

IoT-based Safety Management for Elderly People

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Abstract. Elderly people often stay at home alone and require attention when it comes to their health and safety. World Health Organization(WHO) reports that 646k severe falls occur all around the world annually. People aged above 65 suffer from such falls more often. The project is based upon development of smart wearable using multiple IOT sensors that helps in detecting fall of elderly people, abnormal health conditions and make calls immediately. When equipment is worn, the heartbeat, temperature, infrared sensors and accelerometer begin to track the health conditions. Similarly, if accelerometer sensor's axis values (pitch and roll) surpass the threshold value, the elderly person's fall gets detected. Finally, if any abnormal health values are detected or a fall is detected, an alert call is made to the appropriate caretaker/family member using the GSM module.

Keywords: *Pitch, Roll, DHT, IR sensor, Heartbeat sensor, Accelerometer, Arduino UNO, GSM module.*

1 INTRODUCTION

From the previous information, followed by road traffic injuries, fall is the next major cause for unintentional death. For people aged above 65, fall death rates increased by 30% from 2009 to 2018. Adults aged 85 and up experienced around 4% per year. In this we give detect the fall based on abnormal health conditions and accelerometer values. Before introducing this algorithm, [1] Foroughi proposed a method that is useful for detecting various events based on posture of elderly person using CCTV cameras and is unable to differentiate a real fall incident with an event when a person is lying or sitting down normally, so alternate studies by [6] Usmani proposed the latest research trends in fall detection and prevention systems using Machine Learning (ML) algorithms but it also fails to select the correct machine learning algorithm and a proper dataset which is efficient and acceptable. The fall detection includes safety and health monitoring. The health monitoring module tracks the heartbeat and temperature of the elderly people. On wearing the smart device, the IoT sensors monitors the vitals and updates it to the family member. It ensures the safety of the elderly person by detecting any fall or slip to provide assistance immediately. The fall is detected using the acceleration values calculated by accelerometer sensor.

2 RELATED WORK

Intelligent video surveillance for monitoring fall detection of elderly in home environments is a typical monitoring application in a home monitoring scenario, and a new method is presented to detect multiple posture-based events. A useful index for identifying different behaviors is a combination of the properly estimated ellipse around the human body, the projection histogram of the segmented silhouette, and the change in head position over time. A MLP Neural Network is fed with the extracted feature vectors to precisely classify the motions and identify the fall event [1].

Camera-Based Fall Detection on Real World Data, suggests a brand-new fall detection method. It is based on background subtraction and straightforward measurements like aspect ratio, fall angle, and head speed that are taken from the main foreground object. We talk about the findings, paying particular attention to the challenges that came up in the actual world[2].

Survey on Fall Detection and Fall Prevention Using Wearable and External Sensors, it is suggested to use a three-level taxonomy to categorise fall risk variables. The most recent FD and FP systems are then in-depth examined and qualitatively compared with regard to parameters and design issues[3].

A Comprehensive Study on the use of Artificial Neural Networks in Wearable Fall Detection Systems, proposed an FDS that uses an ANN either wholly or in part. It discussed the most current developments in the application of neural architectures to the issue of automatic detection and concentrated on wearable devices (since they typically impose higher energy and computing limits)[4].

Monocular 3D Head Tracking to Detect Falls of Elderly People is a novel approach to fall detection with a single camera. The method is based on the head's 3D trajectory and uses 3D velocities to distinguish falls from everyday activities[5].

3 PROPOSED WORK

Here in this the fall detection is detected based on threshold limits of pitch and roll calculated using accelerometer sensor. Along with fall detection, the proposed model aims to monitor vitals of elderly people which include heartbeat, temperature, humidity, wearability. In existing system there is video surveillance which does not provide accurate results and is not affordable, here we introduced sensor-based health and safety monitoring model which is affordable and easily operable. In existing system, the latest

research trends in fall detection and prevention systems using Machine Learning (ML) algorithms fails to select the correct machine learning algorithm and a proper dataset which is efficient and acceptable.

