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Hand Motion Gestures For Mobile Communication Based On Inertial Sensors For Old Age People

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ABSTRACT
This project presents system based on inertial sensors and gesture recognition algorithm for SMS or calling for old age people. Users hold the device to make hand gestures with their preferred handheld style. Hand motions generate inertial signals, which are wirelessly transmitted to a computer for recognition. Here DTW recognition algorithm is used for recognition of hand gestures. Zigbee is used at the transmission section of inertial device to transmit sensor values and at the receiver section of PC to receive values. Recognized gesture is send to the microcontroller for further processing which gives AT commands to GSM to selects the SMS or calling option to the person. GSM model is used for the SMS or calling. An accelerometer-based gestures recognition systems that uses only a single 3-axis accelerometer. 3-axis accelerometer recognizes gestures, where gestures here are hand movements. DTW algorithm is used in this project for recognition. The proposed DTW-based recognition algorithm includes the procedures of inertial signal acquisition, motion detection, template selection, and recognition. Here ‘a’, ‘b’, ‘c’, ‘d’, ‘e’, ‘f’, ‘g’, ‘h’, ‘o’, ‘v’ letters are recognized in this system . This system can be used for the emergency calling or emergency SMS by the old age people or blind people from the home.
Keywords: Inertial sensors, gesture recognition, DTW algorithm

I. INTRODUCTION

Mobile devices have become essential tools in our daily lives. These devices are used by everyone in several different situations. Every human being is different and so every situation. This diversity has not been given enough attention in mobile user interface design.

Particularly disabled target group or elderly people, characterized by specific individual differences, can greatly benefit from an effective mobile user interface. The growing population of elderly people motivates the researchers to develop systems for emergency for calling or SMS.

With the rapid development of computer technology, contemporary human-computer interaction (HCI) devices/techniques have become indispensable in individuals’ daily lives. HCI devices/techniques have also dramatically altered our living habits with computers, consumer electronics, and mobile devices. The ease with which an HCI device or technique can be understood and operated by users has become one of the major considerations when selecting such a device. Therefore, it is necessary for researchers to develop advanced and user-friendly HCI technologies which are able to effortlessly translate users’ needs into corresponding commands without requiring users to learn or accommodate to the device. Technologies are being developed which are able to intuitively express users’ intentions, such as gestures, and human body language, to naturally control HCI devices. These technologies have many applications in the fields of remote control, virtual reality, sign language, signature authentication, sport science, health care, and medical rehabilitation.

An inertial-sensor-based system is presented for hand gesture recognition tasks. The portable device is composed of a triaxial accelerometer, triaxial magnetometer, microntroller, and a xbee wireless transmission module. Users can utilize this device and make hand gestures at their preferred speed without any space limitations. Measured accelerations, and magnetic signals are transmitted to a personal computer via the xbee wireless module.

II. PREVIOUS WORK

This section covers the overview of the other authors work done in this work area. Information about their proposed systems are summarising in this section, and respective pros and cons. This helped us to come up with a concept that allowed us to overcome various limitations faced by the existing systems.

Yu-Lian Hsu et. al presents an inertial pen and its associated dynamic time warping based recognition algorithm for handwriting and gesture recognition. They uses triaxial accelerometer, triaxial gyroscopes and triaxial magnetometer, microcontroller and RF wireless transceiver[1].

Recently, a number of researchers have developed various technologies for inertial-sensing based HCI methods such as activity recognition, gesture recognition, handwriting recognition and motion tracking. Among inertial-sensing-based input devices embedded with accelerometers and gyroscopes can most easily provide intuitive expression through capturing translational accelerations and/or angular velocities generated by hand movements [2].

The increase in human-machine interactions in our daily lives has made user interface technology more important.

Physical gesture as intuitive expressions is easy interaction process and enables humans to naturally command computers. For example, three different gestures recognition models which are capable of recognizing seven hand gestures, i.e., down, up, right, left, circle, tick, cross, based on the input signals from MEMS 3-axes accelerometers uses for a remote controller for visual and audio equipment, or as a control mechanism. These remote controller command machines and intelligent systems in offices and factories [5].

In order to capture the movement of the in-air letters, the mobile phone must include a movement sensor. However, leading mobile phones manufacturers are marketing phones incorporating 3D accelerometer at a very fast rate [7].

Effective trajectory recognition algorithms that can efficiently select most significant features from frequency and time domains of accelerations signals collected from inertial sensor and project the feature space into a smaller feature dimension for motion recognition [10].

The gesture recognition system operates primarily on signals from a single 3-axis accelerometer and comprises two main stages: a training stage and a testing stage [8].

"A Review on frequent pattern mining " by Vivek B. Satpute proposed pattern mining in recent times achieved major importance in the data minin community for the reason of its ability of being used as very important tool for the knowledge discovery and its applicability in the other data mining jobs like classification and clustering. Association rules are always of interest to the both database community as well as data mining users. Here a survey have provided of previous studies made in this area and recognize some vital gaps available in the current knowledge.

