Human Fall Detection and Alert System using Tri- Axial Accelerometer and GSM

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***Abstract*:- Falls in the elderly have always been a serious medical and social problem. To detect and predict falls, a mel frequency cepstral coefficient (MFCC)-based method using tri-axial accelerations of human body is proposed. A wearable motion detection device using tri-axial accelerometer is designed and realized, which can detect and predict falls based on tri-axial acceleration of human upper trunk. The acceleration time series (ATS) extracted from human motion processes are used to describe human motion features, and the ATS extracted from human fall courses but before the collision are used to train MFCC so as to build a random process mathematical model. Thus, the outputs of MFCC, which express the marching degrees of input ATS and MFCC, can be used to evaluate the risks to fall. The experiment results show that fall events can be predicted 200–400 ms ahead the occurrence of collisions, and distinguished from other daily life activities with an accuracy of 100%. Index Terms— Accelerometer, acceleration time series (ATS), fall detection, fall prediction,**

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I. INTRODUCTION

Falling is an accident that threats the health, especially happened to older people. Caused by reducing levels of strength and stability of the body of a person. Hospitalizations due to falls in older people are five times more than due to other causes. The number of elderly people in the world is expected to reach 2 billion by 2050. With the rising cost of healthcare it is not possible to have separate caregivers for each individual, so in many cases in which a person experiences a fall, immediate help might not be available. Fall detection is very important to monitor someone, especially if the person is elderly and also the early detection of fall is very important to rescue the subjects and avoid the badly prognosis. Hence this article presents a fall detection system based on a tri-axial accelerometer, which also provides GPS (Global Positioning System) localization and GSM (Global System for Mobile Communications) wireless communication. This way, in case a fall is detected, family, social care assistants and/or medical personnel are quickly alerted and can easily intervene, knowing the patient's exact location. Also, this paper presents an algorithm for fall detection, which can be easily implemented in a microcontroller. Human fall system is illustrated in Fig.1.

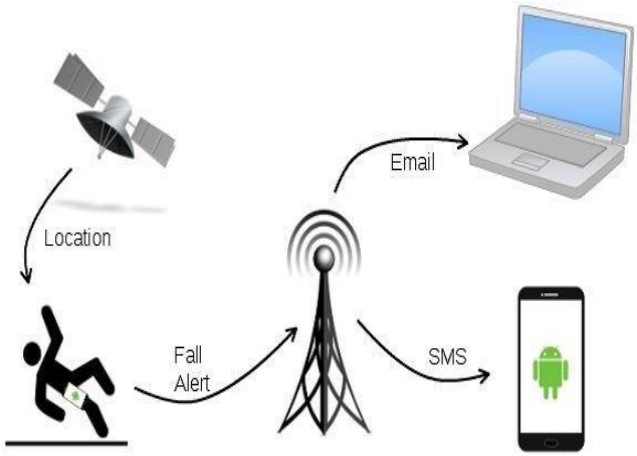

Fig:1. Human Fall alert system

Accelerometers are very suitable for the detection of falls. Studies have also been done on accelerometer data sets for human activity recognition. Hence accelerometer is used in this project to detect an fall. Using this accelerometer has a disadvantage of showing the false positives during the fast movement of the user.

II. LITERATURE SURVEY

Recent years, technical advances in MEMS sensors, microprocessors and wireless communication have been the driving factors to facilitate telemonitoring of people's physical activities. As a result, some wearable automatic sensor based fall detectors have been developed [1]-[11]. Wen J Li' steam[12] introduced the air bag system to secure the hip joining during fall, which is similar to the air bag opening during clashing of the car. This air bag will be in link with the sensors accelerometer and gyroscope and the according to the output of sensors the air bag system works. But the timing efficiency and accuracy are less in this method Tong et al [13] enhanced acceleration for detecting purpose. To monitor the daily activities of an elderly, a system detection and alerting have been implemented. Most of the research has been done to detect the fall. Lindeman [14] implemented a system with sensor using the tri-axial accelerometer to check the fall.