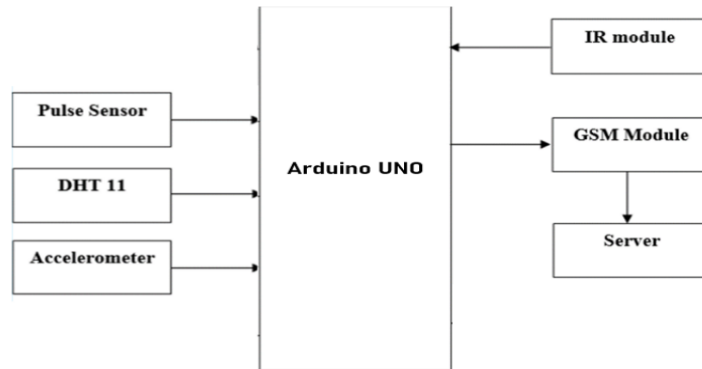


Fig. 1. Architecture of Proposed System

The Arduino UNO acts as a microcontroller connecting all the components of the system which includes: infrared light sensor, which is used to detect when an obstacle appears in front of it. When the sensor detects any obstacle, the LED light illuminates; An accelerometer that measures proper acceleration. An accelerometer uses an electromechanical sensor to measure static or dynamic acceleration and calculate roll and pitch values based on axis values; DHT11(digital temperature and humidity sensor) produces standardized digital temperature and humidity values; a heartbeat sensor that measures heart rate. Body heart rate is an important vital for tracking health conditions; GSM is used for messaging and calling. It is a universally accepted standard for communications through mobile phones.

3.1 Methodology

Initialize and activate the device IoT sensors. Network between the telecom service provider and the device is established by inserting a sim into GSM module. Wearing the smart device, the Heartbeat sensor, temperature sensor, humidity sensor starts tracking the vitals. Accelerometer senses acceleration values in x, y and z axes. The pitch, roll values are calculated based on the above parameters.

$$\text{pitch_value} = - (\text{atan2}(\text{event.acceleration.x}, \sqrt{\text{event.acceleration.y} * \text{event.acceleration.y} + \text{event.acceleration.z} * \text{event.acceleration.z}}) * 180.0) / \text{M_PI}; \quad (1)$$

$$\text{roll_value} = (\text{atan2}(\text{event.acceleration.y}, \text{event.acceleration.z}) * 180.0) / \text{M_PI}; \quad (2)$$

If the pitch and roll values are below -50 or above +50, it is assumed that fall has occurred. In case of any abnormal health condition and if the pitch and roll values exceed the normal threshold value, an alert message/call is sent to the appropriate caretaker/family member using the GSM module.

