



International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 4, April 2015

Case Study: Hand Gesture Based Digital Pen

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ABSTRACT: In this paper an MEMS accelerometer mostly based on gesture recognition algorithm and its application are presented. The hardware module consists of a triaxial MEMS accelerometer, microcontroller, and RF wireless transmission module for sensing and collecting accelerations of handwriting and hand gesture trajectories. Users will use this digital pen to write down digits, alphabets & some hand gestures. The accelerations of hand motions deliberate by the accelerometer are transmit wirelessly to a personal computer for trajectory recognition. The trajectory algorithm collected of information variety assortment, signal pre-processing for reconstruct the trajectory to satisfy the collective errors caused by drift of sensors. So, by altering the location of MEMS (micro electro mechanical systems) we can proficient to demonstrate the alphabetical characters and numerical on PC.

KEYWORDS: MEMS accelerometer, handwritten gesture recognition, trajectory algorithm.

I. INTRODUCTION

Now a day, hotheaded growth of smallness technologies in electronic circuits and components has to a great extent decrease the dimension and weight of end user electronic products, such as smart phones and handheld computers, and thus made them more handy and suitable. Due to the fast development of computer technology, human-computer interaction (HCI) techniques have turn out to be an vital component in our daily life. Recently, an eye-catching alternative, a flexible embedded device with inertial sensors, has been expected to sense the activities of individual and to imprison their motion trajectory information from accelerations for handwriting and recognize gestures. The leading necessary benefit of inertial sensors for wide-ranging motion sensing is that they can be operating without any external reference and constraint in operating conditions. On the other hand, motion trajectory recognition is moderately tough for different users since they have different speeds and styles to generate a variety of motion trajectories. Thus, a number of researchers have tried to avoid the problem field for increasing the accuracy of handwriting recognition system. During this work a small MEMS accelerometer based recognition systems which recognize four hand gestures is constructing by using this four gestures, numerical and alphabets will be recognized in the digital format.

MEMS be termed as micro electro mechanical system where mechanical parts like cantilever or membranes have been manufactured at microelectronics circuits. It uses the technology known as micro-fabrication technology. It has holes, cavity, channels, cantilevers, membranes and in addition imitates mechanical parts. The importance on MEMS is based on silicon. The explanation that prompt the use of MEMS technology are for example smallness of existing devices, expansion of new devices based on most important that do not work at large extent and to relate with micro world. Miniaturization reduces cost by declining material consumption. It also increases applicability by dropping mass and size allowing placing the, MEMS in places where a traditional system. Instead of having a string of external components connected by wire or soldered to printed circuit board the MEMS on silicon can be integrated directly with the electronics. These are called smart integrated MEMS already include data gaining, filtering, data storage, communication interfacing and networking. MEMS technology not only makes the things smaller but frequently makes them better. A typical example is brought by the accelerometer development.

In order to decrease the cost of systems and make straightforward the algorithms, much explore effort has been dedicated to extract significant features from time-series inertial signals. To name a few, Lim *et al.* computed relationship coefficients of the absolute value of acceleration and the absolute value of the first and second derivatives of acceleration to form feature vectors.



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II. RELATED WORK

“An Accelerometer-Based Digital Pen with a Trajectory Recognition Algorithm for Handwritten Digit and Gesture Recognition” [1] in this paper, they developed a pen-type portable device and a trajectory recognition algorithm. The pen-type portable device consists of a triaxial accelerometer, a microcontroller, and an RF wireless transmission module. The acceleration signals deliberate from the triaxial accelerometer are transmitted to a computer via the wireless module. Users can make use of this digital pen to write digits and make hand gestures at normal speed.

This paper has presented a methodical trajectory recognition algorithm structure that can construct efficient classifiers for acceleration-based handwriting and gesture recognition. The proposed trajectory recognition algorithm consists of acceleration acquisition, signal pre-processing, feature generation, feature selection, and feature extraction. With the reduced features, a PNN can be quickly trained as an effective classifier. In this paper they have used 2-D handwriting digits and 3-D hand gestures to authenticate the effectiveness of the projected device and algorithm.

“A Hand written Character Recognition based system based on Accelerations” [52] in this paper, handwritten character recognition system based on acceleration is presented. The character recognition system using a 3-dimensional (3D) accelerometer includes three procedures: original signal detection, signal processing (pre-processing and quantization) and recognition/classification. In quantization procedure, Trajectory Orientation (TO) and Curve Feature (CF) are adopted and compared. In recognition procedure, Fully-connected Hidden Markov Model (HMM) and Left-Right HMM are both implemented and compared. Compare to these technologies, pattern recognition based on inertial devices is comparatively new, but there are some intrinsic advantages of this technology. For example, to control a computer or a mobile phone by inertial devices, what we require is to shake a remote controller or even the computing device directly, provided that its size is small adequate. By doing so, we can evade the annoying interruption in public places where speech recognition or gesture recognition systems served. Furthermore, in the field of medicine, pattern recognition based on inertial devices can help doctors by correcting abnormal behaviour like human abnormal step and can even make real time monitoring of daily activities and physiological parameter possible in practice. Many algorithms for gestures or characters recognition were studied, such as Hidden Markov Model (HMM), Bayesian Networks (BN) and Dynamic Time Warping (DTW). Since the objective to be analysed could be either discrete or continuous, there exist two kinds of HMM, which are Discrete HMM (DHMM) and Continuous HMM (CHMM). The majority researchers use DHMM to find the most feasible activity state which is a lightweight one for math computation.