III. SYSTEM MODEL AND ASSUMPTION

In this proposal system, we use Tri –axial accelerometer to detect the human fall detection. Human

movement is classified into normal movement and abnormal movements. The sensor can be worn comfortably without disturbing wearer's daily life. This sensor will send the analog signal to the FPGA /microcontroller for detecting the status of the body and update the display information. The device consists of emergency help button to display the fall alert and emergency signal.

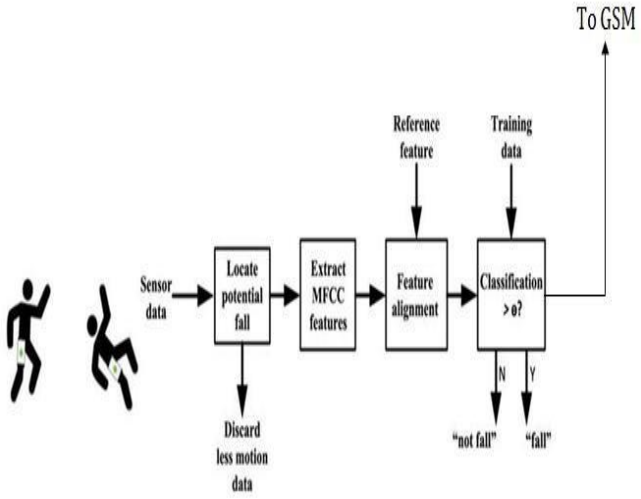

Fig:2 . Block diagram of proposed system

First acquire Tri-axial acceleration at human upper trunk from fall process and other daily life activities. Second, extract features that describe the movement during the series of short time period by turns to make up ATS (Acceleration Time Series) which characterize motion process. By future extracting ATC were extracted to describe fall process especially up to the instant before the impact of collision .Then they were used as training sample to train MFCC (Mel Frequency Cepstral Coefficient). If classification is >0 it indicates that the body has lost its balance that a fall has happened definitely. If classification is not >0 it indicates that the body does not lost its balance that a no fall has happened definitely. The GSM service sends the message to the hospitals medical services and the family person along with the location of the user.

IV. COMMUNICATION TECHNOLOGY

The Global System for Mobile communication(GSM) uses Time Division Multiple Access (TDMA) SYSTEM for transmitting signals. The GSM was developed using digital authorized technology. It has a facility to carry 64 kbps to 120 Mbps of data rates. The GSM provides basic to advanced speech and data services including Roaming. Roaming is the ability to use your GSM phone number in another GSM network. Here GSM technology is used in this paper to send the text message to the health care and family members. A GSM digitizes and pinches data, then transmit it down through a channel with two other streams of user data, each in its own time slot. Global Positioning System(GPS) is a system that provides position and time information in all critical condition, anywhere around the earth where there is an unhampered line of sight to four or more GPS satellites .GPS is enhanced in this system to locate the place of the elderly to health care for timely prevention.

V. RESULT AND DISCUSSION

In this proposal system a human fall is detected using tri- axial accelerometer. Accelerometer is a device which can detect a tilt or a sudden jerk in any of the 3 axis(x, y, z). It can be used to detect any unusual acceleration and tilting of body which indicates that the body is out of control and could have suffered an fall. The accelerometers output can be analyzed by the microcontroller to find if it has crossed the threshold. Tri axial accelerometers provide simultaneous measurements in three orthogonal directions, for analysis of all of the vibrations being experienced by a structure. Each unit incorporates three separate sensing elements that are oriented at right angles with respect to each other.

The following processes are the results of this proposed system:

1. Receives the data from sensor.
2. Compare the data with reference data.
3. Detect either fall or not.
4. Receives an information through GSM to the smart phone.
5. Transmit the text message after the fall of the user to the health care and family members.
6. Locate the position of the user using Global Positioning System.
7. Timely prevention and remote medicine.

