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Ink-Less Electro Pen

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Abstract—This paper presents the HCI device named as Ink-Less Electro Pen to interact the user with computer. Recently, Human Computer Interaction (HCI) techniques have become an important part of our daily lives. To improve the interactions between users and computers by making computers more usable and receptive to users need is the aim of HCI. The Electro pen is composed of accelerator sensor, AVR microcontroller, RF wireless communication module. The accelerator sensor collects the acceleration measurements and sends it to microcontroller. Then via RF module it is given to PC for further processing. Users can hold this the pen to write numerals, alphabets at normal speed. This pen is portable and can be used anywhere without any external reference device. A user would need to simply write or draw, instead of typing, and the computer would recognize it using trajectory recognition algorithm and operate on this input. Thus this writing instrument named as Ink-Less Electro Pen can give efficient output with great accuracy

Keywords—Handwritten digit and alphabet recognition; Trajectory recognition algorithm; PNN classifier

I. Introduction

Nowadays Human Computer Interaction i.e. HCI techniques has extended rapidly and increasingly for three decades and so catch the attention of professionals from many other disciplines and incorporating diverse concepts and approaches. In today's informative age, pen based computing as a field broadly includes computers and applications in which a pen is the main input device. This field carry on, to draw a lot of attention from researcher side because there are number of applications where the pen is the most convenient form of input. Due to tremendous progress in advent technology in electronic circuits and components has greatly reduced the size, dimension and weight of computers and personal digital assistants, thus making them extremely powerful, portable, and suitable and efficient. Based on human behaviour, many researchers have focused on developing novel HCI methods [8], [7], [3],[5]. The novel idea of pen-based computers was that they would bring the benefits of physical paper and pen to computer interaction and allowing people to interact more naturally with the computer.

Due to motion tracking systems have been researched on various indoor applications such as manufacturing human computer interaction, different inertial motion sensors are used. Recently, pen-based input devices embedded with inertial sensor which has been proposed to intellect the motion of human and to capture the motion trajectory information from accelerations for recognizing handwriting. There is one important advantage of inertial sensors for general motion sensing is that they can be operated without any external reference and limitation in working conditions such as friction, wind, directions or dimensions. Pen based input devices embedded with inertial sensors have been provided for hand gesture or handwriting [1], [2], [4], [6], [15].

In this paper, we are presenting HCI device named as Ink-Less Electro Pen. This is portable device which consists of accelerator sensor, a microcontroller, and an RF wireless transmission module. While writing with this pen, the acceleration signals is measured by sensor and then transmitted to a computer via the wireless transmission module. Users can use the Ink-Less Electro Pen to write numerals, alphabets at normal speed.

Recently, tremendous progress in advent technology in electronic circuits and components has greatly reduced the size, dimension and weight of computers, thus making the devices very powerful, convenient and portable. Recently, Human Computer Interaction (HCI) techniques have become an important part of our daily lives. HCI aims to improve the interaction between users and computers. So the studies have focused development of pen type input devices for trajectory recognition and HCI applications. The suggestion of pen as writing instrument is given by Robert baron. He developed instrumented pen for signature verification and handwriting analysis by taking the acceleration measurement [2]. Acceleration measurement generated by pen movements while one is signing, it provide useful information for handwriting analysis research for application like signature verification.

A system for real time estimation of human hand motions is developed by Z. Dong, G. Zha ng, C. C. Tsang, G. Shi, W. J. Li, P. H. W. Leong, and M. Y. Wong [6]. He presented the latest improvement based on software algorithm for the calculation of the acceleration by optical tracking. By using the multiple camera calibration, the OTS (Optical tracking System) was developed for the following two goals first obtain accelerations of the proposed ubiquitous digital writing instrument (UDWI) by calibrating 2-D trajectories and second to obtain the accurate attitude angles. However, in order to recognize or reconstruct motion trajectories accurately, the aforementioned approaches introduce other sensors such as gyroscopes or magnetometers to obtain precise orientation

The inertial-measurement-unit based pen with trajectory reconstruction algorithm and its application is presented by J.Wang [16]. In this, quaternion based orientation estimation and MAD switch for position estimation is used. Using this instrument user can write numerals at normal speed.

W. C. Bang, W. Chang, K. H. Kang, E. S. Choi, A. Potanin, and D. Y. Kim[1] developed a pen shaped input device for wearable computers, which reproduce and recognize three-dimensional hand motions with no external reference device.C.

