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Smart Fall Detection System for Elderly People

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Abstract : One of the most common causes for elderly adults seeking emergency medical assistance is a fall. Because of stability concerns and other factors, older persons regularly harm themselves by falling without realizing it, especially if they live alone and have no one to care for them. Following a fall, medical assistance should be sought as quickly as possible in order to limit the victim's danger and save the individual. Several technologies that employ cameras and sensors to monitor the activities of the elderly have recently been created in this new generation age. However, the operating and installation expenses are substantial, and the services are only available indoors. The currently available equipment for detecting human situations needs the user to wear a wireless wristwatch with various sensors that monitor the user 24 hours a day, seven days a week. This strategy restricts user mobility due to the device's constant swinging and movement. This idea offered a fall detection system for all persons with health difficulties, not only the elderly. This project is intended to be both cost-effective and dependable in terms of monitoring and detecting falls from a person and notifying family members by sending a message with the location for assistance at the moment of the fall. In this study, sensors such as an accelerometer, a gyroscope, and a GPS sensor for the accurate position were utilized to identify the faller's moment of body tilt or a quick collapse of the body, respectively. The system's precision has been greatly enhanced by combining sensors such as GPS and accelerometer. The alert system will convey the alarm system and the precise position to the necessary authorities through Short Message Service (SMS). Furthermore, a buzzer is integrated with the device to inform individuals in the vicinity of a person's fall. This wearable gadget also has a minimal maintenance cost and is extremely rapid in monitoring the human body's activity at all times. As a consequence, the wearable fall detection and alarm system with location service have an accuracy of 95% and 90%, respectively.

***IndexTerms* - Falling Prevention of Senior Citizens; Physical Situation Tracking; Wristband Worn Fall Sensor Network; Falling Quality Monitoring.**

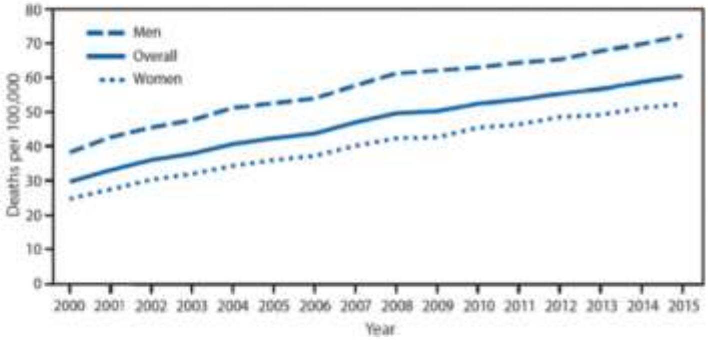
1. Introduction

Globally, the number of older adults living alone is rapidly increasing. Falling is one of the many problems that the elderly encounter. Falling is the most common issue among those over the age of 65. Falls are frequently characterized as "accidentally coming to rest on the ground, floor, or other lower level, excluding conscious modification in a posture to rest in furniture, wall, or other things." On average, 30% of persons over the age of 65 fall once every year, and two-thirds are in danger of falling again, a ratio that climbs with age. According to a World Health Organization (WHO) research, falls are the second leading cause of unplanned or accidental death. A single severe fall can result in an extended hospital stay, long-term incapacity, complex rehabilitation, loss of independence, or worse.

For more than two decades, researchers in both the technological and medical fields have been striving to lessen the impact of falls by decreasing reaction times and providing better treatment when a fall happens. Falls are regarded as one of the most severe mishaps that may occur to an older adult. This topic is being investigated as part of the research towards the development of different systems linked to Ambient Assisted Living Systems; When the outcome of a framework for identifying Activities of Daily Living and their surroundings has previously been studied, Falls can reduce the quality of life of the elderly by triggering severe several health concerns such as fractures and spinal cord injury, as well as a loss in mobility and activity. The "long lay," defined as staying on the ground or floor for more than an hour after a fall, is a severe side effect of falling that can lead to death. Every year, it is estimated that over 646000 persons die as a result of falls globally. More than 80% of these fatalities happened in low- and middle-income nations. Unintentional fall deaths are on the rise all around the world. In 2016, around 30,000 older people aged 65 died in the United States as a result of an unintended fall. Figure 1 displays the death rates per 100,000 people 65 and older from 2000 to 2015. This rate has been progressively increasing at 4.9 percent each year on average.

Furthermore, the death ratio among senior males is higher than that of older people. A fall can cause significant physiological harm as well as psychological grief. Stress, attention disorder, melancholy, and a sense of insecurity are some of the psychological consequences. Dread of tripping is a severe psychological issue limiting the elderly's daily activities.