VI. CONCLUSION

According to the result and analysis in this paper, it is been concluded that human fall detection and alerting system has been implemented by using tri-axial accelerometer and GSM technology. Hence this system provides a timely prevention of an elderly and alerting the health care and family members.

REFERENCES

[1] A.K. Bourke and G.M Lyons, "A threshold – based fall detection algorithm using a bi-axial gyroscope sensor,"Med. Eng.Phys., vol. 30,no. 1,pp. 84-90, Jan. 2008

[2] N. Noury, P. Rumeau, A. K. Bourke, G. Ólaighin, and J. E. Lundy, "A proposal for the classification and evaluation of fall detectors," Integr.River Basin Manage., vol. 29, no. 6, pp. 340–349, 2008.

[3] A. Purwar, D. U. Jeong, and W. Y. Chung, "Activity monitoring from real -time triaxial accelerometer data using sensor network," in Proc.IEEE Int. Conf. Control, Autom. Syst., Oct. 2007, pp. 2402– 2407.

[4] A. K. Bourke, K. J. O'Donovan, and G. Olaighin, "The identification of vertical velocity profiles using an inertial sensor to investigate pre-impact detection of falls," Med. Eng. Phys., vol. 30, no. 7, pp. 937–946,2008.

[5] G. Shi, C. S. Chan, Y. Luo, G. Zhang, W. J. Li, P. H. W. Leong,and
K. S. Leung, "Development of a human airbag system for fallingprotection using MEMS motion sensing technology," in Proc. IEEE Int.Conf. Intell. Robots Syst., Oct. 2006, pp. 4405–4410.

[6] G. Shi, C. S. Chan, W. J. Li, K.-S. Leung, Y. Zou, and Y. Jin, "Mobile human airbag system for fall protection using MEMS sensors andembedded SVM classifier," IEEE Sensors J., vol. 9, no. 5, pp. 495–503,May 2009.
[7] M. N. Nyan, F. E. Tay, and E. Murugasu, "A wearable system for pre-impact fall detection," J. Biomech., vol. 41, no. 16, pp. 3475–3481, 2008.
[8] L. Tong, W. Chen, Q. Song, and Y. Ge, "A research on automatic human fall detection method based on wearable inertial force information acquisition system," in Proc. IEEE Int. Conf. Robot. Biomimetics, 2009,pp. 949–953.
[9] Q. Li, J. A. Stankovic, M. A. Hanson, A. T. Barth, J. Lach, and G. Zhou,"Accurate, fast fall detection using gyroscopes and accelerometer-derived posture information," in Proc. Body Sensor Netw., 2009,pp. 138–143
[10] G. C. Chen, C. N. Huang, C. Y. Chiang, C. J. Hsieh, and C. T. Chan,"A reliable fall detection system based on wearable sensor and signalmagnitude area for elderly residents," in Proc. 8th Int. Conf. Smart Homes Health Telematics Aging Friendly Technol. Health Independ.,2010, pp. 267–270.
[11] R. Gomez, T. Toda, H. Saruwatari, and K. Shikano, "Techniques in rapidunsupervised speaker adaptation based on HMM-sufficient statistics,"Speech Commun., vol. 51, no. 1, pp. 42–57, 2009.
[12] SHI Guanyi, CHAN C.S, LI Wenjun, LEUNG K.S, et al. Mobile human airbag system for fall protection using MEMS sensors andembedded. SVM classifier[J]. Sensors Journal, IEEE, 2009.
[13] TONG Lina, SONG Quanjun, GE Yunjian, LIU Ming. HMM-Based Human Fall Detection and Prediction Method Using Tri-AxialAccelerometer[J]. Sensors Journal, IEEE,2013.
[14] ZHANG Tong, WANG Jue, XU Liang, LIU Ping. Fall detection by wearable sensor and one-class SVM algorithm[J]. Lecture Notes in Control and Information Sciences, 2006.