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Implementation of Hand Gesture Recognition System In FPGA Using Pulse-Coupled Neural Network

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Abstract: An approach to develop a real-time hand gesture recognition enabling human-computer interaction which is "Vision Based" that uses only a webcam and Computer Vision (CV) technology. Existing systems use hand detection primarily with some type of marker. However, the proposed uses a real-time hand image recognition system without any marker, simply using bare hands. To perform and analyze the sign, the pulse coupled neural networks and k-Nearest Neighbors algorithm (k-NN) are used. It implements sign language, is the method of communicationamong deaf and dumb peoples. Thus it provides complete solution for the development of systems that canfacilitate automatic translation between sign language to text form and the recognized sign are also translated into user-frequent languages.

Keywords - Image processing, K-Nearest Neighbor algorithm (KNN), Pulse coupled neural network (PCNN) and Feature extraction of image.

I. INTRODUCTION

The human gesture are recognized by the mathematical algorithm in computer vision, such as hand gesture recognition, facial emotion recognition and human pose recognition.

Most of the mathematical algorithms are proposed to recognize the hand gesture and facial emotions. In recent years, the gesture are recognized by the computer vision through image processing and same hand held machines are used to recognize the hand gesture. For image processing the image is captured through camera in real time.

The sign languages recognition is proposed to improve the communication effectively with the deaf and dumb people. The gesture recognition has been implemented not only for deaf and dumb people, it can be useful for machine interaction which is used to control the peripherals and also for computer interactions. In this paper, theproposed method is used to recognize the hand gesture for deaf and dumb people to communicate with the normal person by using gesture, sign language examples are shown below fig 1.

Fig.1. Sign Language

Sign language are used to convey some meaningful information. The different types of ideas and actions are used to differentiate the gestures that includes shapes, orientation and figure pattern.But the hand gesture recognition is a challenging task, the major task in this paper is a recognition and classification of gestures with high accuracy.

The remaining part has structured like: In section 2 literature review of this paper is discussed section 3 consist of proposed methodology. Section 4 explains about simulation results. The conclusion of this paper is discussed in section 4.

II. LITTERATURE SERVEY

In paper [1], presented a review for the translating between Arabic sign and spoken language by the methods for the automatic recognition of the performance of sensor-based and image-based

systems,someresearchershavestartedlookingintohybridapproachesthat combine information from cameras as well as gloves.

In paper [2], proposed a hardware posture recognition system with a hybrid network. The hybrid network consists of self-organizing map (SOM) and hebbian network. Feature vectors are extracted from input posture images, which are mapped to a lower dimensional map of neurons in the SOM. The hebbian network is a single-layer feed forward neural network trained with a hebbian learning algorithm to identify categories.

In paper [3], with the developed HFR multi object extraction system to perform the recognition for human gestures with tracking method is done.

In paper [4], it consists of two interactive hardware components, one for key point identification, and the other for feature descriptor generation and developed a segment buffer scheme that could not only feed data to the computing modules in a data-streaming manner, but also reduce about 50% memory requirement. With a parallel architecture incorporating a three-stage pipeline.

In paper [5], introduces an automatic Arabic sign language (ArSL) recognition system based on the Hidden Markov Models (HMMs). A large set of samples has been used to recognize 20 isolated words from the Standard Arabic sign language. The proposed system is signer-independent. Experiments are conducted using real ArSL videos taken for deaf people in different clothes and with different skin colours.

In paper [6], a real-time vision-based hand posture recognition approach, based on appearance-based features of hand. For the hand segmentation, "Adaptive Histogram Template of Skin" which tries to extract histogram of the subject hand by sampling its color and texture. With the use of back projection method to find skin color areas in an image. In the feature extraction step, extracted globalhand's features using hand's edge contour and hand's edge convex hull.

In paper [7], the hardware and software co-design and implementation of KLT (Kanade Lucas Tomasi) tracking algorithm in a FPGA-based smart camera prototype for recognize simple hand gestures consisting of a CMOS image sensor capture unit and FPGA main video processor. This tracking system uses face and hand detections as a tool to detect and track gesture (face and hand motion).

In paper [8], application of the artificial neural networks (ANN) implemented in field programmable gate arrays (FPGA) for the hand static gestures (postures) recognition. The adopted recognition method uses an ANN structured on two levels. The first level, feed forward ANN trained using supervised hebbian algorithm, is used for input data pre-processing. The second one, used for data classification is a competitive ANN.

