

# AN IoT- BASED WEARABLE FALL DETECTION SYSTEM

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**Abstract** - Falls are a major public health problem. We know that falls are dangerous, especially for older adults. Older people have the highest risk of death or serious injury arising from a fall and this risk increases with age. Approximately 28-35% of people aged of 65 and over fall each year. Although it is not possible to prevent all falls it is possible to take actions that will reduce the chances of a bad fall. This paper proposes an IoT based patient specific fall detection prototype system for elderly people. This is a wearable device that mainly uses a single triaxial accelerometer sensor attached to the person's body to distinguish between the activities of daily living and fall events. Other sensors used in the device also measure some vitals of the person such as body temperature, pulse rate, ECG etc. The design and implementation of the product combines both hardware and software that work continuously in detecting and reporting a fall. The system is able to detect and report the falling incident to the contact person and also to the concerned hospital via an autogenerated message so that necessary medical treatment can be provided to the injured person soonest possible.

**Key Words:** Fall detection, Internet of Things, Accelerometer sensor, ECG, Threshold detection.

## 1. INTRODUCTION

The world population is increasing tremendously. Now, as the population is increasing, the demand for earning livelihood is increasing and becoming more tough making younger generation leave their homes and settle in distant urban localities to earn and send money to their elderly parents. As a result of which, unlike older times, elderly people are gradually becoming lonely and staying solitude in their houses. As people get older, they get vulnerable to different medical and physiological problems. The problem increases when there is nobody to take care of them. This means that no one can help them if any accidents happened during this time. If the elderly fell down and injured, they need to call the ambulance or their relatives to seek help which may not be possible. Rural India still lacks a facility to hire a caregiver or a nurse, who would take care of the elderly people living alone. Hence, it is the left alone elderly population, who has to do the daily chores of life and also take care of own selves till they die.

There is a lack of studies about how "elderly people staying alone" cope with their deteriorating health in rural India. Even though the medical resources and facilities are expanding daily, still the suffice level is not attained. The United Nations Department of Social Affairs projected that the elderly population in India is going to rise from 8% in 2015 to 11.5% in 2025 and 19 % in 2050. According to the World Health Organization approximately 28-35% of people aged 65 and over fall each year increasing to 32-42% for those over 70 years of age. Falls exponentially increase with age-related biological changes, which is leading to a high incidence of falls and fall related injuries in the ageing societies. Falls are a major problem in the elderly because they may cause significant morbidity and mortality. This is due to the complications arising from falls causing a significant decrease in functional status, serious injury, and an increase in the utilization of medical services. Elderly people's falling percentage is higher because their body become weaker and their physical strength also become lower. Once they fall down they may not be able to stand up themselves or become unconscious, they need helps from others. Usually, not many people think about elderly people falling until some dreadful events happens such as someone has injured badly or even death. If preventive measures are not taken in the immediate future, the number of injuries caused by falls is projected to be a 100% higher in 2030. According to the doctors, while the debilitating effects of old age cannot be avoided, risks can be minimized through careful planning. In this context, assistive devices that could help to alleviate this major health problem are a social necessity. In order to reduce these types of risks, Fall detection sensor system is the solution to solve these problems. Since falls are a major public health problem among older people, the number of systems aimed at detecting them has increased dramatically over recent years. In this paper, an enhanced fall detection system based on IoT is proposed for elderly people.

## 2. EXISTING SYSTEM

A wide variety and large amount of passive monitoring systems are currently available to detect when an individual has fallen. These systems can be wearable or non wearable systems. Non-Wearable Based Systems (NWS) are environmentally mounted system such as

cameras, floor sensors, infrared sensors, microphones and pressure sensors that detects when falls have occurred.

However, they are costly and there is consequent lack of privacy for elderly people because these systems require the sensors to be strategically placed in the indoor environment in which the elderly lives. Their operation is limited to those places where the sensors have been deployed. Smart phone based detectors are also available but they may face difficulties with real time operations, sensing architecture, stability of the accelerometers sampling frequency etc. Also smartphones cannot be overloaded with continuous sensing commitments that undermine the performance of phones. Environmentally mounted system that automatically detects when falls have occurred. All methods start with a feature extraction, for example, the ratio of people’s height and weight, the edge points from the silhouette of a person, changes in illumination, the orientation of the main axis of the person, the width, height and depth of the human posture, the skin colour to detect people, etc. Then these features are compared and classified to distinguish normal activities from real falls using different techniques[7]. Wearable devices can be miniature electronic sensor-based devices that are worn close to and/or on the surface of the skin, where they detect, analyze, and transmit information concerning to a fall event. Most of the wearable fall detectors are in the form of accelerometer devices. These devices are not much costly due to the availability of cheap embedded sensors included in smartphones. Most of these systems uses a GSM module to generate an SMS to the doctor but does not convey the actual readings of the patient during the critical condition[7]. Since such a devices are in close contact with the user, it can easily collect data.

