TOUCHLESS WRITER A HAND GESTURE RECOGNIZER FOR ENGLISH CHARACTERS

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Abstract—Gesture recognition is a field of computer science wherein the human gestures are interpreted via mathematical algorithms. Hand gesture recognition is one of the widely focussed areas in this field. The earlier method of using data gloves or high sensitivity sensors, to provide input to the system, proves a costly affair. The current paper deals with the English character recognition of the upper case. The system takes the gesture input done by means of a coloured object through the webcam. Artificial Neural Network (ANN) serves a useful method for the pattern recognition of the characters given as input. Thus by using cheap hardware like webcam, we can extend the use to various applications like gaming, paint, etc.

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I. INTRODUCTION

Humans have made tremendous advancements in the field of technology. Humans are trying to find more and more ways of making the computer intelligent because of the major developments in the field of science and education. Humans interact with the computer in many ways, which has lead to advancing the ways of human computer interaction (HCI) by creating many intuitive interfaces between them.

Gesture recognition is an advanced way of enhancing HCI. Gesture recognition has garnered much attention due to its apparent superiority over the known techniques in HCI. Gesture recognition enables a person to communicate with the computer and interact with it without using any mechanical device. The major fields under gesture recognition are emotion recognition from face and hand gesture recognition.

Hand gesture recognition has become a wide field of research due its extensive application in virtual reality, sign language recognition and gaming. Despite lots of previous works, the methods of recognizing a hand gesture become a challenge for many applications, which has ultimately lead to increase in the scope of the field.

The main difference between human and machine intelligence comes from the fact that humans perceive everything as pattern, whereas for a machine everything is data [1]. Humans understand patterns while machines can be said to recognize patterns in data. So, a pattern created by hand gesture is merely a data input given to the computer. This basic difference has led to identify and discuss pattern recognition tasks which humans can perform effortlessly, whereas no simple algorithms exist to implement these tasks on computer.

Humans are able to identify these patterns easily due to integrated process involving use of biological neural processing. It is for this reason attempts are being made to explore new models of computing, which are based on Artificial Neural Networks (ANN). In machine learning, ANN is a family of statistical learning algorithms, which are used to estimate the functions which can depend on the large number of inputs given. ANN is generally presented as a system of interconnected “neurons” which can compute values from the inputs.

Artificial Neural Networks comprises of a set of input values, hidden layer and output layer. There may be varying number of neurons in these layers. The output of a neuron is weighted sum of inputs with a bias. The function of the entire neural network is simply to compute the resultant output of all neurons.

II. LITERATURE SURVEY

Many attempts were made to improvise the means of making hand gesture recognition useful for recognizing the English characters. Given below are the works of some researchers in this field.

A. English Sentence Recognition through Mouse-based gestures:

FirojParwej [2] focused on the technique of using mouse gestures. Mouse gestures were used to give input to the system. The English Sentence was given as an input to the system, which was recognized by the system and the same sentence was displayed on the screen after recognition.

Various techniques such as pre-processing and feature extraction were applied so as to filter the data and generate accurate output.

B. Recognition of characters of text images:

Gaurav Kumar and Pradeep Kumar Bhatia [3] implemented the method of recognizing the

characters present on the text images. The process was divided into 2 phases. First phase focuses on image pre-processing, in which image is firstly converted into binary form based on some threshold value. After that, noise removal and feature extraction takes place. A multilayer feed forward neural network is formed and trained through back propagation algorithm. After the training phase, testing is carried out to match the pattern with test data.

C. Finger writing in the air using Kinect sensor:

In this paper, author WenjunZeng [4] focused on the following points:

a. The fingertip is made use of as a virtual pen. The Kinect sensor accepts the input given through hand gesture.
b. Segmentation: Depth-skin-background mixture model (DSB-MM) is used. This method sees for the distance of the virtual pen from the sensor, the colour of the pen and the background of the pen whose movements are to be identified.
c. The above segmented output is given as input to the ANN. This ANN gives us the confidence factors.
d. The next step is fingertip detection.
e. Character is recognized by compact modified quadratic discriminant function (MQDF) character classifier for finger writing trajectory recognition.