Tsang, P. H. W. Leong, G. Zhang, C. F. Chung, Z. Dong, G. Shi, and W. J. Li [11] developed a digital writing instrument system based on micro inertial measurement unit which is used to record and recognize human handwriting motion in large writing area i.e. a large whiteboard or screen.

An alternative method of conventional tablet-based handwriting recognition is proposed by Milner [12]. In that, he introduced two dual-axis accelerometers are mounted on the one side of a pen to generate time-varying x- and y-axis acceleration for handwriting motion. He used an HMM with a band-pass filtering and a down-sampling procedure for classification handwritten data. A µIMU for 2-D handwriting applications was prsene by S.Zhou[15]. In that he, extracted the discrete cosine transform features from x- and y-axis acceleration signals and one angular velocity and used an unsupervised self-organizing map to classify 26 English alphabets and ten numerical digits.

G.Zang [14] introduced an useful algorithm- an error compensation method, called zero velocity compensation, to compensate the acceleration signals.To improve the handwritten recognition accuracy, W.C.Bang[1] illustrated that the Kalman filter is proficient technique to reduce noise of inertial sensors. Y.Luo [9]also proposed one helpful algorithm- an extended Kalman filter based on a micro inertial measurement unit with magnetometers for real-time attitude compensation. This is used to compensate the orientation of the proposed writing device.

II. Block diagram of system and working flow

Figure 1 shows block diagram of electro pen system. The block diagram of Electro pen system composed of two modules:

1) Electro pen module, used to write the digit or alphabet and this data can transmit to PC via wireless module RF module. 2) Receiver module, which receives the signals from transmitter and sends to PC for further processing.

The Ink-less electro pen composed of sensor ADXL 335, AVR controller, and an RF wireless transmission module at the transmitter side. And at receiver side it includes receiver module, RS232 and personal computer. The accelerometer is used to measure the acceleration signal. The accelerometer plays a role in detecting the acceleration, velocity, and position of hand motion writing. The output of sensor is transmitted to the AVR microcontroller. For further procedure such as signal processing and analysis it transmitted to computer via RF wireless module. After receiving data, by using USB cable all data is received and given to computer for further processing. All the signal processing and analysis can be done on computer side. The size of the ink-less electro pen is small. And it is portable, convenient and efficient HCI device.

Below flowchart shows the working flow of pen module system. Fig. 2.

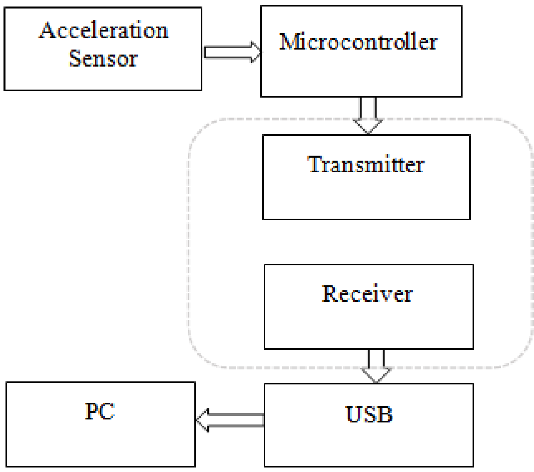


Fig 1: Block Diagram of Electro Pen system

III. Trajectory recognition algorithm

The block diagram of the proposed trajectory recognition algorithm consisting of acceleration acquisition, signal preprocessing, feature extraction, Classifier construction is shown in Figure. The motions for recognition include numbers and alphabets hand gestures. The acceleration signals of the hand motions are measured by a tri-axial accelerometer and then preprocessed by filtering and normalization. To reduce the computational load and increase the recognition accuracy of the classifier, we utilize various feature extraction and selection flow to reduce the dimension of the selected features. The reduced feature vectors are fed into a PNN classifier to recognize the motion to which the feature vector belongs .The detailed procedure of the proposed trajectory recognition algorithm as follows.

A. *Signal Preprocessing*

The raw acceleration signals of hand motions are generated by the accelerometer and collected by the microcontroller. Due to human nature, our hand always trembles slightly while moving, which causes certain amount of noise. The signal preprocessing consists of calibration, a moving average filter, a high-pass filter, and normalization.

