length, operating on real data with even symmetry.

The definition of the two -dimensional DCT for an input image A and output image B is where M and N are the row and column size of A, respectively. If you apply the DCT to real data, the result is also real[4]. The DCT decomposes a signal into its elementary frequency components. When applied to an MxN image or matrix, the 2D-DCT compresses all the energy information of the image and concentrates it in a few coefficients located in the upper left corner of the resulting real-valued MxN DCT/frequency matrix. [4][12]

$$A=\begin{bmatrix} a_{11} & a_{12} & \cdots & \cdots & \cdots & a_{1m} \\ \cdots & \cdots & \cdots & \cdots & \cdots & \cdots \\ a_{m1} & a_{m2} & \cdots & \cdots & \cdots & a_{mn} \end{bmatrix} \quad (1)$$

$$B=\begin{bmatrix} b_{11} & b_{12} & \cdots & \cdots & \cdots & b_{1m} \\ \cdots & \cdots & \cdots & \cdots & \cdots & \cdots \\ b_{m1} & b_{m2} & \cdots & \cdots & \cdots & b_{mn} \end{bmatrix} \quad (2)$$

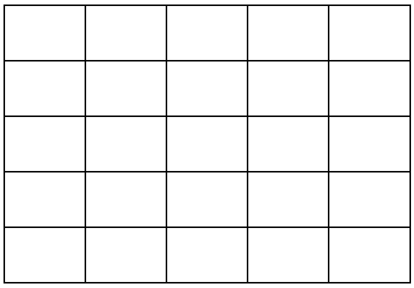
These DCT coefficients can be used as a feature vector (FV) to retrieve the sign images. The retrieval becomes possible because of the DCT coefficients as the DC components of DCT coefficients reflect the average energy of pixel blocks whereas the AC components reflect the intensity. DCT is a lossy compression technique that separates an image into discrete blocks of pixels of differing importance with respect to the overall image [5].

5. ENERGY COMPACTION USING DCT

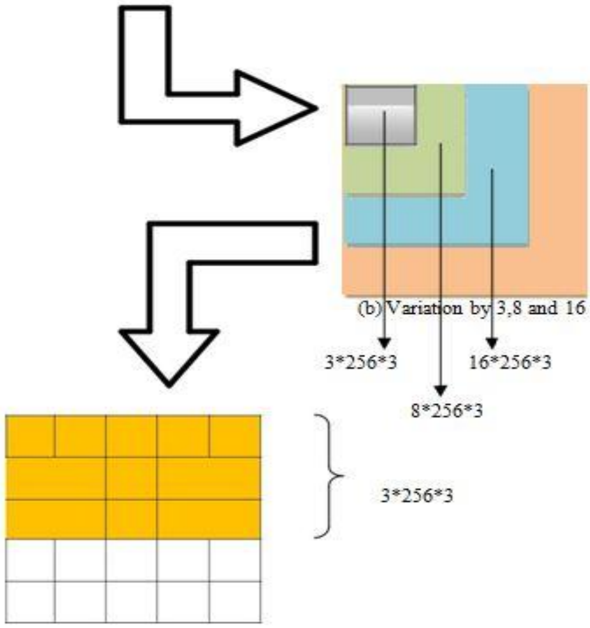
DCT exhibits excellent energy compaction for correlated images. The uncorrelated image has its energy dispersed out, whereas the energy of the correlated image is packed into the low frequency region. The DCT concentrates energy into lower order coefficients than does the DFT for image data and thus it is proved that energy compaction can be achieved to the maximum using Discrete Cosine Transform.[7][8]

6. EXPERIMENTATION

Two techniques have been proposed in order to observe the performance of feature extraction. The conventional method which is to perform feature extraction on full 256*256 image is shown in Fig 3(a).The first technique is shown in Fig 3(b) which is the representation after selecting fractional co-efficients from high energy area in sign images. The second technique is shown in Fig 3(c) which is the image which represents a feature vector of size 3.[1][9]



(a)Transformed image of 256*256



(c)Transformed image of feature vector 3

Fig 3: Proposed Techniques for Feature Extraction

1. Platform

The system is implemented in MATLAB version 12.0. The testing and training were run on standard laptop(1.18 GHz Core-2Duo processor, 1.96GB of RAM running under windows XP) and web camera (640*480 resolution) is used for capturing images.

2. Testbed

The dataset used for training and testing is specified to consist of 260(26*10) sign images each of black background of Indian Sign Language. Each image is resized to 256*256.

7. RESULTS AND DISCUSSIONS

When Discrete Cosine Transform is applied on fully transformed image, the results obtained are accurate up to 89. 23% i.e. out of 260 sign images in the dataset, 232 images are detected correctly. But this result is at the cost of high computational complexity which makes the system less efficient.

In Fig 3(b), the DCT is applied on fractions of fully transformed image and results are observed.

i) On applying DCT upon 16*256*3, the results obtained were accurate up to 75.38% and,

ii) On applying DCT upon 8*256*3, the results obtained were accurate up to 76.1%.

iii) On taking a minimum feature vector of size 3, the results obtained were accurate up to 84.61%.

In Fig 3(c), to obtain the best of the two most important factors i.e. computational complexity and feature vector size, a minimum of 3*256*3 feature vector size is chosen which is observed to give an accuracy of 84.61%. This is achieved by reducing the fully transformed image of 256*256*3 to 3*256*3. Thus, we are reducing the computation time up to 99.9% and at the same time achieving a performance of

84.61%. Therefore, it proves to be an efficient technique over all the proposed techniques.

Table 1: Result of proposed system

Serial No.	Letter	GAR(in %)
1	A	70
2	B	100
3	C	100
4	D	90
5	E	0
6	F	100
7	G	70
8	H	100
9	I	90
10	J	90
11	K	50
12	L	80
13	M	50
14	N	100
15	O	100
16	P	80
17	Q	80
18	R	80
19	S	0
20	T	90
21	U	70
22	V	50
23	W	70
24	X	100
25	Y	90
26	Z	100
GAR		220/260=84.61%

Accuracy of 84.61% achieved for feature vector of size 3 with Genuine Acceptance ratio(GAR)=220/260.

Future Scope for this project will be real time processing of words and sentence gestures.

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