D. Handwritten Character Recognition using Neural Networks:

In this paper, the authors namely Amita Pal and Dayashankar Singh [5] have made contributions towards developing automatic handwritten character recognition system for English language. The sample is acquired by scanning, on which pre-processing is done. Boundary Detection Feature Extraction(BDFE) technique is then applied. By neural network classifier the character is recognized.

III. PROPOSED SYSTEM

The ways of recognizing the character according to the works of various researchers, mentioned above, were either scanning images or using sensors. We aim to provide the user with a much more easy and cheap means of interacting with the machine, eliminating the need of any external hardware device.

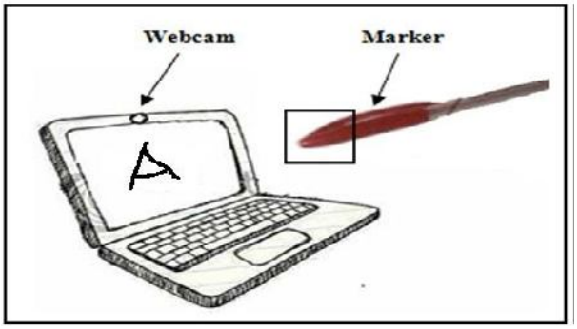

Fig. 1. Proposed Work

The system provides a way to interact with the computer without physically touching it. We aim to create a system which possesses the intelligence of recognizing the English characters of uppercase. The points below give an overview of the system:

1. The webcam is started.
2. The system recognizes a dark coloured object, which is contrasting to the background.
3. The user then needs to draw an English character pattern through hand gesture in front of the webcam.
4. After the input is captured by the webcam, the system will recognize the character and display on the screen.

IV. SYSTEM ARCHITECTURE

The system comprises of three major modules as shown in Fig. 2. The description of each is stated below.

1. Image processing module:

The images captured by the webcam are passed to the image processing module. It processes these images, matches them with the marked color pattern and translates the result into movement data.

The image processing module provides ability to track multiple objects through cameras. In this system, we specifically track one object. For the system to effectively track the object, it is required that the color of the object should be unique in the environment.

Once the object is recognized as the target object, the position data of its movement is tracked automatically.

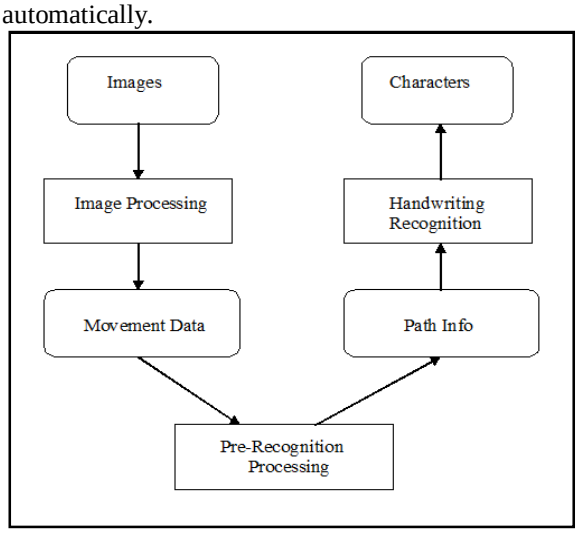

Fig. 2. System Architecture

2. Pre-recognition processing module:

Before the path information obtained by image processing module could be processed by neural network, they need to be pre-processed. When devices like digital tablets are used to capture handwriting strokes, the shapes of the strokes present the jagged forms. Generally, such noise information

influences the exploration of the profile of the handwriting in such a way as to influence further processes, such as feature extraction and classification. Three operations are involved here:

- Smoothing: Remove hooks and sharp points by down samplingthe stroke data.
- Deduplicate: Remove duplicated points from the strokes.
- Spatial Normalization: Scale the strokes into the same size.

