

Digital Pen for Gesture Recognition of Handwritten Digit Using PNN Classifier

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Abstract – Today human computer interaction (HCI) techniques become a research topic in the field of computer technology. This paper present MEMS accelerometer based digital pen for handwritten digit and human gesture. This paper gives design idea about the digital pen. This digital pen consist of MEMS accelerometer, AVR Microcontroller (Atmega 16) & RF module. The accelerometer sense the accelerated signal along the three axis generated due to human hand motion. AVR microcontroller is used for processing & manipulating the accelerated signal & RF wireless transceiver module is used to transmit the accelerated signal towards receiver section wirelessly. The MATLAB tools with complete programming are used for the generation of feature vector. For that purpose we use zero crossing detector (ZCD) & range to recognize handwritten digit which is written by human virtually in the air. In this paper we used trajectory recognition algorithm with PNN classifier for best recognition of handwritten digit written in air.

Index Terms – MEMS, HCI, ZCD, PNN.

1. INTRODUCTION

The recognition of handwriting digit is mostly used for authentication & security purpose. Basically there are two types of recognition that is online recognition & offline recognition. In this proposed system we used online recognition system. The digit recognition is done by using triaxial accelerometer. This accelerometer is developed using MEMS technology so it gives response for every slight deflection or movement in the system.[1] The most advantages of this accelerometer for sensing the motion of human hand motion & gesture in air is that it can be operated without any surface, reference & limitation in working place. However, gesture recognition is relatively complicated because each users have different speeds and styles to generate various motion trajectories. Thus, many engineers have tried to increasing the accuracy of handwriting recognition systems[1]. Recently, some engineers have working on reducing the error

& noise from the raw accelerated signal of handwriting trajectory reconstruction by using effective algorithms & classifier to improve the recognition rate of the system[2]. In the proposed system we use the trajectory recognition algorithm & PNN classifier for best recognition of handwritten digit. In trajectory recognition algorithm we use zero crossing detector (ZCD) & range for feature generation & feature selection. Finally for better recognition of handwritten digit PNN classifier is used[1].

2. HARDWARE STRUCTURE OF DIGITAL PEN

The simplified block diagram of proposed system shown in below figure which consist of 3-Dimensional MEMS accelerometer(ADXL335), RF transceiver module(CC2500) & AVR microcontroller(ATMEGA 16), serial to USB converter & USB to serial converter & relay as a control unit. The accelerometer is based on MEMS technology which is used for measuring the acceleration signals generated due to user's hand motions & gestures. The AVR microcontroller convert the analog acceleration signals into its relative digital ones via the A/D converter. The wireless RF transceiver module is used to transmit the acceleration signals wirelessly to a personal computer (PC) at receiver side. The signals sensed by the accelerometer are sampled at rate of 100 Hz by the 12-b A/D converter. Finally, all output signals sensed by the accelerometer are transmitted wirelessly to a PC by an RF transceiver in 2.4-GHz ISM band with rate of 1-Mbps[1]. By using MATLAB tools with graphical user interface (GUI) window digit is displayed on LCD screen of PC. By deciding any two digits the relay action can be controlled connected to the another microcontroller. Serial to USB converter has been used to send data from PC to microcontroller. The schematic hardware structure of digital pen is shown in fig1.

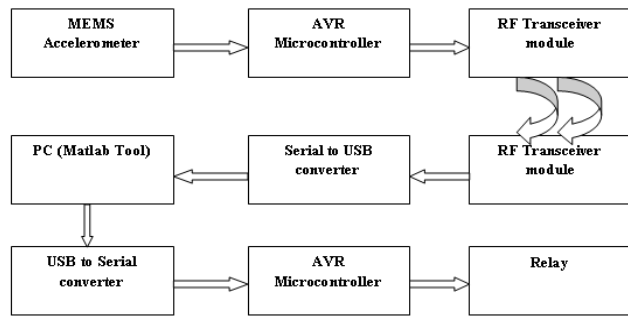


Figure 1 Block Diagram of Accelerometer based digital pen

3. TRAJECTORY RECOGNITION ALGORITHM

The simplified block diagram of the trajectory recognition algorithm consisting of acceleration acquisition, signal preprocessing, feature generation, feature selection, and feature extraction is shown in fig. 2.

