ONLINE HAND WRITTEN CHARACTER RECOGNITION USING DIGITAL PEN FOR STATIC AUTHENTICATION

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Abstract—Due to the rapid development of computer technology, Human Computer Interaction (HCI) techniques have become an indispensable component in our daily life. HCI focuses on the understanding between humans and the computer. Also the protection of password involves different methods and it is being a great challenge to the computer industry. Hand Written Character is one form of human interaction can be used effectively in HCI for static authentication with better password protection. In this paper, the Digital Pen consists of triaxial micro-electromechanical (MEMS) Accelerometer, to capture the activities of the human and to capture motion trajectory information from accelerations for recognizing gestures for handwriting. The pen operates in two modes. It can operate as mouse by recognizing the gestures and other mode it can operate as Handwritten Character Recognition for identifying the digits and characters also in this mode it provides static authentication for the systems by recognizing the characters. An Integrated Development Interface is developed using dotnet to recognize the characters.

Keywords—Accelerometer, Integrated Development Environment (IDE), Motion Trajectories, Online Handwritten Character Recognition, Static Authentication

I. INTRODUCTION

Hand written Character Recognition (HWCR) provides a way to communicate between the human and the computers in order to record information and also provide authentication for the user with the specific character recognition. HWCR can be done by two methods: 1.Offline recognition and 2.Online Recognition. Offline Recognition is referred to as the ability of the computer to receive and interpret intelligible handwritten input from sources such as paper documents, photographs by optical scanning, also referred to as Optical Character Recognition or Intelligent word Recognition. Many researchers have find the solution for the Offline character recognition with good recognition rates. This paper proposed the Online Character Recognition system in which the character is processed while it was under creation. To capture the motions online, the general motion sensor, MEMS which can be operated without any external reference and limitation in working conditions is used. However, motion trajectory recognition is relatively complicated because different users have different speed, pressure and strokes to generate various motions. Thus many researchers have tried to narrow down the problems for increasing the accuracy of handwriting recognition systems. By manipulating the acceleration signals and angular velocities of inertial sensors, some researchers have reduced the error of handwriting trajectory reconstruction. However, these trajectory reconstructions suffer from different intrinsic errors due to the usage of inertial sensors. Hence, Yang et al proposed a pen to track motions in 3-D space by accelerometer and gyroscopes to improve the recognition accuracy by introducing the efficient acceleration error compensation algorithm which is based on zero velocity compensation. Luo et al proposed an extended Kalman filter with magnetometers to compensate the orientation of the digital writing device. If the orientation of the instrument was estimated precisely, the motion trajectories of the instrument were reconstructed accurately. Dong et al proposed optical tracking calibration method to obtain accelerations of the proposed device by calibrating 2-D trajectories and to obtain accurate attitude angle by using multiple camera calibration. However, aforementioned systems increase the cost by introducing additional sensors such as gyroscopes or magnetometers and also increase the computational burden of the motion trajectories algorithm. In order to reduce the additional cost due to additional sensors and the computational cost, Lim et al proposed the system to recognize the characters using the time-lagged feed forward neural network which gives the overall accuracy of 95%. Later Krishnan et al calculated the time and frequency domain features with overall accuracy of 86%. Recently Wang, Jeen-Shing proposed the accelerometer based digital pen to track the motions based on the probabilistic neural network with 98.75% gesture recognition rate. However, these systems uses sophisticated environment such as image processing and neural network for processing. Gruber, C and Bashir M have proposed online signature verification based on novel biometric pen using the ensemble techniques based on the finger grip pressure, acceleration, and tilt data using the ensemble techniques and dynamic time wrapping (DTW) algorithm respectively. Sayed B have proposed mouse dynamic biometric authentication which performs static authentication in short time.
However these biometric gesture authentication techniques involves the sophisticated neural network environment and also these systems rely on the complex data processing algorithms for biometric verification, which may not scale when deployed in globally distributed network environments. In this paper, we proposed a portable digital pen consists of triaxial accelerometer, microcontroller and zigbee wireless transmission module. The block diagram of the input device is shown in Fig.1. The accelerometer measures the acceleration of the signal in three coordinates such as x-axis, y-axis, z-axis. The measured acceleration signals of the motion are recognized using the Integrated Development Environment (IDE) which was developed using DOTNET. The gesture generated by the device is verified with the user database and thus in turn provides static authentication for the systems. Since we are using DOTNET as an IDE, the cost of the entire system is reduced as compared to the systems with the neural network processing. The system is non-specific user authentication system, thus it can be widely applicable to the global networks with the accuracy of 94.56%.