“Hand written Character Recognition using MEMS motion sensing Technology” [43] In this paper, a Micro Inertial Measurement Unit (_IMU) based on Micro Electro Mechanical Systems (MEMS) sensors is applied to sense the motion information created by characters written by human subjects. The _IMU is built to record the three-dimensional accelerations and angular velocities of the motions throughout hand-writing. The work discussed in this paper focuses on human interactions with computing devices using characters and gesture recognition. There are two major character recognition methods based on different inputs: one is Optical Character Recognition (OCR), which gets data information by scanning the printed text; the other is Dynamic Character Recognition (DCR), which recognizes the characters based on their motion information, such as acceleration, angular velocity and so on.

“MEMS Accelerometer Based Hand Gesture Recognition” [34] this paper presents a MEMS accelerometer frequently based on gesture recognition algorithm and its applications. The hardware unit consists of a triaxial mems accelerometer, microcontroller, and zigbee wireless transmission module for sensing and collecting accelerations of handwriting and hand gesture trajectories. Users will use this hardware module to write down digits, alphabets in digital manner by making four hand gestures. The accelerations of hand motions deliberate by the accelerometer are transmitted wirelessly to a personal computer for trajectory recognition. The trajectory algorithm composed of information assortment collection, signal pre-processing for reconstructing the trajectories to satisfy the cumulative errors caused by drift of sensors. So, by changing the position of MEMS (micro electro mechanical systems) we can able to show the alphabetical characters and numerical within the PC.

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III. PROPOSED SYSTEM

The portable device consists of a triaxial accelerometer microcontroller with a 10-b A/D converter, and a wireless transceiver. The triaxial accelerometer measures the acceleration signals generated by a user's hand motions. The microcontroller collects the analog acceleration signals and converts the signals to digital ones via the A/D converter. The wireless transceiver transmits the acceleration signals wirelessly to a personal computer (PC). 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 accelerometer works with three modes, they are Standby mode, auto sleep mode and Low power mode. The microcontroller 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 RF transceiver, 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.

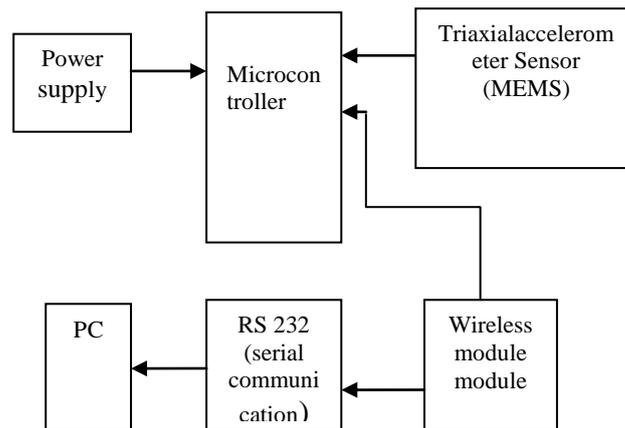


Figure1: Block diagram of proposed system

This system we are using triaxial-accelerometer, a microcontroller (with A/D converter), and a wireless transceiver (RF). The triaxial accelerometer measures the acceleration signals generated by a user's hand motions. The microcontroller collects the analog acceleration signals and converts the signals to digital ones via the A/D converter. The wireless transceiver transmits the acceleration signals wirelessly to a personal computer (PC). The acceleration signals measured from the triaxial accelerometer are transmitted to computer via the wireless module.

IV. ALGORITHM FOR SYSTEM PROCESS

The entire system process is explained below in detail by step by step process.

- Step 1: The motion of accelerometer in any direction is send to microcontroller in form of analog voltages through wire connection.
- Step 2: The inbuilt 10 bit ADC in microcontroller will convert this voltages in digital values.
- Step 3: These values are passed to averaging filter to make stable values.
- Step 4: These values are converted in ASCII format for transmit them to RF receiver wirelessly.
- Step 5: The RF receiver send data o PC using RS232 serial connection.
- Step 6: Here we use serial to USB communication for fast response.
- Step 7: Using Matlab software PC displays the motion in terms of character or digit or hand gesture.



ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

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V. CONCLUSION AND FUTURE WORK

This paper has presented a systematic trajectory recognition algorithm framework that can construct effective classifiers for acceleration-based handwriting and gesture recognition. The proposed trajectory recognition algorithm consists of acceleration acquisition, signal pre-processing, feature generation, feature selection, and feature extraction.

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 are wirelessly transmitted to the computer. The proposed system uses single stroke handwriting algorithm.

The Digital pen can be use for multi stroke handwriting by making some modifications in algorithm. With the multistroke handwriting user can write the full sentence with normal speed. In this system the pen section can be interface with microcontroller wirelessly or microcontroller can be installed inside pen section by using system on chip technology to fabricate a microchip.

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