In paper [9], proposes a two level approach to solve the problemof real-time vision-based hand gesture classification. The lower level of the approach implements the posture recognition with Haar-like features and the Ada Boost learning algorithm. By the algorithm, real-time performance and high recognition accuracy can be obtained. The implementation of the linguistic hand gesture recognition using a context-free grammar-based syntactic analysis.

In paper [10], the use of polynomial classifiers as a classification engine for the recognition of Arabic sign language (ArSL) alphabet. Polynomial classifiers have several advantages over other classifiers in that they do not require iterative training, and that the results are highly computationally scalable with the number of classes.

III. PROPOSED METHEDOLOGY

The proposed methodology combines the features of k – nearest neighbours (KNN) and pulse coupled neural networks (PCNN). KNN is used for segmentation and PCNN is used for training and testing gestures. The segmentation using KNN is done from the difference of total area and the difference of hand gesture which is the sign captured by the webcam.The flow diagram of hand gesture recognition is given below in fig. 2.

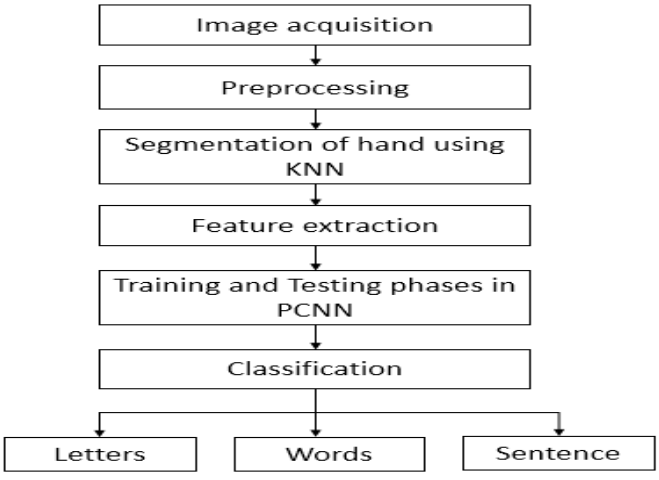

Fig.2. Flow chart

The blocks in the flow diagram is explained as follows.

A. Image Acquisition

The image is captured in real time by using web camera the gesture is captured and recognized as follows.

B. Image Preprocessing:

The image preprocessing is defined as the image can be previously processed before giving to the main application. The image is preprocessed to get suitable input image to recognize the gesture some preprocessing techniques are image de-noising, image conversion and image size conversion. The image de-noising or image filtering is used to remove the noise, which has been induced while capturing the image. Image conversion is performed at the colour level. (i.e) RGB to HSV, gray level, and binary or black & white conversion. The image can be converted based on the requirement. Size of the image can be changed by using resize function.

C. Image Segmentation:

The segmentation process is used to detect or segment the origin of interest in an image. Segmentation operation can be done by using threshold method. Threshold can be fixed based on the required object by segmentation, the inputs for the segmentations are features the object such as colour, shapes etc. In our proposed methodology segmentation is used to detect and segment level. The skin colour or hand colour is given as the input for thresholding. The segmented hand gesture will be converted to binary image.

Hand segmentation using KNN algorithm. The segmentation of hand is shown in below fig 3.

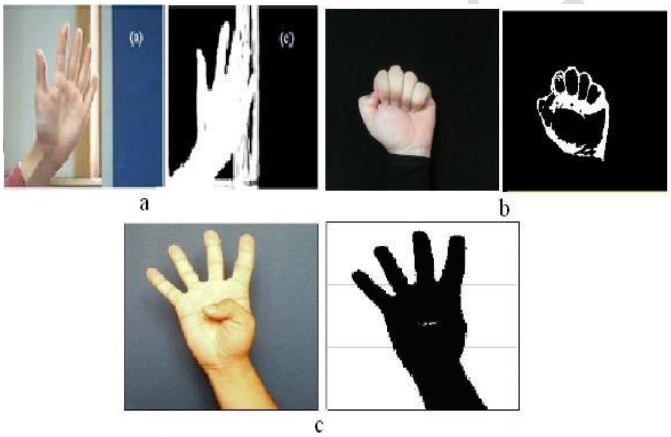

Fig.3. Segmentation of Hand by KNN

K - Nearest Neighbour algorithm is used to segment hand based on the feature of objects. KNN computes the objects by using the connectivity. It computes the nearest neighbours property based on its feature of pixels. First it detects the threshold value matched pixel after that if finds the other neighbour pixel feature whether it matches with the threshold value or not if the value is matched the neighbour pixel can be added as a connected objects. Likewise all pixels in the image is verified and the pixels are added in the two levels one is the connected component and another one is non connected component. The 'K' value specifies the connected components number of pixels. Finally the hand is segmented using KNN algorithm.