II. HARDWARE DESCRIPTION AND DESIGN

Portable pen consists of triaxial accelerometer ADXL345, a microcontroller (PIC16F877A with 10-bit A/D converter) and the wireless transceiver (nRF2401, Nordic). The triaxial accelerometer measures the acceleration signals generated by a user’s hand motions with the digital pen. The microcontroller collects the analog acceleration signals and converts the signals to digital ones via the A/D converter in-built in the microcontroller. The wireless transceiver transmits the acceleration signals wirelessly to a personal computer (PC). The ADXL345 is a 3-axis digital output sensor. It is a small thin, low power which measures up to ±16g. It has both SPI and I2C bus supporting features. The output of any axis is analog voltage which is directly proportional to the acceleration in that axis. Acceleration values can be positive, negative or zero. So, the output voltage has a zero bias output. The output given at this point means zero acceleration in that particular axis. So, the zero point voltage is greater than output voltage, it indicates the negative acceleration. The general gravity of earth is 9.81 m/s², thus the gravity accelerates at 1g or at 9.81 m/s². If the movement is upward 1g, then the sensor will detect 2g. Acceleration is measured relative to earth’s gravity; hence acceleration showed in free fall is zero. For calculating the maximum acceleration it includes a maximum values from all axis = (x²+y²+z²)1/2. Tilt measurement is done when an object is tilted with respect to ground. The accelerometer works with three modes, they are Standby mode, auto sleep mode and Low power mode. In this project the ADXL345 is used as I2C communication is used. The I2C bus is enabled only if the CS bit is enabled and made into active high to VDD/IO. It supports both the single and multiple byte reads/writes, with the ALT Address pin high, the 7-bit address for I2C device is 0X1D, followed by R/W bit. An alternate I2C address of 0x53 followed by R/W bit can be chosen by grounding the ALT address pin (12). This translates to 0xA6 for write and 0xA7 for read. The PIC16F877A integrates a high-performance 10-bit A/D converter and 8-b microcontroller unit (MCU) on a signal chip. The output signals of the accelerometer are sampled at 100 Hz by the 10-bit A/D converter. Then, all the data sensed by MEMS are transmitted to PC wirelessly by an zigbee transceiver, nRF2401 at 2.4-GHz transmission band with 1-Mb/s transmission rate. The overall power consumption of the digital pen circuit is 30 mA at 3.7 V. The hardware of the input device, portable pen like structure is shown in the Fig.2.

III. FLOWCHART FOR SYSTEM PROCESS

The entire system process is explained below in detail by step by step process. The Fig.3 shows the diagrammatic representation of the system process in flow chart.

Step 1: Accelerometer is given power supply it gets ON, and upon the movement of the accelerometer it provides various tilt angles in X, Y and Z axis respectively. These values can be zero, positive or negative.

Step 2: If there is password for the system to login with Gestures, then draw your correct gesture for password.

Step 3: If the Password matches with the stored password, system logins Login will be failed and tried to login again.

Step 4: Once login into the
system, select the mode to operate either as mouse or Character recognition mode.

Step 4: If the mode selected is mouse, then pen will function as the mouse.

Step 5: If the mode selected is Character Recognition, then open the IDE for recognize the characters.

Step 6: Characters will be displayed on the IDE.