First, the accelerations are calibrated to remove drift errors and offsets from the raw signals. The second step of the signal preprocessing is to use a moving average filter to reduce the high-frequency noise of the calibrated accelerations.

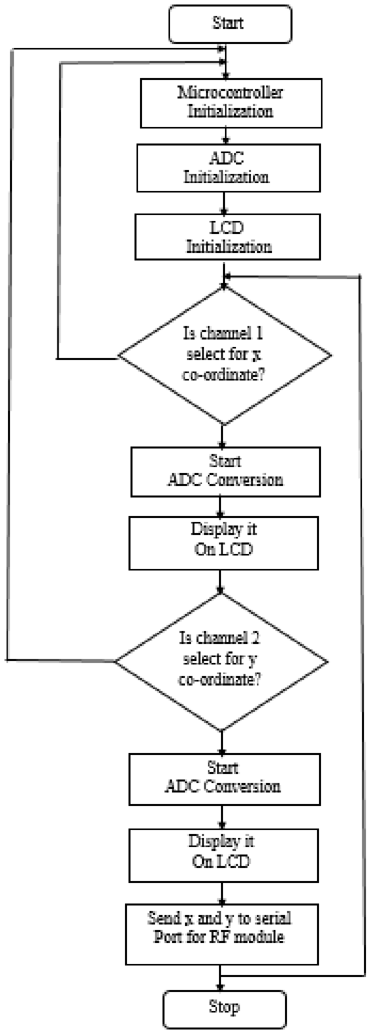


Fig. 2. Flowchart of working flow of pen module

B. Feature Extraction

For feature extraction part we are using two factors as follows:-

1) ZCD

On the basis of below table following groups are made to distinguish the digits on the basis of ZCD. The digits having same number of ZCD for X & Y are kept in the same group & the digits having Unique value for ZCD forms their own groups as shown in the table.

2) Range Factor:-

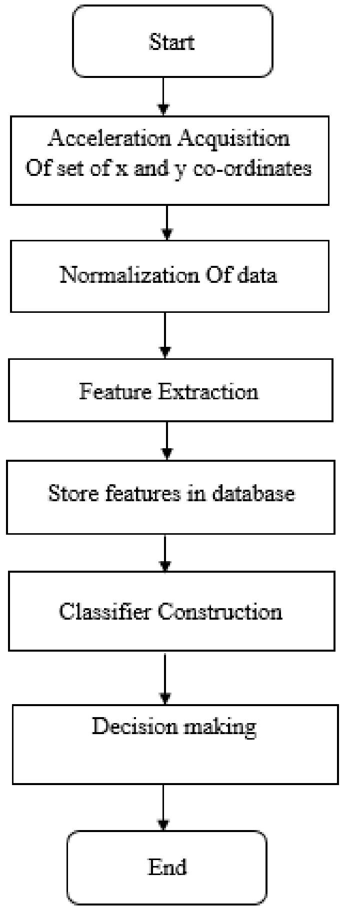
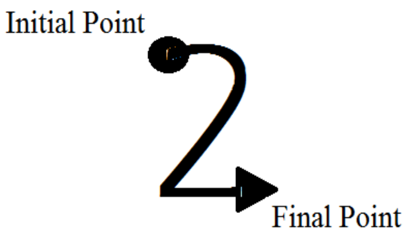


Fig. 3.Trajectory recognition algorithm.



Range:

To overcome the confusion between the digits of the same group, this Range factor is considered. On the basis of the range the expected digit is recognized and displayed. Range is calculated as:- Final point– Initial point.

C. Classifier Construction

The PNN first with enough training data, the PNN is guaranteed to converge to a Bayesian classifier, and thus, it has a great potential for making classification decisions accurately and providing probability and reliability measures for each classification. In addition, the training procedure of the PNN only needs one epoch to adjust the weights and biases of the network architecture. Therefore, the most important advantage of using the PNN is its high speed of learning. Typically, the PNN consists of an input layer, a pattern layer, a summation layer, and a decision layer.

The function of the neurons in each layer of the PNN is defined as follows.

1) Layer 1 : The first layer is the input layer, and this layer performs no computation. The neurons of this layer convey the input features x to the neurons of the second layer directly

$$x = [x1, x2, \dots, xp]^T \quad \dots\dots\dots\dots\dots\dots(1)$$

where p is the number of the extracted features.

