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A Novel Approach for Fall Detection Methods for Elder People Monitoring Using Home Networks

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Abstract:
As we grow old, our desire for independence does not diminish; yet our health increasingly needs to be monitored. Injuries such as falling can be serious problem for the elderly. If a person falls and is not able to get assistance within an hour, casualties arising from the fall can result in fatalities as early as 6 months later. It would seem then that a choice between safety and independence must be made. Fortunately, as health care technology advances, simple devices can be made to detect or even predict falls in the elderly, which could easily save lives without too much intrusion on their independence. Much research has been done on the topic of fall detection and fall prediction. Some have attempted to detect falls using a variety of sensors such as cameras, accelerometers, microphones, or a combination of the same. This paper is aimed at reporting which existing methods have been found effective and the combination of which will assist in the progression towards a safe, unobtrusive monitoring system for independent living.

Keywords: Fall Detection; Kinect camera; Sensors; Elderly people

I.INTRODUCTION

Traditionally, elderly care has been the responsibility of family members and was provided within the extended family home but in the recent years in modern societies this is decreasing. The reasons for this change include decreasing family size, the greater life expectancy of elderly people, the geographical dispersion of families, and the tendency for women to be educated and work outside the home. Falls are one of the most important health care issues for elderly people at home, old age homes and Hospitals. Fall detection system is becoming more important to elderly people and patients who will be left alone in the home because the fall may cause severe injury or even mortality. Due to the limited number of nursing staff and increasing costs of health care facilities, many research groups are focusing on the development of scientific methodologies to assist the elderly people in their homes where continuous monitoring of the elderly people and patients is required. Patient monitoring and surveillance systems based on information and communication technology are attractive for their potential to reduce the burden and cost of giving care to elderly people while maintaining safety, Privacy and autonomy. The main motivation is to minimize human involvement in surveillance and to detect more complex activities and situations using various sensors and design a novel classifier that identifies risky situations with the collected information and inform the caretakers. Robots can be used to provide the primary aid required. Therefore Automatic fall detection systems are very essential and are being developed.

Several kinds of approaches for detecting falls automatically have been proposed they can be mainly classified into three categories: wearable sensorbased, ambience device based and computer visionbased methods. Wearable sensor based methods often use specialized equipments and sensors, such as accelerators and gyroscope sensors, which are attached to the human body. When a fall occurs, it can be detected by the sensors and a help is automatically called for or be made manually via help buttons. One of the major problems is that wearable sensors are disturbing and often burdensome. Ambience device-based methods often take advantage of ambience sensors installed on the elders‟ active regions such as vibration sensors on the floor and IR sensors, or combine these sensors together to improve the performance

II. METHODOLOGY OF DETECTION

An initiatory estimation of the body movement can be obtained from the Signal Magnitude Vector (SMV) defined as:

$$SMV = \sqrt{Acc_x^2} + \sqrt{Acc_y^2} + \sqrt{Acc_z^2} \dots\dots (1)$$

Where Acc_x, Acc_y and Acc_z represent the outputs of x-axial, y-axial and z-axial, respectively. Since the direction of possible falls cannot be predicted, it is inappropriate to use only one output of the axis. At the beginning, acceleration due to gravity, *g*, liesin the z direction.The acceleration changes along with body movement, furthermore, vibration becomes significant when the fall happens. A typical fall events ends with the person lying on the ground or leaning on walls, orfurniture that will cause a significant change in trunk angle. In this case , it is desirableto consider changes on the trunk angle to detect whether the detected acceleration was due to fall event. Trunk angle, , can be defined as angle between the SMV and positive z-axis and can be calculated by trigonometric function as

$$\theta = \arccos\left(\frac{Acc_z}{SMV}\right)\dots\dots(2)$$

III. RELATED WORK

Many fall detection techniques are available to detect fall detection rate, some of the techniques are described in this existing system which are illustrated below very clearly.