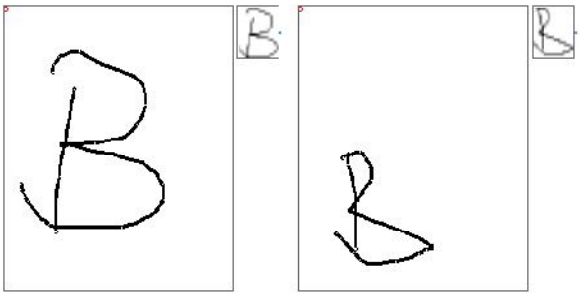

Fig. 3. Pre-recognition Processing

3. Handwriting recognition module:

In thissystem, we use Back Propagation Neural Networks withone input layer, two hidden layers and one output layer for handwriting recognition as shown in Fig.4. For better accuracy, we utilizeone neural network for distinguish each pair of the character.Only the 26 upper-case English characters are recognized in thesystem. That is to say, we have $C_{26}^{2} = 26 \times 25 \div 2 = 325$networks for recognition. The result is obtained after 25compares.

To train these networks, we use handwriting sample fromNeuronDotNet that contains 185 different scripts for eachupper-case characters. We train each network with these samplesfor 200 cycles so that the average mean square error ofthe networks can be reduced to a large extent.

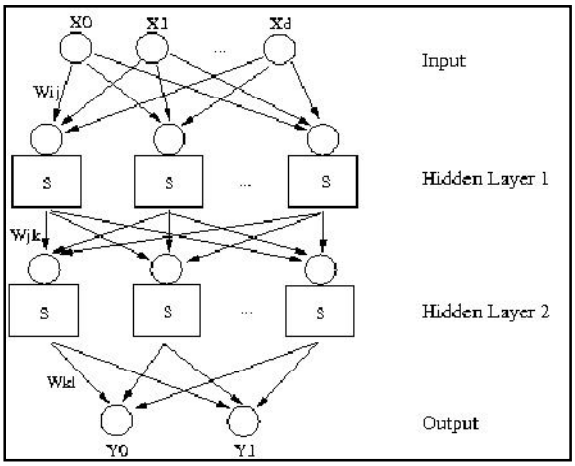

Fig. 4. A sample neural network

V. EXPERIMENTAL SETUP AND RESULTS

The setup includes two sections of experiments in research, first of which is to examine the effect of training cycle to the network mean square error and training time. The second one is to test the performance of Touchless input in handwriting recognition with pre-trained neural network. Along with this, we also conduct performance tests, which include the performance measures of the hardware used. This test determines the boundary levels for optimal results.

The experimental results, finding show excellent recognition rate for English characters. The recognition system achieves an average recognition rate of 91% for isolated English characters i.e. the sample data collected from 4 people for 50 set of English characters each as given in table I. The results were generated with Microsoft Visual Studio 2008. The results environment has been established under Windows XP and Windows 8 operating system. The hardware included Intel core i3 processor 2.0GHz, with 4 GB DDR3 RAM, and 500 GB Hard Disk.

E. Neural network training

Considering the training samples are fixed, it is usually believed that larger amount of training cycles would yield better mean square error, which in general indicates better test result. However, more training cycles spend more training time as well. This is because for general training algorithm, majority of the training time is spent along the connection between neurons, is propagating data, which determines the traversing time for each cycle. We run the training algorithm on the same training samples for different cycles and examine the relation between the number of cycles and the output mean square error.

In the raw result, as shown in Fig. 5, the training time increases as number of training cycle goes up.

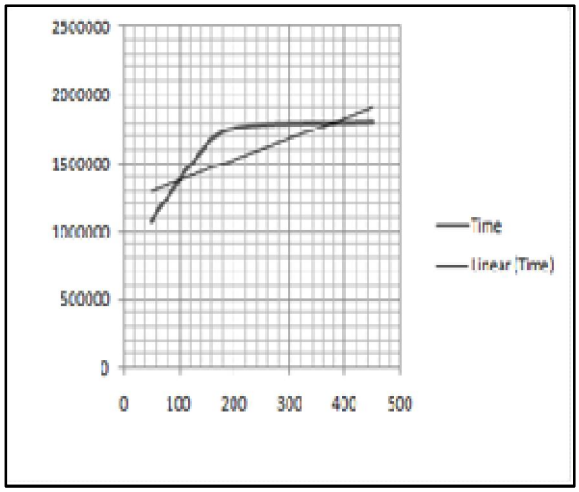

Fig. 5. Training Time

We can see that before first 200 cycles the time curve climbs really fast, and then it becomes steady when it reaches an inflection point.