Approximately 60percent of the total aged restrict their regular living activities due to a fear of falling. This exercise restriction may result in poor gait balance and muscle weakness, impairing the elderly's range of motion, and, as a result, the falling incidence increases. A fall loop can reoccur due to the trauma of falling. Deaths from falls are more common in adults over the age of 65.

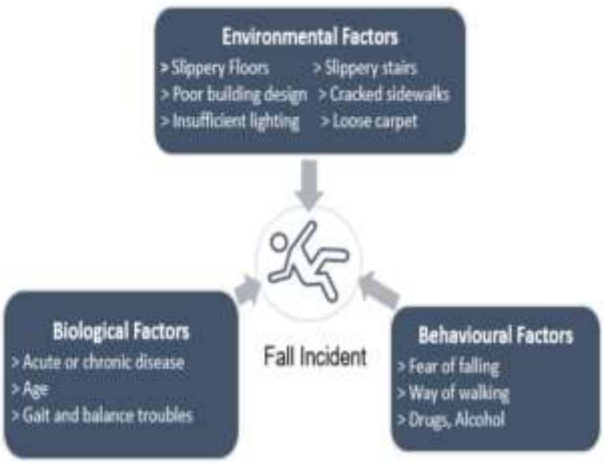


The probability of a fall grows as people age and their bodies degrade. Year after year, 30 to 50% of patients at long-term clinical services fall, while 40% drop repeatedly. Falls become more severe as people age based on biological factors. Specific fall injuries, including such breaks and spinal injuries, have grown by 131percent of the total in the last three decades. Therefore, it is expected that just by 2050, one or more people in each of the five groups will be 65 or older.

Consequently, unless quick precautionary strategies are taken, the number of injuries falls are the most common will soar. The acute and lengthy repercussions of slipping could be minimized simply by recognizing a fall earlier and providing immediate medical attention. As little more than a result, the falling tracking system could minimize such issues by putting out an urgent notice whenever a fall happens. Several techniques for monitoring crashes have indeed been proposed for this purpose. Several accelerometer and gyro sensor collapse monitoring devices were also developed. However, many of them incorrectly view regular life activities as falls or falls. This paper presents a wearable watch-based fall detection system to accomplish this purpose. The balance of this work is outlined. Describes the associated work. Describes the method. The findings are discussed,

2. Falling Risk Factors

People lack stability and are unable to stand erect. Whenever a youngster misses their posture, individuals have had the ability to rebound themselves; but, if an older person loses their stabincluility, rebounding is much more challenging because they are physiologically weaker at around that age. A variety of causes could cause the fall. All of the variables that can trigger a collapse were associated with risk variables of injuries. In actuality, every incidence of such a collapse result from complex interactions between numerous parameters. That signifies that as the number of circumstances climbs, so has the probability of falling. Because as the population of older adults' climbs, so should the chances of mortality throughout old age. Shows the categorization of potential confounders into three groups: behavioral, ecological, and physiological risk factors. Potential confounding factors have been linked with personality characteristics, feelings, and daily things. Such uncertainties can indeed be controlled by strategy development. For instance, when an older relative collapses due to excessive alcohol or drug usage, proactive therapy may tackle such addiction and habit. Risk factors that have been identified are derived from an individual's immediate surroundings. Slippery floors, inadequate lighting, or broken pathways are some of the major environmental and genetic factors.



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Physiological factors have been associated with just an individual's age, sexuality, and overall wellbeing. Physical lifestyle factors include chronic health diseases, heart issues, eyesight abnormalities, fluctuations in blood circulation, etc. stride, or imbalance problems. Even though natural factors such as age and gender are uncontrollable, diseases may be eased or managed with medical attention, and health status can indeed be enhanced. Inside the physical drop arena, there seem to be two main research paths: dropping surveillance and fall avoidance. The original objective of a collapsing detector sector would be to minimize the recovery period once per fall has happened. Another major goal of the falling prevention domain is to anticipate falls by examining the range of motion. Fall detection methods may drastically reduce the amount of time it takes for individuals to respond to a falling incident. Effective prevention devices could assist you in preventing and preventing future falls. Human fall-related systems were divided into three types based on sensor deployment: camcorder devices, ambient-based devices, and wearable systems. Due to its higher infrastructure costs, camcorders and ambient-based gadgets were rarely utilized. With wearable technology, inertial measuring elements, including gyroscopes and accelerometers, were extensively adopted.