I.Akyildiz, W.Su,Y.Sankarasubramaniam, And E.Cayirci, have designed "Wireless Sensor Networks: A Survey". Which describes two thirds of elderly with hip fracture never regain their pre-fracture activity status and one-third require nursing home placement. Given these facts, human behavior analysis can contribute with a strong point both on the prevention and detection of this type of hazardous situation. Systems monitoring the elderly living space could analyze potential risks of falls occurring and identify potential causes of falling and consequently correct adaptations on the living space. In terms of fall detection, it would be advantageous, for those situations where full monitoring is not possible, to have systems with the capabilities for alarming cares about abnormal situations. This system use only alarm to indicate the elders falling situation.

M.Yu, A.Rhuma, S.Naqvi, L.Wang, And J.Chambers, have proposed "A Posture Recognition-Based Fall Detection System For Monitoring An Elderly Person In A Smart Home Environment".In this paper global (ellipse) and local (shape context) features from static postures and an improved Directed Acyclic Graphic Support Vector Machine (DAGSVM) is applied for posture classification. After classifying different postures, certain rules are set to detect falls. This fall detection system is shown by evaluation on real datasets to achieve a good fall detection performance. For a comprehensive evaluation of this fall detection system, the volunteer is asked to simulate 32 fall activities and 64 non-fall activities. Final results which show that 31 out of 32 (96.88%) falls can be detected while only 3 out of 64 (4.7%) non-falls were mistaken as falls; and a high fall detection rate is obtained with an acceptable false detection rate.

Y.W Bai, S.C. Wu, And C.L. Tsai have designed "Design And Implementation Of A Fall Monitor System By Using A 3-Axis Accelerometer In A Smart Phone"Here the Various fall-detection solutions have been previously proposed to create a reliable surveillance system for elderly people with high requirements on accuracy, sensitivity and specificity. In this paper, an enhanced fall detection system is proposed for elderly person monitoring that is based on smart sensors worn on the body and

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operating through consumer home networks. By utilizing information gathered from an accelerometer, cardio tachometer and smart sensors, the impacts of falls can be logged and distinguished from normal daily activities. The proposed system has been deployed in a prototype system as detailed in this paper. From a test group of 30 healthy participants, it was found that the proposed fall detection system can achieve a high detection accuracy of 97.5%, while the sensitivity and specificity are 96.8% and 98.1% respectively.

S.Demura, S.Shin, S.Takahashi, And S.Yamaji, have developed "Relationships Between Gait Properties On Soft Surfaces, Physical Function, And Fall Risk For The Elderly" Which describeshealthcare technologies are slowly entering into our daily lives, replacing old devices and techniques with newer intelligent ones. Although they are meant to help people, the reaction and willingness to use such new devices by the people can be unexpected, especially among the elderly. We conducted a usability study of a fall monitoring system in a long-term nursing home. The results gave us useful insights, leading to ergonomics and aesthetics modifications to our wearable systems that significantly improved their usability and acceptance. New evaluating metrics were designed for
the performance evaluation of usability and acceptability. This system took motion pictures only. In case of falling any obj cts it can took a image and send an indication. Where there any elder person falling means the image is sending delay. In case the picture was not accuracy, the message is not sent.

IV. PROPOSED WORK

The structure of proposed fall detection system whose core structure is based on a Micro programmed controller unit. The accelerometer sensor along with cardio tachometer is integrated on one single board, recording real time acceleration and pulse rate. Both acceleration and pulse rate are first captured using an analog-to-digital converter. Then the digital signal is transmitted to the MCU for further processing. The heart rate is captured by a pulse pressure sensor and also passed directly to the MCU and the location is detected using GPS and communicated using GSM. The message can be set to reach the nearest hospital and the relatives. The message contains latitude and longitude values of accident place. Thus, wearable sensor based methods are considered in this research. By using information from an Accelerometer and cardio tachometer, the impacts of falls can successfully be distinguished from activities of daily lives reducing the false detection of falls. This system has a set value to distinguish a high fall detection rate and low false detection rate.