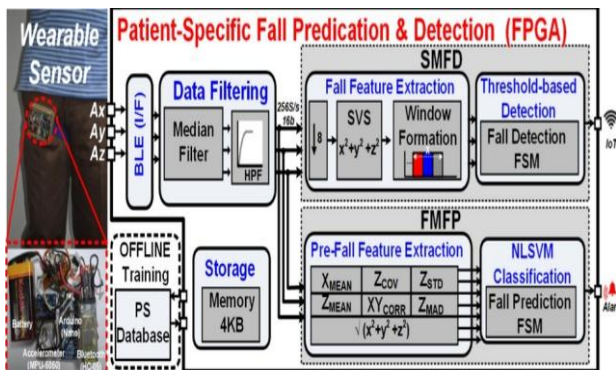


Fig- 1 : Block diagram of Fall prediction and Detection system

The block diagram of a fall detection system is shown in Fig-1. This is a fall detection system comprised of two parts; the data acquisition part followed by the PS classification part. In the sensing part, a tri-axial accelerometer is used to extract the acceleration of the elderly person in three orthogonal directions, the X, Y, and

Z-axis, at a sampling rate of 256 S/sec. The acquired accelerometer data along X-, Y-, and the Z-axis, respectively, are then transferred via low energy Bluetooth interface to the classification part that is implemented on a Field-Programmable Gate Array (FPGA) [1]. The system board is designed with an accelerometer sensor, an Arduino (Nano) microcontroller, a 16-bit ADC, and Bluetooth (HC05), powered by a 9V battery. The sensor used is MPU-6050 Tri-Axialaccelerometer with an adjustable full-scale range of ±2g, ±4g, ±8g, and ±16g, which can be attached comfortably to the patient’s thigh. For the fall prediction, it is required to regularly check (every 100 msec) for potential fall event to take timely actions while for the fall detection; it is required to look at longer period to identify a fall event (3 sec in this system). If a large sampling rate to be used for fall detection too, extra overhead of unnecessary computation will be performed which will consume more power. If a fall event is detected, it will be transferred via the internet to the health care providers to initiate an immediate help.

### 3. PROPOSED SYSTEM

The cause of dementia in elderly is impaired vision and hearing, muscle and joint weakness, dizziness and neuropathy affecting the nasal nerves.

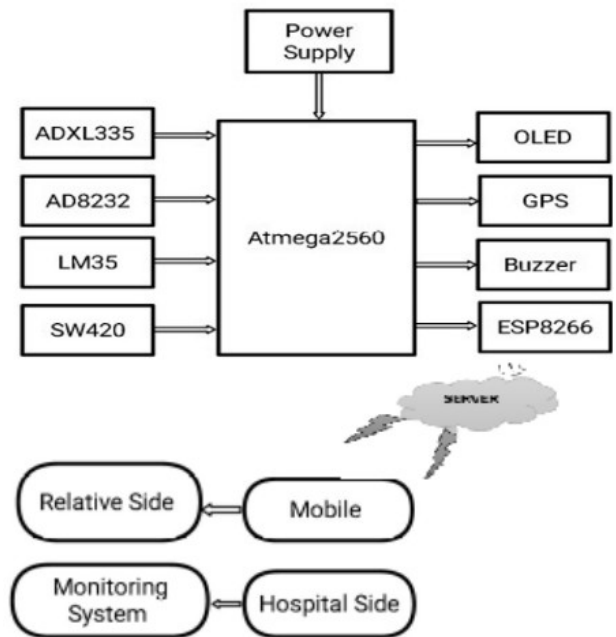


Fig- 2: Block Diagram of Proposed system

This device provide an alert to the relatives or other about the fallout in elderly people. Here used the Arduino Mega or Atmega 2560, is a microcontroller board, it contains everything needed to control the microcontroller.

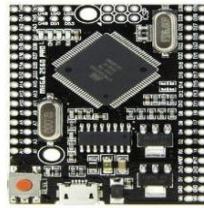


Fig -3: Atmega 2560

In this system an Accelerometer is used, will worth when an elderly person falls. The Accelerometer can measure the static acceleration of gravity in tiltsensing applications, as well as dynamic acceleration resulting from motion, shock or vibration. ADXL335 is a 3-axis analog output accelerometer with  $\pm 3g$  measurement range. It contains pre-determined threshold axis values. When ever the acceleration of the body exceeds this threshold value, the fall is detected. It reads off the x, y and z acceleration as analog voltages.

