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CONTINUOUS MONITORING UNIT OF FALL DETECTION FOR GOLDEN AGER USING SVM CLASSIFIER

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Abstract - *Continuous monitoring unit of patient fall detection system is used for monitoring the patient activity and emergency treatment. Unusual inactivity of the patient is interpreted. User movement is monitored using sensor devices. Accelerometer sensor are used for recognizing the patients movements and transmit patient movement data wirelessly to the Support Vector Machine (SVM) classifier is used here. The SVM algorithm creates a line or a hyperplane which seperates the data into classes. It can be used as wearable device. This research also can distinguish condition of people between falls and daily activity. The main goal of this surveillance is the detection of major incidents such as a fall, or a long period of inactivity in theirarea.*

Key Words: Fall detection, SVM classifier, accelerometer, wearable device, unusual inactivity.

1. INTRODUCTION

People ageing is an even more important trend in our society: for example in Italy Italy the percentage of people aged over 60 will increase from 24% in2000to41%in 2050.For the elderly oneof themost hazardous eventisthefall:about 30% of people aged over 65 fall each year (35% over 70 years of age) . Fall-related injuries represent the 6% of all medical expenditures for persons aged over 65 in the U.S., and are a significantly notable cause of death for this category of people. Golden agers cannot return to their standing position after a fall and it is a very dangerous situation for a lonely patient.

Wearable devices, ambience sensors, and vision sensors are based on the different categories of fall detection systems.

The solution presented in this work belongs to thefirstcategory. Embedded sensors are used to estimate the motion, the posture and eventually the location of the user. Systems of this type are environment-independent can be used everywhere and are the easiest to use. Moreover, if the device contains a communication module (e.g. RF, Zigbee). The one or more wearable sensors are used for identifying falls of the persons. The proposed system uses accelerometer. Signals are processed which are acquired from the sensors , and the most used methods to recognize fall events or unnatural postures are acceleration magnitude threshold based, Pattern Recognition Methods based and Neural Network based.

Support Vector Machine (SVM) algorithm is used for classification of regression problems. The kernel trick technique is used to transform the data. The linear and nonlinear problems can be solved by SVM method and is already used for detecting the fall of the patient over accelerometer signal. We can detect the fall by calculating with the sample falls collected in daily activities. The arrays are then continuously adjusted in order to avoid false positives. Finally, the application allows to carry out an automatic alert to presets family numbers in case of accidental fall**.**

The solution implimented in this work belongs to the first category action.

(1) Pre-fall phase, the action is based on usual/normal activities of daily living.

(2) Critical phase, the movement, when the person fall suddenly towards the ground.

(3) Post-fall phase, is based on fall of a patient on the ground with no action ;

(4) Recovery phase, when the patient stands up on his own, or with the help of others after fallen.

Critical fall suddenly moves the body to the ground without any clue of imbalance, producing a shock. Therefore, a 3-axis accelerometer is used. The acceleration gives the result of high negative and positive peak value. The high negative occurs when the body moves suddenly towards the ground. When the body contacts the ground, the high positive occurs.

The aims of this study are

(5) The minimum and maximum resultant accelerations observed that is shown during a critical phase fall of a torso can distinguish falls from ADL using a Support Vector Machine, without a fixed threshold for sensitivity or specificity,

(6) A min-max feature is proposed and evaluated for a short time from the minimum and maximum resultant accelerations, and

(7) A short time min-max and a maximum peak feature is compared and shown that the short time min-max feature can provide the better performance.

2. MATERIALS AND METHODS

A. Materials

Accelerometer sensor is used for recognizing movement of the humans falls, MEMS sensor which stands for micro electromechanical system and applies to any sensor manufactured using microelectronic fabrication techniques. Accelerometer was constructed using two dual- axis MEMS accelerometers (Analog Devices ADXL321) mounted at right angles to each other, and attached to a person's torso . The X-axis is anterior-posterior, the Y axis is left-right, and the Z axis is superior-inferior. The accelerometer sensor which sense the movement of the humans falls and transfers the fall signals from analog to digital. All signals were acquired at 12-bit resolution with a 1-kHz sampling frequency, and processed by a second-order low-pass Butterworth digital filter with a cut-off frequency of 20 Hz. Zigbee is used as a wireless communication which has a specification of IEEE 802.15.4. It is used to create PAN with small, low-power digital radios, such as for home automation. Zigbee is a Wireless adhoc networks, low data rate, and close proximity (i.e., personal area).