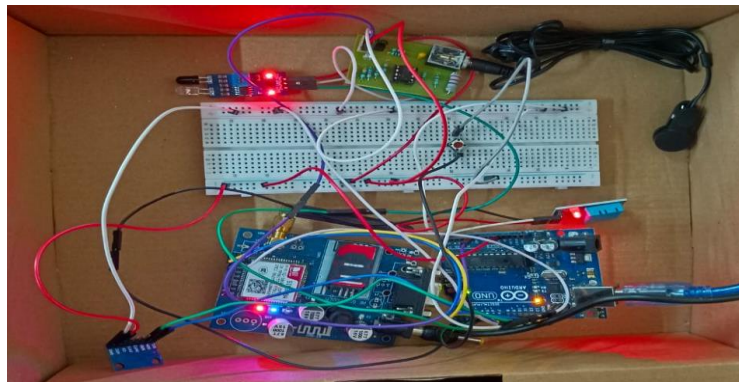


Fig. 2. Working Model

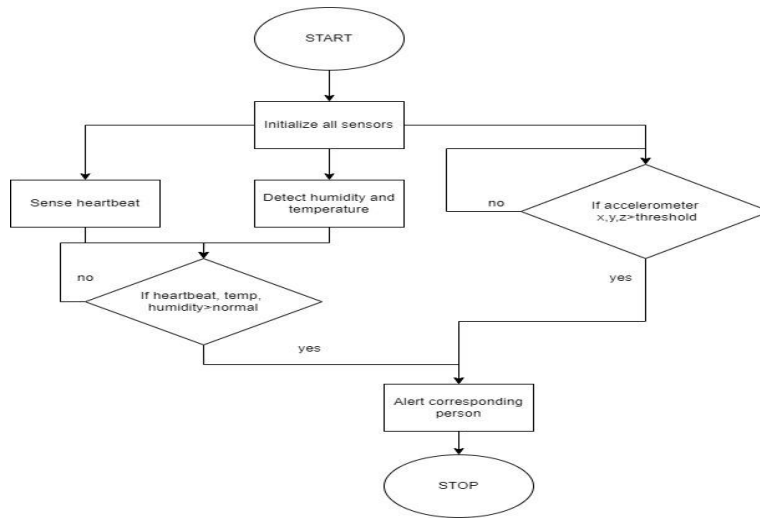


Fig. 3. Workflow of Proposed System

4 RESULTS

A person's heartbeat varies depending on the situation. Under normal circumstances, a healthy person's heart beat rate should be from 60 to 100 beats per minute. Second, according to medical knowledge, a person's normal body temperature ranges between 36 and 39 degrees Celsius. The external temperature will have an effect on the values, which may result in slight deflection of the data. The acceleration threshold value for the accelerometer sensor is set to -50 to 50 based on roll and pitch values. The accelerometer was tested manually by performing a jerk. This sudden movement changed the value to less than -50 or greater than 50, and a fall detection notification is sent to the appropriate caretaker/family member using the GSM module.

CASE 1: No Fall

```

COM9
Counting Heart Beat

Heart Beat: 86 BPM
Temperature = 31.80 *C
Humidity = 56.00 %
Alert: Wearable worn
X: -2.98 Y: 2.82 Z: 8.98 m/s^2
Side = 17
Roll = 17
No Fall
    
```

Consider the case where the heartbeat, temperature and humidity of the individual are in normal conditions and the wearable is worn. The accelerometer calculates the pitch/side and roll values using the x,y,z axes values
 X=-2.98 Y=2.82 Z=8.98

$$\text{pitch_value} = - (\text{atan2}(\text{event.acceleration.x}, \sqrt{\text{event.acceleration.y}^2 + \text{event.acceleration.z}^2}) * 180.0) / \text{M_PI} \quad (3)$$

Values applied for the formula

$$= - (\text{atan2}(2.98, \sqrt{2.82^2 + 8.98^2}) * 180.0) / 3.14$$

$$= 17$$

$$\text{roll_value} = (\text{atan2}(\text{event.acceleration.y}, \text{event.acceleration.z}) * 180.0) / \text{M_PI}$$

Values applied for the formula

$$. = (\text{atan2}(2.82, 8.98) * 180.0) / 3.14 \\ = 17$$

From the above calculations, (pitch_value > -50 || pitch_value < 50), (roll_value < -50 || roll_value > 50) and heartbeat < 100.
Hence, no fall occurred.

Case 2: Fall

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COM9
Counting Heart Beat

Heart Beat: 101 BPM
Temperature = 31.60 *C
Humidity = 56.00 %
Alert: Heart Beat above 100BPM
Alert: Wearable worn
X: 2.90   Y: -0.08   Z: -10.12   m/s^2
  Side = -16
  Roll = -179
Alert: Sudden Fall occurred
Calling
```

Consider the case where the heartbeat, temperature and humidity of the individual are not in normal conditions and the wearable is worn. The accelerometer calculates the pitch/side and roll values using the x,y,z axes values
X=-2.90 Y=-0.08 Z=-10.12

$$\text{pitch_value} = - (\text{atan2}(\text{event.acceleration.x}, \sqrt{\text{event.acceleration.y} * \text{event.acceleration.y} + \text{event.acceleration.z} * \text{event.acceleration.z}})) * 180.0) / M_PI$$

Values applied for the formula

$$= - (\text{atan2}(2.90, \sqrt{-0.08 * -0.08 + -10.12 * -10.12})) * 180.0) / 3.14 \\ = -16$$

$$\text{roll_value} = (\text{atan2}(\text{event.acceleration.y}, \text{event.acceleration.z}) * 180.0) / M_PI$$

Values applied for the formula

$$= (\text{atan2}(-0.08, -10.12) * 180.0) / 3.14 \\ = -179$$

From the above calculations, (pitch_value < -50 || pitch_value > 50), (roll_value < -50 || roll_value > 50) and heartbeat < 100.

Hence, fall is occurred and call is made to the concerned family member/caretaker.

5 CONCLUSION

This paper gives an advanced fall detection model to protect the elderly and keep track of their health. The system uses heartbeat sensor, temperature sensor, humidity sensor, an accelerometer, and a GSM module to make calls to monitor the health and safety of older individuals. The system will quickly identify a fall and notify the accountable party so that medical attention can be given. In future, the project will be made in a compressed size to be fixed into wearable gadgets like watches. The GPS system can also be combined to notify the location of fall and improve the efficiency of the project. The corresponding person can divert the call to a nearby hospital in case of emergency.

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