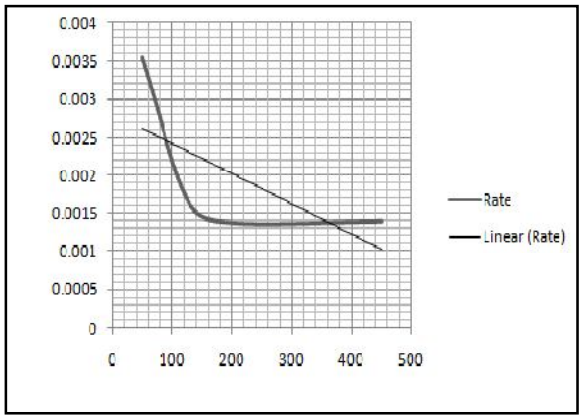

Fig. 6. Training Result

F. Handwriting Recognition

With our pre-trained neural network, we aggregate the performance of Touchlessas input device in handwriting recognition. The input sample of the experiment is the set of alphabets present in English language. The English language character set is used as the scope of the system until now, is just recognising English characters. Each set of test includes one person to draw each character of the sentence sequentially into the computer, using marker in front ofthe camera(Touchless). Every drawing of character is followed by recognition the character. If the drawing by the user fails to be recognized by the system, the person needs to redraw the same character until the drawing can be recognized as the correct character. The whole process is timed, including the recognition time and the time for re-drawing.

As shown in Table I, unique errors and error rate of Touchless is pretty low compared to rest of the systems.This means that by utilizingTouchlesswith neural network in handwriting recognition, itsinaccuracy is well compensated, thus the performance is not affected by this factor.

TABLE I. Recognition percentage

Set	Total input	Valid output	Errors	Error rate %
1	50	46	4	8
2	50	46	4	8
3	50	43	7	14
4	50	47	3	6
Average	50	45.5	4.5	9

G. Performance Tests

The camera intensity, difference in the performance with respect to the distance from the camera will be calculated. For every distance measure we have carried out 50 iterations. The success level will then be aggregated out of 100 to calculate the overall success percentage.

TABLE II. Success Percentage

Distance from camera in meters	Expected positive result in %
0.25	82%
0.5	92%
0.75	88%
1	84%

VI. APPLICATIONS AND FUTURE SCOPE

H. Applications

1. The people who are physically challenged can use this software to write on the display, so this can prove a great project/idea success in various cases.
2. Can be used as a supplement application in business use.
3. Interactive banking using sensitive walls.
4. Doctors can use it at work where touch less removes concern about sterility and cleanliness raised by traditional methods.
5. To zoom in X-ray images, in medical diagnosis and surgery.
6. It can be used in gaming.
7. Interactive displays in airports, restaurants, hotels museums, exhibition or public places, and household necessities.

I. Future Scope

In future, we could implement this system in variety of fields like the authentication system, combining it with biometric scanning for better security. It can also be used to develop a variety of gesture oriented games and applications virtually removing the use of hardware input device. It can be integrated with the internet of things making this technology truly user and common man oriented.

CONCLUSION

As per the analysis based on the market survey, the growth for touch less and gesture recognition is immense and multiplying exponentially. So the market is huge for us to play in this technology and also to introduce new things. Using this technology, we can develop a cheaper solution for interacting with the software, without touching the underlying hardware. Also the Human Machine Interface (HMI) technology (of which touch less technology is a part of) has been promoted by corporations to make it economically and socially viable.

Furthermore, as we know the need for the new and interesting things is ever-increasing so we have a mammoth marketplace to build our base, as the technology is just strengthening its grip for the personal use as well as in corporate industry. By introducing the consciousness about the technology in

this field, we can be the early movers. It will also help us in creating business with major OEMs and Tier 1 players.

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