Fall detection system of technology is defined by the zigbee specification is intended to be simpler and less expensive than other wireless personal area networks such as Bluetooth or more general wireless networking such as Wifi. Zigbee wireless technology has applications of home automation and low data transfer.

Zigbee requires long battery life and secure networking. Zigbee wireless technology which has a defined rate of 250Kbit/s, best suited for intermittent data transmissions from a sensor or input device.

Voltage regulator integrated circuit (7805) is a member of some series of fixed linear voltage regulator ICs. In a circuit, the voltage source may have fluctuations and would not give the fixed voltage output. The output voltage is maintained by voltage regulator IC at a constant value. 7805 provides +5V regulated power supply. Capacitors of suitable values can be connected at input and output pins depending upon the respective voltage levels.

ZIGBEE

Zigbee requires long battery life and secure networking. Zigbee wireless technology which has a defined rate of 250Kbit/s, best suited for intermittent data transmissions from a sensor or input device.

Zigbee works at mesh networking technology each node within the network which is connected to each other. Zigbee has low power consumption and it is used in low data rate applications. The devices like Amazon echo plus Philips hue that supports the Zigbee protocol. Zigbee technology which transmits data over long distances by passing the information through a mesh network.

Fig - 1: Zigbee

RF module CC2500 , a wireless communication device could even be a Transceiver module which provides easy to use RF communication at 2.4 GHz. RF module is employed to transmission and reception of data at multiple baud rates from any standard TTL source. It works in Half Duplex mode. The switching from receiver to transmitter mode is finished automatically.

Fall detection includes a ability to reduce the physical and mental damage caused not only by the fall but time after a fall before discovery. The fall detection technologies will help to reassure those at a risk of falling furthermore as their caregivers and family. These devices can help physical therapists in future and other clinicians to obviously understand not only when the person experienced the fall , but also circumstances surrounding the fall, allows for better treatment of the individual.

IOT

In this paper, we introduce a Fall Detection system based on Internet of Things in the wearable system to detect the falls of humans.

ESP8266 WI-FI MODULE

Wireless technology is used for wireless local area networking with devices based on the IEEE 802.11 standards.

Wi-Fi uses the the range of 2.4 gigahertz (12 cm) UHF and 5.8 gigahertz (5 cm) SHFISM radio bands. Within the range of network anyone can attempt to access network with a

wireless modem; because of this, Wi-Fi is more vulnerable to attack (called eavesdropping) than wired networks. Wi-Fi Protected Access is created to protect information moving across Wi-Fi networks and includes solutions for personal and enterprise network and it is a family of technologies

Fig - 1: Wi-Fi module

3. FALL PREVENTION ALGORITHM

A Support Vector Machines (SVM) was employed as the classifier to separate falls from ADL. It is composed of either an input for max(A_res) or two inputs for Smin and Smax. Data are normalized for training and testing. Computing effort and resources is saved.

The datas collected and trained can be stored for future analysis. It the datas matches a current fall, and satisfying the threshold value condition, then the detection of fall is performed based on the type of fall.

A. To detect a fall, five types of parameters are used

in the analyses.

B. The fall-feature parameters of sum vector magnitude (SVM) Asvm, differential SVM (DSVM) of acceleration, angle , gravity-weighted SVM (GSVM) , and gravity- weighted DSVM (GDSVM) are calculated using the following equations.

B. Algorithm used in this fall alarm system is based on thresholds of sum acceleration and rotation angle information. When a real fall happens, collision between human's body and ground will produce obvious peak value at the sum acceleration a which has magnitude as

$$|a|=\sqrt{ax2+ay2+az} \quad (1)$$

where ax, ay, and az present accelerometer measurements of three axes. In order to distinguish high intensity movements from others, sum acceleration is used by the system. Additional detection features are required in order to prevent false detection that can be produced from actions like jumping and sitting. A normal fall can be distinguished from a sudden fall or jump by the patient. The activity of daily living actions are noted and trained to the sensor by SVM, in order to identify and detect the actual fall.

Table - 1: Fall prediction conditions

(1)if the parameter > threshold value
then
(2)if > threshold value of
(among 100 samples after satisfying the condition in Line 1)
then
(3)return fall detection
(4)return no fall detection

Angles can also be calculated based on acceleration measurements. It is convenient to get gravity component in each axis by using a Low pass filter. The humans fall can be of any type. It can be back and forth of motion. The back and forth of human's fall can be separated by the gravity components. The rotation angle can also be calculated. The rotation angle is calculated in order to measure the fall more accurately. Since, the 3-axis accelerometer is used, the position can be sensed more precisely and it can be easily checked by the physician.