Trajectory Recognition Algorithm

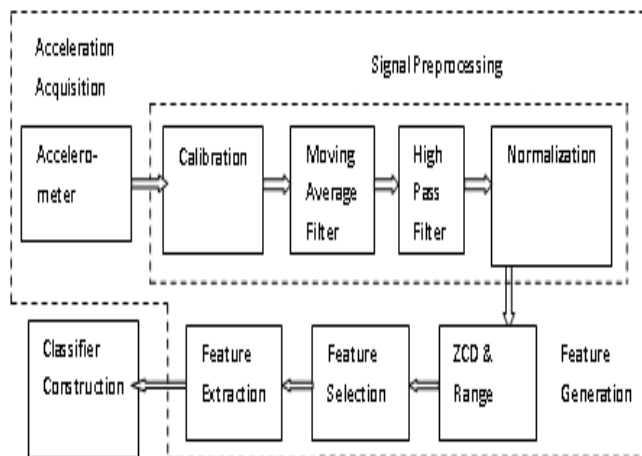


Figure 2 Block diagram of trajectory recognition algorithm[1]

3.1. Flow of Trajectory Recognition Algorithm

The raw accelerated signals due to user hand motions are generated by the 3D MEMS accelerometer are given to AVR microcontroller (ATMEGA 16). The raw accelerated signal contains different types of noises. These noises are reduced by using signal preprocessing method. The signal preprocessing consists of calibration, a moving average filter, a high-pass filter, and normalization [1]. First the drift & offset is reduced from the accelerated signal by using calibration process. Due to human nature, our hand always trembles slightly while moving which causes certain amount of noise. Using moving average filter high frequency signal noises are completely removed. For that purpose we collect set of 10 values received from accelerometer & take average of this value because of that the signal becomes smoother and if there is any sudden change in signal due to hand movement is avoided with the help of high pass filter. The normalization is to start the signal from

start point. The characteristics of different hand movement signals can be obtained by extracting features from the preprocessed x, y, and z-axis signals, and we extract two features from the tri axial acceleration signals, include Zero Crossing Detector(ZCD) & Range.

Digit	ZCD value for X axis	ZCD value for Y axis
0	1 point	2 point
1	1 point	0 point
2	1 point	3 point
3	1 point	4 point
4	2 point	1 point
5	1 point	3 point
6	1 point	3 point
7	1 point	1 point
8	1 point	4 point
9	2 point	2 point

Table 1 ZCD Table

From above table we observed that ZCD value for digit 2, 5, 6 & 3, 8 are same. So to overcome this problem we have to use PNN classifier to recognize the digit correctly. For feature extraction there are different types of classifier like FDA, FNN, HMM, GMM, LDA, PNN. They have different recognition rates but in our system we are using PNN classifier because of its higher recognition rate.

3.2. Classifier For Recognition

PNN Classifier:- The Probabilistic Neural Network (PNN) was first proposed by Specht. By taking the number of results from different classifiers we can conclude that PNN classifier has a great potential for making classification decisions accurately and providing probability and reliability measures for each classification. The most important advantage of using the PNN is its high speed of learning. Typically, the PNN consists of four layers that are an input layer, a pattern layer, a summation layer, and a decision layer as shown in Fig. 3. The operation of the neurons in each layer of the PNN is defined as follows.

Layer 1: The initial layer is the input layer, and this layer performs no working out. The neurons of this layer communicate the input features x to the neurons of the second layer.

Layer 2: The next layer is the pattern layer, and the number of neurons in this layer is equivalent to NL .

Layer 3: The third layer is the summation layer. The contributions for each class of inputs are summed in this layer to produce the output as the vector of probabilities. Where N_i is the total number of samples in the k th neuron.

Layer 4: The fourth layer is the decision layer [8].