D. Feature Extraction:

The segmented hand is given to the binary object feature extraction. The extracted features are

1. Extrema Points
2. Area
3. Centroid
4. Diameter
5. Perimeter

1. Extrema Points:

The feature is extracted based on the extrema points in edge of the object. For every binary object will have an eight extrema points. Each points having two points which represents x and y position of that particular extrema points.

2. Area:

Area can be calculated for the white pixels in the binary image. The white pixels represents hand object.

3. Centroid:

Centroid point has been represented in two positions that's x and y values.This points are calculated from an objects center points.

4. Diameter:

It is the diameter of the objects, which is relevant to the area.

5. Perimeter:

This is a circumstance of the object, which is in the binary image the above parameters are different for each gesture. So, these parameters are used to recognize the gestures pulse coupled neural networks.

Pulse coupled neural network (PCNN):

Generally neural networks are designed to conclude the situation and decision making purpose with human brain technology, which is called as artificial intelligence. In that way many neural networks are proposed based on multiple technology and methods.

The PCNN is one of the suitable method for image processing, which is working based on pulse methods. The pulse can have the upper middle and lower thresholds values. It makes

decision based on it features, and it concludesabout the input features which consists of two phases.

1. Testing Phase
2. Training Phase

1. Testing Phase:

The test image of the hand gesture is proposed by above steps till feature extraction. The extracted features of the test image is given to the PCNN testing phase and the input features are compared with stored features in a data bases. It classifies the gesture based on features.

2. Training Phase:

The set of samples are taken for each and every gestures and all above steps are performed till feature extraction of gestures. Hundreds of sample images are taken for every gesture and their features are stored in the neural network system. Likewise all the gestures are trained and their features are stored in neural network.

Classification of gestures:

In our proposed methodology, it detects and classify the gesture like letters, words and sentence. In our proposed methodology the continuous sign language are classified.The detected gesture is converted into text and speech in matlab.

IV. SIMULATION RESULTS

MATLAB R2013a is used for simulation. The analysis and classification of hand gesture is performed.

Simulation result of image acquisition :

In this first phase, image acquisition is accomplished by means of a webcam, which captures images frame by frame. In fig. 4 the simulation of image acquisition is shown**.**

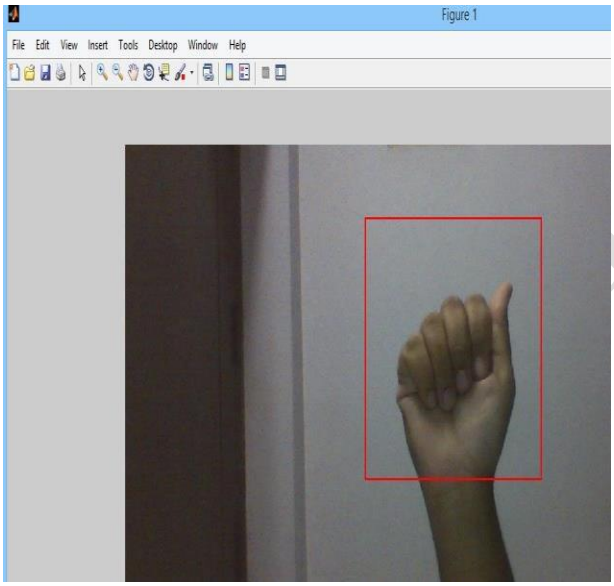

Fig.4. Simulation result of image acquisition

Simulation result of image segmentation :

In fig. 5 the image segmentation simulation is shown. The segmentation is one of the most important steps leading to the analysis of processed image data. Its main goal is to divide an image into parts that which has a strong correlation with objects or areas of the real image. In image analysis, thresholding is the simplest method of image segmentation.