Coordinate axis constructed by the gravity vector and accelerometer is shown in Figure.

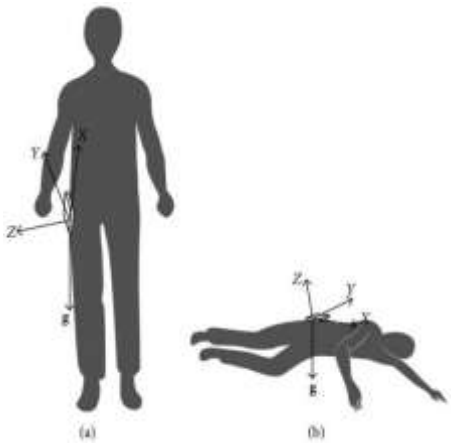

Fig - 2: Fall detection coordinate axis

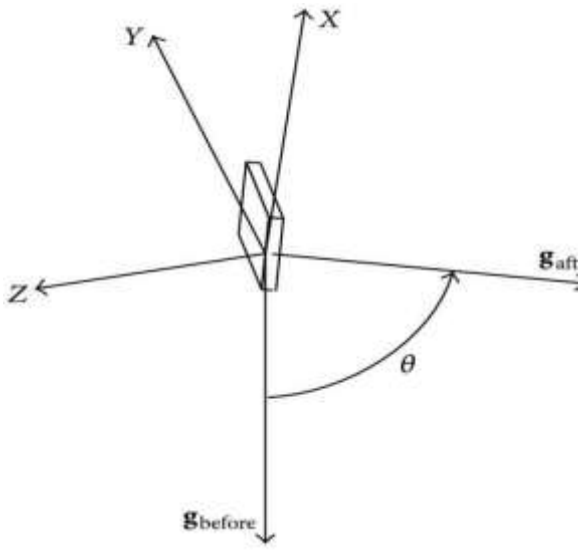

Fig - 3: Angles of coordinates

4. FLOW DIAGRAM

The five types of fall feature parameters from the sample data in the learning and evaluating range are calculated by sending the real-time 3- axis accelerations from sensor of the subject to the server through Zigbee network. Zigbee is an wireless network, so it is predominantly used in this project.

The obtained fall feature parameters are stored. Then it is applied to the threshold method. It is determined whether the fall feature parameter is above the threshold value within a time interval. If the parameter is above the threshold value, then it is considered to be certain fall designating a subject fall or a fall event.

The algorithm for simple threshold used for multiple parameters using double parameters is shown in Algorithm 1. The true positive and false positive rates are calculated for all parameter values by the thresholds which are decided from the Receiver Operating Characteristics (ROC) curve. When the specificity is good with a sensitivity of 100%, the threshold values are determined. The possible falls from the simple threshold method are applied to the HMM algorithm only for the fall feature parameters.

An activity is estimated by registering the HMM with the parameter based on the leaning database. Using the HMM evaluation algorithm, all the single parameters are calculated. Eventually, the maximum probability among the four types of ADL and three types of fall is determined. If the selected motion with high probability is within the three types of fall, then the fall is alerted or alarmed. Else, it is determined to be an activity of daily living (ADL).

5. RESULT

The result of accuracy and efficiency of detection of patient falls were evaluated. Three different experiments were conducted; volunteers wearing the sensors devices performed fall, ADL and run. The classification model with parameters and data is used in order to validate the obtained accelerometer data. Acceleration value in X, Y and Z axis was validated as a equivalent movement type was associated with it. Decision regarding a patient fall is taken based on the number of sequential or linear occurrence of a movement. Accuracy is improved by applying latter decision on the linear sequence of the movement type of acceleration data set. Using the SVM model, the classification results are conducted. Actual run and fall events are also commentated. The overall detection is improved by smoothing the sequential occurrences of run or fall events respectively. A threshold (t=20) has been selected. It has been discovered the moment of fall from the total equivalent movement types. Using the classification and the threshold value, fall events were detected with an average accuracy of 98%, whereas run events were detected successfully at 96.75%.

6. CONCLUSION

This paper presents an efficient approach to distinguish falls from ADL using wearable tri-axial accelerometer sensor, the data classification algorithm based on SVM was adopted to extract the suspicious data. Satisfactory performance and efficiency of our system for falling action detection has been prove through experiments. Our experiments indicate that SVM methods are more suitable for human motion recognition than the other methods. The simplicity and high performance of our proposed featured makes it suitable for implementation on using in practical situations.

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