Fig. 3. Flow Chart for System Process

IV. SYSTEM IMPLEMENTATION

A. Character Recognition IDE

The Character recognition Integrated Development Environment (IDE) is used to recognize the handwritten characters and is developed using DOTNET. The Fig shows the character recognition IDE. The white space in the screen is the area where the characters can be recognized. The recognized characters can be saved for future use and for editing purposes. The file can be saved either as .doc or .txt format. The characters in the screen are represented as Times New Roman with size 14. However, the text style and font can be formatted as per the user requirement. The IDE consists of file, tools, and edit menu. Fig. 4 shows the Character Recognition IDE developed using DOTNET.

B. System Authentication IDE

Generally the authentication can be done using the user name and keyboard typed character password. In this proposed system, the password can be set using the character generated by the user’s digital pen. In order to authenticate the system, another Integrated Development Environment (IDE) is developed using DOTNET to verify the user’s handwritten password.

The Fig shows the IDE for the static authentication system. This can be applied to login to the PC, website and to any type of static authentication system widely used. The IDE consists of the username, gesture drawing, login and reset password features as usual. Unless another person knows the gesture password of the user, the person cannot login to the system. It is not as easy as shoulder surfing to track the characters that the user is typing on the keyboard. Thus it provides strong password protection. Fig. 5 shows the IDE for authentication based on the gesture using the pen.

C. Digital Pen Operates as Mouse

The pen can also be used as mouse by selecting the mouse in the pen. The each and specific gesture of the mouse is used to recognize the specific mouse functions. The table I shows the respective gestures used for doing the specific mouse function in PC.

TABLE I. Mouse functions for the gestures

Fig. 4. Character Recognition IDE

Fig. 5. Static Authentication IDE
V. EXPERIMENTAL RESULTS

In this section, the effectiveness of the proposed accelerometer based pen device and its associated IDE developed using dotnet were validated by the handwritten digit recognition experiment. We collected the acceleration signals of this experiment from 12 subjects (5 females and 7 males; ages varying from 23.5 to 26 years old). The digital output signals of the accelerometer are sampled at 100 Hz. Our experiment was performed on a PC running Microsoft windows 7 ultimate operating system with an Intel Core 2 Duo processor and 4 GB RAM. Fig 6 shows the gestures used for generating the digits.

<table>
<thead>
<tr>
<th>Gestures</th>
<th>Mouse Functions</th>
</tr>
</thead>
<tbody>
<tr>
<td>UP</td>
<td>Move Cursor up</td>
</tr>
<tr>
<td>DOWN</td>
<td>Moves Cursor Down</td>
</tr>
<tr>
<td>RIGHT</td>
<td>Moves Cursor Right</td>
</tr>
<tr>
<td>LEFT</td>
<td>Moves Cursor Left</td>
</tr>
<tr>
<td>ALPHABET</td>
<td>Opens the file starts with respective Alphabet</td>
</tr>
</tbody>
</table>

In this experiment, we have requested 12 persons to draw the each and every digit 4 to 5 times, and calculated the recognition rate and false recognition of the digits. Table matrix shows the number of times the digit has been recognized correctly. The fig shows the recognition rate of two users for the digits from 1 to 9.

![Fig. 6. Pictorial digit Trajectories](image)

From the experimental results the worst recognition rate inferred as 96% and the best recognition rate as 98.8%. Thus, the character can be recognized in the rate of 98.25%.

CONCLUSION

The development of the portable device is used to generate desired commands by hand motions to control electronic devices without space limitations. The acceleration made by the hand motion is measured by the accelerometer and wirelessly transmitted to the computer. In this experiment we used 2-D handwriting digits, alphabets by using the hand gestures and recognized using IDE developed by DOTNET. The overall recognition rate of the hand written characters by this system is calculated as 98%. Thus the results give us satisfaction in recognizing the characters at low cost. Also the usage of simple sensor for the process of authentication using gestures using the same digital pen helps for better, simple and accurate way of verification. The gestures generated by the hand motion for authentication cannot be easily recognized by the human naked eye. Thus the system as online character recognition is efficient and provides strong password protection.

FUTURE WORK

Further the system can be implemented to recognize the continuous handwritten digits with multistrokes.

REFERENCES


Online Hand Written Character Recognition Using Digital Pen For Static Authentication