The convex hull is the set of continuous points in the Euclidean space that is connected to contours. When the convex hull is drawn around the contour of the hand, it fits set of contour points of the hand within the hull.

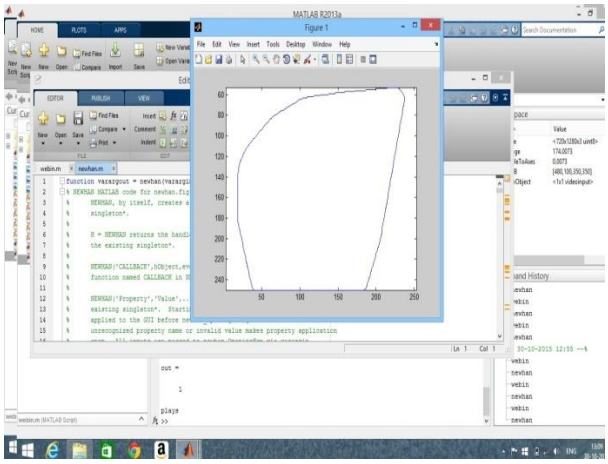

Fig.5. Simulation of image segmentation

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Simulation result of feature extraction :

This step is used to find and extract features of region of interest (ROI). The features to be extracted includes centroid, contour based features such as convexity defects and convex hull useful for gesture recognition.

It uses minimum points to form the hull to include all contour points inside or on the hull and maintain the property of convexity. This results in the formation of defects in the convex hull with respect to the contour drawn on hand.

Simulation result of hand sign recognition :

In the simulation result fig. 6.1, 6.2 and 6.3 the recognition of the sign is detected and the particular isolated alphabet, numbers and sentence is defined well.

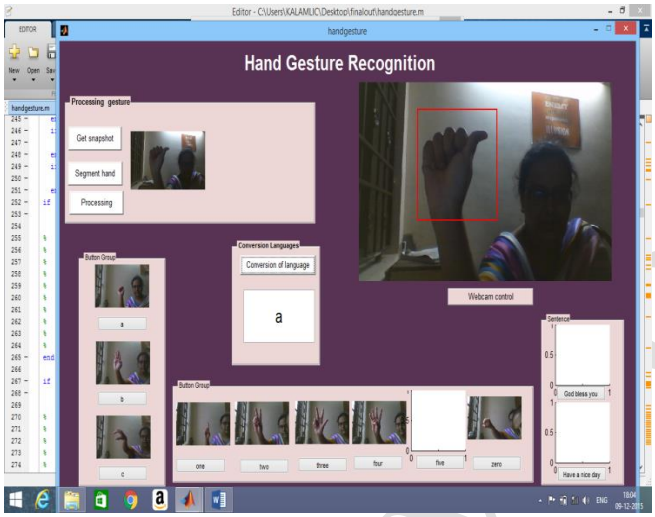

Fig.6.1 Simulation result of alphabet 'a'

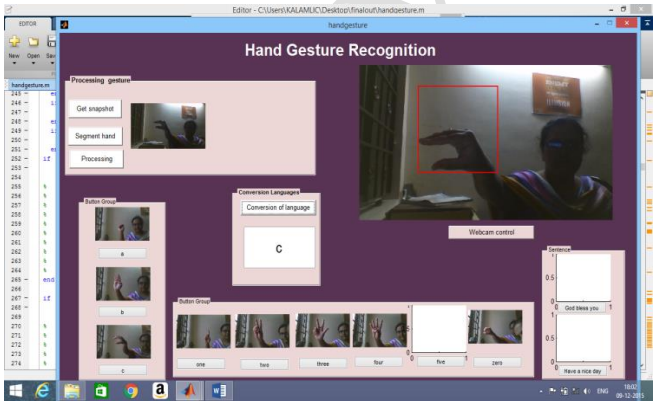

Fig.6.2 Simulation result of alphabet 'c'

Fig.6.3 Simulation result of number '3'

IV CONCLUSION

The simulation using MATLAB software the image processing done the image acquisition, image enhancement, image segmentation and feature extraction was done. The simulation of hand sign gesture recognition is perfectly detected and the simulation result is obtained in the form of text and speech.

Thus it provides the necessary solution for the communication between the deaf/dumb peoples. In future the image capturing is performed easily. The capturing of image through webcam. The training done to obtain the determined text form is difficult by using PCNN is difficult.

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