2) Layer 2: The second layer is the pattern layer, and the number of neurons in this layer is equal to N_L. Once a pattern vector x from the input layer arrives, the output of the neurons of the pattern layer can be calculated as follows:

$$\varphi ki(x) = \frac{1}{(2\pi)^{\frac{d}{2}}\sigma^d} \exp\left(-\frac{(x-xki)^T(x-xki)}{2\sigma^2}\right) \dots\dots\dots\dots(2)$$

Where xki is the neuron vector, σ is a smoothing parameter, d is the dimension of the pattern vector x, and φki is the output of the pattern layer.

3) 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 ofprobabilities. Each neuron in the summation layer represents the active status of one class. The output of the kth neuron is

$$Pk(x) = \frac{1}{(2\pi)^{\frac{d}{2}}\sigma^d} \frac{1}{Ni} \exp\left(-\frac{(x-xki)^T(x-xki)}{2\sigma^2}\right) \dots\dots\dots(3)$$

Where Ni is the total number of samples in the kth neuron.

4) Layer 4: The fourth layer is the decision layer.

$$c(x) = \arg\max\{pk(x)\}, \qquad k = 1, 2, \dots, m \quad \dots\dots\dots(4)$$

Where m denotes the number of classes in the training samples and c(x) is the estimated class of the pattern x.

If the a priori probabilities and the losses of misclassification for each class are all the same, the pattern x can be classified according to the Bayes' strategy in the decision layer based on the output of all neurons in the summation layer.

IV. RESULT

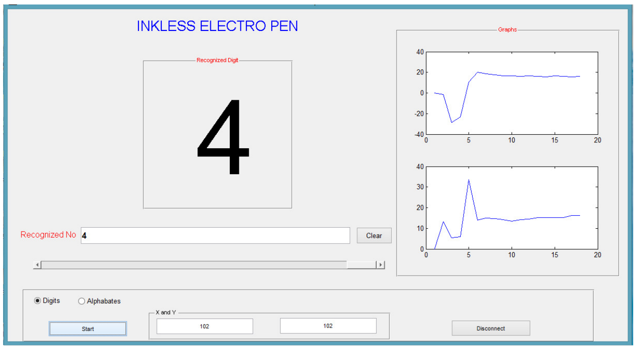


Fig4. Showing result of number 4

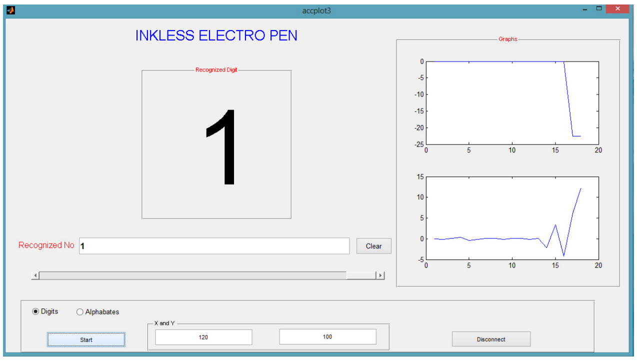


Fig 5. Showing result of number 1

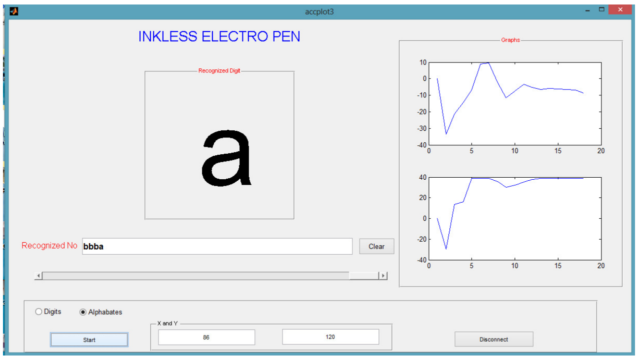


Fig 6. Showing result of alphabet a

After writing digit or alphabet by using this device acceleration signals generated by acceleration sensor goes to PC wirelessly using RF module. And then applying trajectory recognition algorithm we get recognized digit or alphabet

V. CONCLUSION

The HCI device named as ink-less electro pen device can used to write the alphabet or digit at normal speed. For this device we used acceleration sensor ADXL335, AVR microcontroller, and RF wireless module. We get the data of x, y, axis while writing from pen side module. On processing on this data and by applying trajectory recognition method we got output as shown in result section. Using this algorithm we can able to recognize handwritten digits and few alphabets efficiently on computer without use of keyboard. This device is portable, handy and efficient.