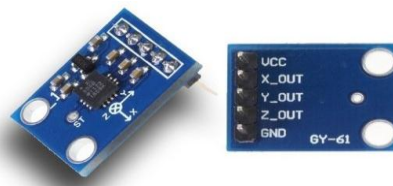


Fig- 4: ADXL335

The Temperature Sensor, LM35 device is related to operate over a  $-55^{\circ}c$  to  $150^{\circ}c$  temperature range. People who fall will definitely experiencetemperaturevariation. TheLM35 detects that variations.

The AD8232 module which is a neat and little chip used to measure the electrical activity of the heart. It records the fall victims ECG variations.

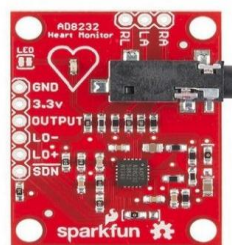


Fig- 5: D8232

An Organic Light Emitting Diode(OLED), also known as an organic diode, is a light emitting diode in which the emissive electroluminescent layer is a film of organic compound that emits light in response to an electric current. It displays ECG, pulse, temperature etc.

A Buzzer is used in this device in order to produce an alarm if a person fell down and this alarm produced will help the person to be get noticed by near ones, getting noticed is important to the fallen person that he will get external help from others, hence he can avoid a dangerous situation.

The WiFi module, ESP8266 is used in this device that help to transfer the data through IoT.



Fig- 6:ESP8266

GPS is also enabled in our system, which is helpful to identify the location of the patient. If the person is fell down then the location will be shared to the hospital or to the family members automatically which is useful to the authority to provide medical help.

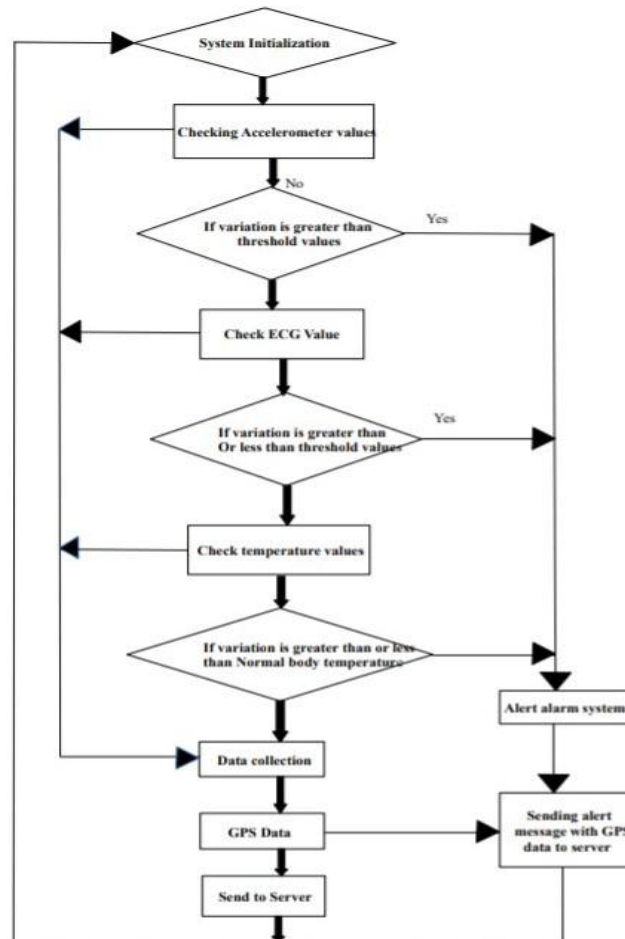


Fig- 7: Flow chart

#### 4. CONCLUSION

Since fall detection is a major challenge in the health care domain, especially in case of elder people, we have built an IoT based wearable fall detection system using an accelerometer sensor. The system monitor the movement of the human body and the detection method uses a threshold value to detect a fall from the activities of daily living like sitting, walking, lying down etc. When the acceleration exceeds the critical threshold, the fall is detected and an alarm is generated along with a message to the patient's contact person's mobile and the hospital side. The use of vibrator ensures less chances of false alarm. The system consumes less power and is efficient. Is also keep track of some of the biological parameters such as ECG, temperature etc. The system does not interfere in the daily activities or privacy of the person unlike other vision based or pressure sensor based systems. This product can be worn on the person's thigh or can be kept in the pocket. This system works well for indoor as well as outdoor fall detection since both the hardware and software designs are suitable for this purpose.

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## BIOGRAPHIES



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