Basic mobile phone functions were considered to be more important for elderly users. The eight features most frequently used by the respondents were calling, address book, alarm, display of date and time, panic button for emergency, incoming call with caller's picture, and camera. The results of this study can facilitate the design of mobile phones for the elderly [22].

III. PROPOSED DESIGN

Below fig. shows the block diagram of the whole system. Block diagram shows both the hardware require for the system.

An inertial-sensor-based device and a recognition algorithm are presented for gesture recognition tasks. The portable inertial device is composed of a triaxial accelerometer, a triaxial magnetometer, a microcontroller, and an Xbee wireless transmission module. Users can utilize this inertial pen to make hand gestures at their preferred speed. Measured accelerations, and magnetic signals are transmitted to a personal computer (PC) via the Xbee wireless module. The proposed recognition algorithm is composed of the procedures of inertial signal acquisition, signal preprocessing, separation, feature extraction, and recognition.

This inertial device consist of a triaxial accelerometer ADXL335, a triaxial magnetometer which is digital compass IC HMC 5883L, microcontroller is (PIC 16F877A),and an Xbee wireless transceiver (XBEE-1B2, Nordic).

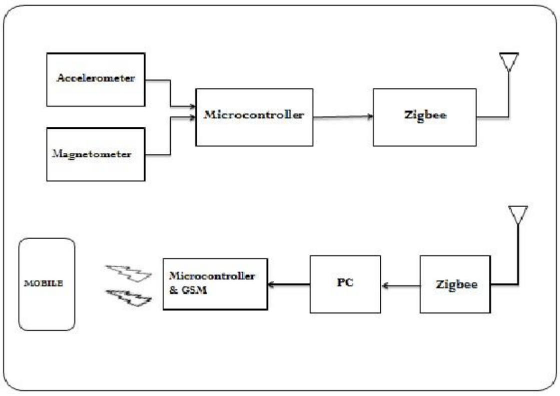


Figure 1: Block diagram of System

The accelerometer, and magnetometer are used to detect accelerations, and magnetic signals generated by hand movements. Whichever character we write in the air inertial sensor collects the reading of acceleration and magnetic movements of the hand. The readings are in digital form. These readings transmitted to the microcontroller for processing.

The microcontroller collects the digital accelerations, and magnetic signals, and transmits wirelessly the above mentioned inertial signals to a PC main processor via the Xbee wireless transceiver for further signal processing and analysis. All signal processing procedures are performed on a PC. We will use recognition algorithm for the signal acquisition. This algorithm recognizes the hand gesture and send appropriate signal to hardware where GSM module is placed. The microcontroller further process the signal and gives AT commands to the GSM to make call or to SMS.

IV. RECOGNITION ALGORITHM

In this project we have used DTW algorithm. Dynamic time warping (DTW) algorithm is developed to ensure a minimal cumulative distance between the aligned sequences, and to find the similarity for the optimal alignment between two temporal sequences [25]. The DTW algorithm in the current paper is used to classify time sequences (movement signals) of different digits, letters, or gestures based on the nature of the movement signals generated from the handwriting and gesture trajectories. Most importantly, the training procedure of the DTW recognizer only needs one class template for each class. Thus using the DTW recognizer to handle recognition problems is potentially much simpler and faster, providing significant advantages for HCI devices.

Dynamic time warping algorithm:

Here four steps are used for the recognition.

- Step 1: Signal Acquisition.
- Step 2: Motion detection
- Step 3: Template Selection
- Step 4: Recognition using recognition algorithm

Step 1: Signal Acquisition:

Typically motion is acquired using a accelerometer sensor and a magnetometer sensor to capture the hand motion gesture. These sensors used for the sensing hand movements are MEMs sensors.

Step 2: Motion Detection:

Motion detection acquires following two steps

1) Segmentation
2) Feature extraction

1) Segmentation: After filtering the measurements, we first segment each inertial signal properly to extract a precise motion interval, since the size of measurements of each movement frequently differs between fast and slow writers.

2) Feature extraction: In this we are extracting some features of the accelerometer and magnetometer signal.

A) Calculation of initial Euler angles

The signals measured from the accelerometer and magnetometer are utilized to estimate the orientation angles during the non-motion interval .

1. Pitch angle:

$$\theta = atan2\left(-R(3,1), \sqrt{(R(1,1,))^2}\right) + R(2,1)^2$$

2. Yaw angle:

$$\varphi = atan2\left(\frac{R(2,1)}{\cos\theta}, \frac{R(1,1)}{\cos\theta}\right)$$

3. Roll angle:

$$\emptyset = atan2\left(\frac{R(3,2)}{\cos\theta}, \frac{R(3,3)}{\cos\theta}\right)$$

B) Calculation of parameters of the initial quaternion representation q0, q1, q2, q3.