Due to improvements in micro-electro-mechanical devices, smartwatches can now be manufactured compact yet inexpensive. A researcher devised a global classification strategy that included a fall detection system and a fall prevention system. Researchers categorized fall detection systems and fall prevention systems under three categories based on the sensor implementation: comfortable-to-wear systems, non-wearable-based devices, and hybrid systems. Devices were placed just on the older person's skin into wearable-based gadgets to detect or avoid mishaps. Both are traditionally worn all around the midsection and around the wrist. With non-wearable-based solutions, sensing such as ambiance, sight, and Radio detectors are positioned inside the external environment rather than on the human body. By contrast, integration or fusion systems include combined wearable and non-wearable instruments. J. T. Perry classified fall detection systems using the accelerometer technique. There are three types of fall detection system methodologies: those which measure velocity, those which combine accelerated using further sensor information, and those that do not collect acceleration. According to R. Iguala et, accident detection systems are classified into wearables and situationally systems. A variety of data processing approaches are being used by sensing technologies. In such procedures, data information collected from the detectors was utilized. A fall detection system utilizes two sources of data process parameters: analytical approaches and machine learning methods

3. Fall Detection Algorithm

As shown in Eq.1., the overall combined amount acceleration vector Acc, which encompasses two very different static and dynamic accelerating elements, was computed using sample information.

Acc= $\sqrt{\ }$ (������)^2 + (������)^2 + (������)^2 (1)

These linear acceleration inside the x, y, and z directions were designated by Ax, Ay, and Az, correspondingly.

This rotational motion, such as the velocity, was calculated using observed variables which can be seen in Equation (2)

w =$\sqrt{\ }$ (������)^2 + (������)^2 + (������)^2 2)

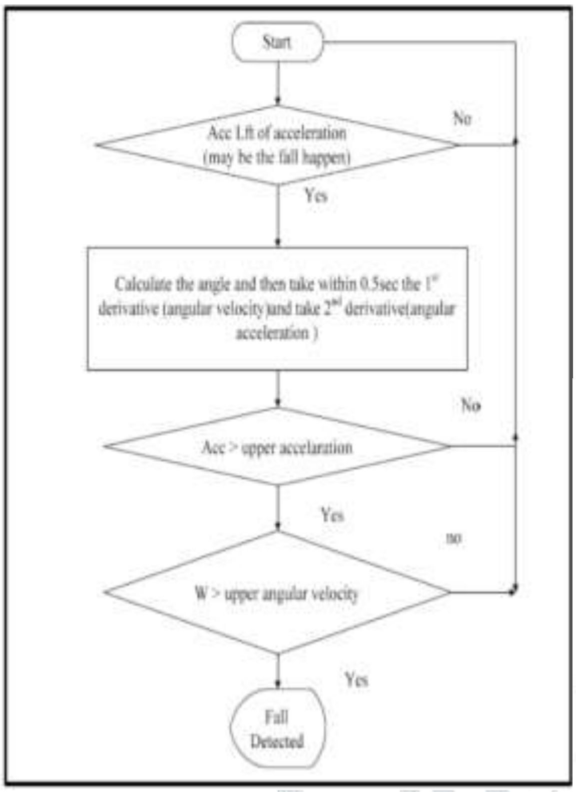
Correspondingly, Wx, Wy, and Wz are the accelerating variables inside the x, y, and z directions.

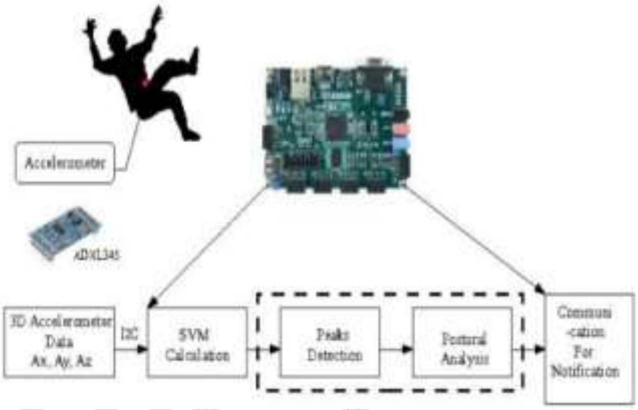
Whenever the tri - axial sensor stands static, its amount of a velocity, Acc, remains fixed, and the angular momentum equals 00/S. Whenever a head falls, its velocity frequently fluctuates, as well as the change in momentum generates a variety various indicator all along fall path. The Falling Index (Acc) may overlook slow falls since it demands a high sample frequency and quick acceleration adjustments. As just a consequence, generally do not even utilize Acc until we want to compare the overall system performance with previous studies which utilized the very same coordinates with varying velocities as well as maximum acceleration. Bottom and top velocity and angular speed drop criteria are utilized.