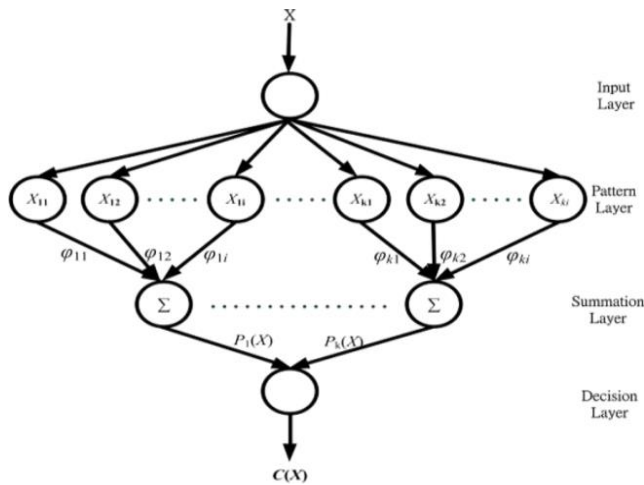


Figure 3 Topology of PNN Classifier

4. PERFORMANCE ANALYSIS & RESULT

The Digit which we want to recognize can be draw in air using gesture analysis as follow.

1	2	3	4	5	6	7	8	9	0

Table 2 Pictorial Digit Trajectories

4.1. Character Success Index

In character success index we plot a graph between recognized digit & recognition rate in percent. In this a single digit we can draw continuously & count how much time it successively recognized is as shown in following fig. 4. From the figure the digit recognition rate calculated from character success index is 85%.

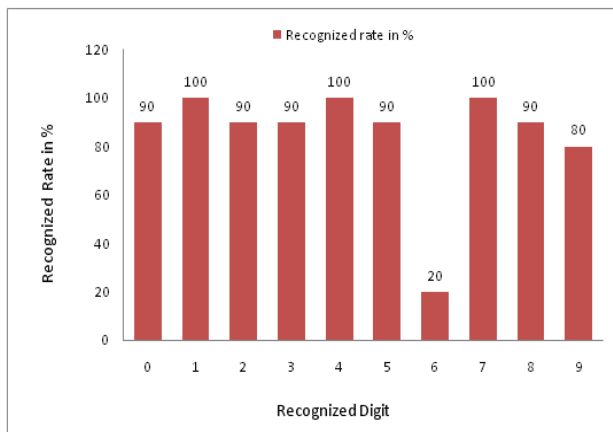


Figure 4 Character Success Index

4.2. Simulation Result

The following diagram show the simulation result for digit 1 & digit 7. To show simulated result in MATLAB we constructed a graphical user interface window which show the recognize digit as well as the value & graph of the X axis & Y axis.

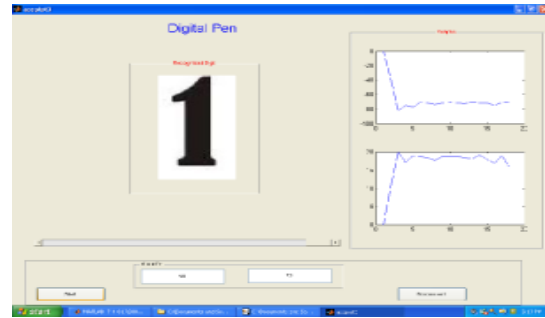


Figure 5 Digit 1 Recognize On GUI

The graphical user interface window shows the recognize digit output. In this as the slider moves from one end to another end we have to draw the digit then we get recognize digit along with X value & Y value graph. We can use this project work in the various applications where gesture recognition is used.

The application area like providing the security using gesture recognition that means operating the system with predefined digit stored in the database & the digit will act as a authenticate digit of accessing the system & second any other digit will act as a closing the system.



Figure 6 Digit 7 Recognize On GUI

To operate relay we use digit 1 & digit 7 as we recognize the digit 1 then relay will be ON & when we recognize the digit as 7 then relay will be OFF. we can use any digit to operate the relay.

5. CONCLUSION

In this work we construct trajectory reorganization system for developing handwriting & gesture reorganization which can be implemented in the data protection. We also use the PNN for accurate measuring of digit. In this work by using Trajectory recognition algorithm & PNN, we try to recognize perfect matching of gesture in Handwriting. For this purpose we

construct a hardware model which gives the 85 % efficiency in recognition of gesture & digit conclude from database & character success index This can be implemented as HCI application using the given design. This can also be implemented for blind person for security purpose or any other application. The result showing that this can be very useful for further development of HCI application in this area.

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