After obtaining the initial Euler angles (φ, θ, ψ),we can compute the parameters of the initial quaternion representation for the motion interval by the following equation:

$$q_0 = \cos\frac{\varphi}{2}\cos\frac{\theta}{2}\cos\frac{\emptyset}{2} + \sin\frac{\varphi}{2}\sin\frac{\theta}{2}\sin\frac{\emptyset}{2}$$

$$q_1 = \cos\frac{\varphi}{2}\cos\frac{\theta}{2}\sin\frac{\emptyset}{2} - \sin\frac{\varphi}{2}\sin\frac{\theta}{2}\cos\frac{\emptyset}{2}$$

$$q_2 = \cos\frac{\varphi}{2}\sin\frac{\theta}{2}\cos\frac{\emptyset}{2} + \sin\frac{\varphi}{2}\cos\frac{\theta}{2}\sin\frac{\emptyset}{2}$$

$$q_3 = \sin\frac{\varphi}{2}\cos\frac{\theta}{2}\cos\frac{\emptyset}{2} - \cos\frac{\varphi}{2}\sin\frac{\theta}{2}\sin\frac{\emptyset}{2}$$

Step 3: Template selection:

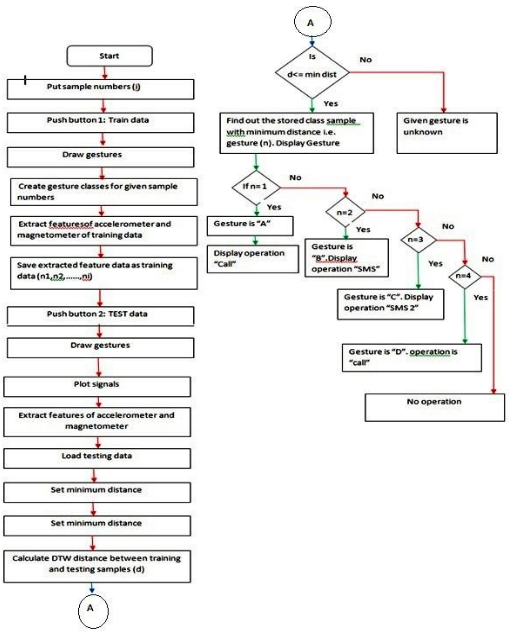
We have developed a minimal intra-class to maximal inter-class based template selection method (Min-Max template selection method) to perform the template selection task. This approach utilizes both intra-class and inter-class DTW distances to select the reliable patterns for the class templates.

Step 4: DTW recognizer:

After extraction features of training samples of each class that samples. When test signals are coming calculate distance of the test signal and each class. Find out the minimum distance between testing and training signal that would be our identified gesture.

Once each class template of each digit, English lowercase letter, or gesture is selected, the similarity between each class template and the movement patterns will be measured through the DTW recognizer.

Flowchart of the algorithm:



Above flowchart shows the flow of the system.

V. RESULT

In this project hand motion recognition is done. According to hand gestures calling function and SMS function is working. Taking care of necessity of the old age people I have created easy hand gestures, which can easily draw in air. Hardware 1 should be in hand of user by keeping switch pressed, user should move their hand according to gesture in air. These generated signals send to PC.

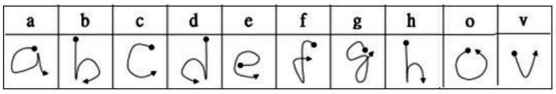
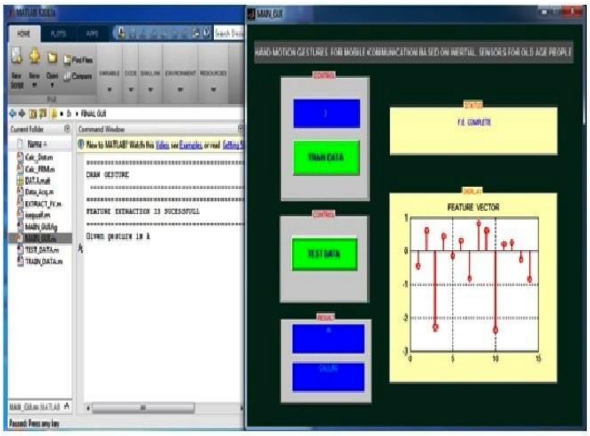


Figure 2 : English letters hand gestures

Following fig. shows the result of the first gesture, which is used to call. Fig. 3 shows the GUI, which we made for user to use device easily. This fig. 3 shows the result for letter ‘a’, which we have used for the call.



Result obtained in this experiments are 80% for calling SIM no.1, 70% for SMS 1, 70% for SMS 2, 90% for calling SIM no.2.

Function	Accuracy
Call 1	90%
SMS 1	85%
SMS 2	85%
Call 2	90%

The overall result obtained is 87.5%.

VI. CONCLUSION

In conclusion, inertial sensors are one of the major input devices used for the gesture sensing or hand motion sensing. The ease with which the HCI device or technique can be understood and operated by Users has become one of the major considerations when selecting such device. This device is user friendly and highly accurate.

The average accuracy of this proposed system is approximately 87.5 %.

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