To determine the fall, the following formulae are used:

Lower fall threshold (LFT): These signal lower peak values are indeed the lower values again for resultant of each practices conducted. With velocity impulses, this lowering fall limit is set to some of the most insufficient intensity lesser drop spike detected.

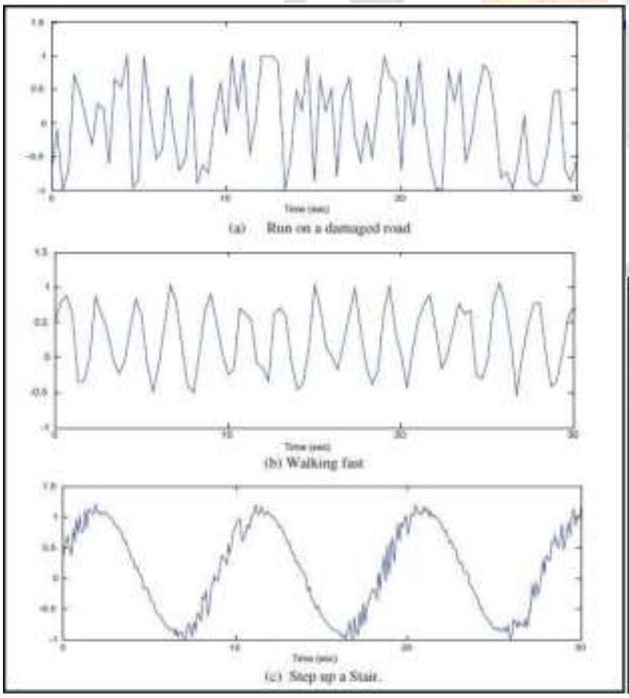
Upper fall threshold (UFT): The positive peaks for the observed data for every practice conducted were indicated by the signal higher maxima. Every accelerator and angular speed transmitter higher falling limit was adjusted to a minor size recorded. Its higher fall barrier is proportional to the peak impact load felt by body part during in the ability to apply knowledge of a fall. Fall detection techniques depending on threshold are classified into two parts: ones based on the lowest fall barrier analyses of values obtained as well as those depending on higher fall cutoff comparison of accelerometer data. Notwithstanding many significant results through previous research, reliability remained under desired values. The bottom and top drop threshold were adjusted in this experiment, as well as the outcomes was 83 percent and 67, correspondingly.

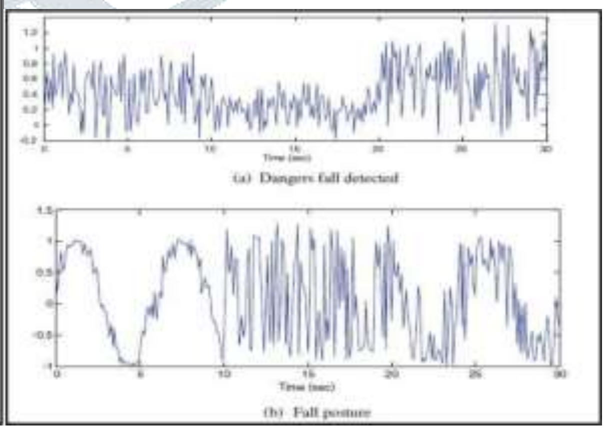




4. Results

Most existing increases in speed fall detection methods could only tell the difference between falls and ADL. Nevertheless, certain tasks, including such quickly sitting in a chair, require considerable vertical motion. The trunk's velocity and rotation rate because it runs on the degraded roadway, cruises briskly, or moves up a staircase. In any of the three scenarios shown inside the picture, there really is no collapse. There really is no reason for concern. While seated fast, both the velocity and rotation rate of a spine and leg is illustrated inside the diagram. This fall was recognized very quickly in the following cases, as well as an alarm was issued within the first thirty seconds, whereas the caution was issued after ten seconds since there was no collapse.





4. Conclusion

Numerous drop variables of a six-axes velocity are introduced and applied by the algorithm. It's simple criterion is employed for selecting prospective falls that were then input into the MPU to solve problems such as divergence from social falling behavior patterns or comparable falling actions. Three hundred fifty different research papers have been used to test the proposed system. The top and bottom velocity values and the speed have indeed been optimized, so they provide the best accelerometer sensor with sensitivity, specificity, and accuracy of more than 95%. Compared to using all of the events, these findings demonstrate a reduction in computational work and resources. The proposed methods were thus simply because they rely on a simple sensor angle, after which the software calculated both rotational acceleration of an object.

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