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REFERENCES

[1] W. C. Bang, W. Chang, K. H. Kang, E. S. Choi, A. Potanin, and D. Y. Kim, “Self-contained spatial input device for wearable computers,” in Proc. IEEE Int. Conf. Wearable Comput., 2003, pp. 26–34.

[2] R. Baron and R. Plamondon, “Acceleration measurement with an instru- mented pen for signature verification and handwriting analysis,” IEEE Trans. Instrum. Meas., vol. 38, no. 6, pp. 1132–1138, Dec. 1989.

[3] Z. Z. Bien, K.-H. Park, J.-W. Jung, and J.-H. Do, “Intention reading is es- sential in human-friendly interfaces for the elderly and the handicapped,” IEEE Trans. Ind. Electron., vol. 52, no. 6, pp. 1500–1505, Dec. 2005.

[4] E. S. Choi, W. C. Bang, S. J. Cho, J. Yang, D. Y. Kim, and S. R. Kim, “Beatbox music phone: Gesture-based interactive mobile phone using a tri-axis accelerometer,” in Proc. IEEE Int. Conf. Ind. Technol., 2005, pp. 97–102. .

[5] A. D. Cheok, Y. Qiu, K. Xu, and K. G. Kumar, “Combined wireless hard- ware and real-time computer vision interface for tangible mixed reality,” IEEE Trans. Ind. Electron., vol. 54, no. 4, pp. 2174–2189, Aug. 2007.

[6] Z. Dong, G. Zhang, C. C. Tsang, G. Shi, W. J. Li, P. H. W. Leong, and M. Y. Wong, “µIMU-based handwriting recognition calibration by op- tical tracking,” in Proc. IEEE Int. Conf. Robot. Biomimetics, 2007, pp. 382–387.

[7] C.-S. Fahn and H. Sun, “Development of a data glove with reducing sensors based on magnetic induction,” IEEE Trans. Ind. Electron., vol. 52, no. 2, pp. 585–594, Apr. 2005.

[8] Y. S. Kim, B. S. Soh, and S.-G. Lee, “A new wearable input device: SCURRY,” IEEE Trans. Ind. Electron., vol. 52, no. 6, pp. 1490– 1499, Dec. 2005.

[9] Y. Luo, C. C. Tsang, G. Zhang, Z. Dong, G. Shi, S. Y. Kwok, W. J. Li, P. H. W. Leong, and M. Y. Wong, “An attitude compensation technique for a MEMS motion sensor based digital writing instrument,” in Proc. IEEE Int. Conf. Nano/Micro Eng. Molecular Syst., 2006, pp. 909–914.

[10] Z. F. Syed, P. Aggarwal, C. Goodall, X. Niu, and N. El-Sheimy, “A new multi-position calibration method for MEMS inertial navigation systems,” Meas. Sci. Technol., vol. 18, no. 7, pp. 1897–1907, Jul. 2007.

[11] C. C. Tsang, P. H. W. Leong, G. Zhang, C. F. Chung, Z. Dong, G. Shi, and W. J. Li, “Handwriting tracking based on coupled µIMU/Electromagnetic resonance motion detection,” in Proc. IEEE Int. Conf. Robot. Biomimet- ics, 2007, pp. 377–381.

[12] B.Milner, “Probabilistic neural Network,” in proc. InstElect.Engg.-Colloq. Doc. Image Process Multimedia,1999, pp. 5/1-5/6.

[13] X. Yun and E. R. Bachmann, “Design, implementation, and experimental results of a quaternion-based Kalman filter for human body motion track- ing,” IEEE Trans. Robot., vol. 22, no. 6, pp. 1216–1227, Dec. 2006.

[14] G. Zhang, G. Shi, Y. Luo, H. Wong, W. J. Li, P. H. W. Leong, and M. Y. Wong, “Towards an ubiquitous wireless digital writing instrument using MEMS motion sensing technology,” in Proc. IEEE/ASME Int. Conf. Adv. Intell. Mechatronics, 2005, pp. 795–800.

[15] S. Zhou, Z. Dong, W. J. Li, and C. P. Kwong, “Hand-written char- acter recognition using MEMS motion sensing technology,” in Proc. IEEE/ASME Int. Conf. Adv. Intell. Mechatronics, 2008, pp. 1418–1423.