V. PROPOSED DESIGN

There are 2 major steps involved in this project
1. First is to sense the position of elderly person using sensors. Accelerometer gives details about movements and ultrasonic sensor detects free fall.
2. The care-giver must be alerted by means of a SMS once the fall of elderly is detected

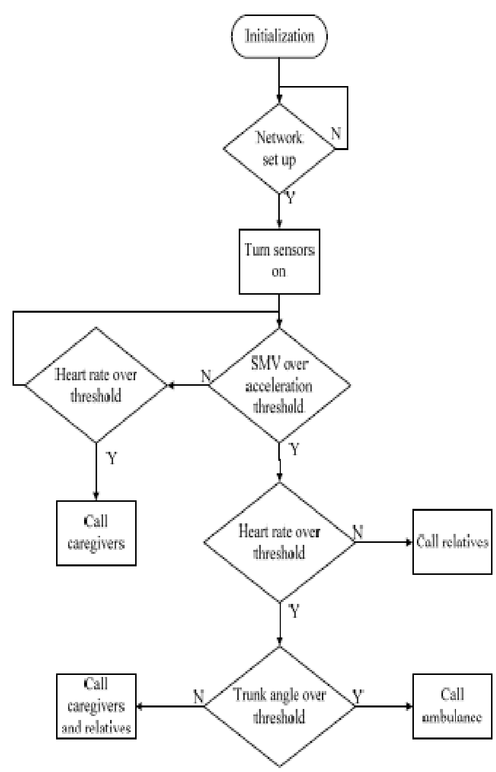

Figure.1 Flow Chart of the experimental system

The fall detection rate is effective when we combine and use the two or more conventional approaches. This reduces the amount of false alarms and increases the efficiency to 90% - 95%. The choice of choosing which methods are to be employed and the test conditions to be set decides the scope of the entire systems functioning. Among choosing the fall detection methods, position detection plays a vital role. To detect the position, tri-axial accelerometers are most preferred. Accelerometers are compact as well as low cost. The accelerometer readings alone are not sufficient to determine the fall detection of the elderly. Because it shows steep change in the values when a person sits suddenly. The choice of a support system to detect a fall using passive sensors avoids most false alarms. Ultrasonic sound sensors are employed in this project for this purpose. This sensor is preferred over IR sensors as they are not affected by thermal interferences. Moreover the impact of a fall can be sensed reliably by reading the abrupt change in distance and checking for obstacles like the floor, etc. . A pair of 433MHz RF transmitter and receiver proves to be a cost effective wireless medium to be employed. Upon reaching the test condition, a GSM module interfaced to the receiver section will send an emergency alert to the care-giver. The transmitter section consists of a microcontroller to sense the sensor values and RF transmitter to transmit these values to the receiver section. The receiving section consists of a microcontroller board to read the RF receiver values and a GSM module to send an alert to the care-giver upon reaching the threshold values set for emergency alert. The program for testing the system modules and entire system is written in Embedded C. The codes are compiled, verified and uploaded to the microcontrollers using Arduino IDE.

VI.CONCLUSION

The proposed project gives an easy mechanism to detect falls in elderly persons using user friendly tools. Time is one of the key factors that determine the severity of a fall. This provides an opportunity for the immediate medical attention to the elderly at the earliest once the fall detection alert is sent. The performance under real-life conditions, usability, and user acceptance as well as issues related to power consumption, real-time operations, sensing limitations and record of real-life falls are analyzed using this kit. The system can be implemented with inclusion of a few more sensors to improve its efficiency. Gyroscope, along with accelerometer, performs better than accelerometer alone. Blood pressure sensor and heart beat sensor provides the state of the person during normal and fall events. By incorporating the above sensors in the system more reliable false alarms and also the health of the elderly can be monitored.

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