IOT-based Smart Fall Detection System Design and Implementation

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ABSTRACT
A significant public health issue is falls. Elderly people who fall and are not helped in time may have functional impairment, a loss of mobility and independence, and a decline in the quality of their lives. The number of deadly falls among employees on construction sites is rising daily. In order to inform the career about the occurrence and the place where the fall happened, we intend to create a system that can detect the fall. In the proposed project for fall detection, the wearable sensor continually collects acceleration data from the person and compares it to a threshold. If an actual fall is detected, an IoT notice will be delivered to the career in the form of a text message that includes the person's position. A threshold-based approach for the fall detection has been used to get the sensor data and set the threshold on accelerometer readings. A complete algorithm has been designed for the genuine fall detection.
Keywords - medical interventions, acceleration data, wearable sensor, threshold, genuine fall detection.

1. INTRODUCTION

Safety and security are viewed as being important considerations in today's modern, fast-paced environment. As people age, it becomes important to keep an eye on them to ensure their wellbeing and security. They are at a significant danger of falling because of their frailty and flimsy joints. Workers at high-rise construction sites frequently experience falls. Knowing whether someone has fallen is crucial for prompt assistance. To minimize the detrimental impacts of falls, quick help for the individual is required following a fall.
Nowadays, with the advancement of technology on a daily basis, everyone wants to automate as many tasks as they can to make life easier. One of the important things is to monitor our loved ones to save their lives. In this project a wearable device is developed that can detect the fall by acceleration analysis. Then it will get the person's location and send fall alarm text message to caregivers. So the person who has fallen can get timely help to minimize the negative effect. Our project aims to develop smart fall detection system and communication system using IoT technology and also reduce the response time needed to help.

2. LITERATURE SURVEY

Several criteria have been used to select a safety system required to monitor a person. From the data and statistics gathered by US it is said that: Fall deaths rates have been increased 30% from 2007 to 2016 for older adults. If rates continue to rise, we can anticipate 7 Fall deaths every hour by 2030.
The existing technique is to detect the person using Machine learning and image processing. Image Processing is a computer technology applied to images that helps to process, analyze and extract useful information from them. Machine learning is a type of artificial intelligence that allows software applications to become more accurate at predicting output without being explicitly programmed to do so. Machine learning algorithms use past data as input to predict new output values. From the existing approach the main drawbacks that have been noted are:
Using Image processing requires the use of camera which will interrupt the privacy of the person and it work only if the person is indoor.
Complexity of the existing system increases in terms of code and circuitry.
Considering all the drawbacks into account we have formulated a proposed system which overcomes all the existing drawbacks.

3. METHOD AND METHODOLOGY

Now a days researchers and developers have come up with a wide range of systems that are used for monitoring, alerting as well as controlling tasks through affordable and easy way to implement hardware systems. The main method used in this fall detection system is using embedded C programming language. Embedded C is a set of language extensions for the c programming language by the c standards committee.

In our prototype module we will be using a fall detection system technique. The accelerometer sensor continuously acquires the acceleretion data and compare with the threshold. It identifies the true fall by waiting 5 seconds from the time the person fallen, if the fall position is noticed even after 5 seconds, then the GPS location is identified and message is sent. The text message containing fall occurred location, time and date is send to the caregiver using IFTTT application.

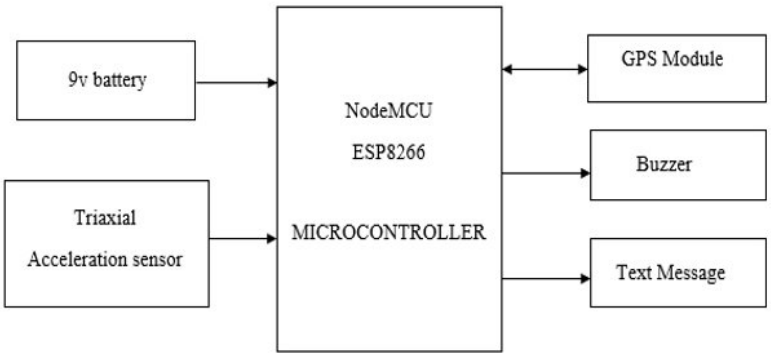


Figure 1: Block diagram of Proposed system

4. PREREQUISITE

4.1 Hardware Requirements

The hardware consists of Battery, Node MCU, MEMS sensor, GPS, buzzer.

4.1.1 Battery:

Any invention of latest technology cannot be activated without power source. In the fast moving world we deliberately need a power source which will be apt for a particular requirement. Zinc-Carbon battery is connected to the NodeMCU to make it operate. This is a dry cell primary battery that provides direct electric current from chemical reaction between zinc and manganese dioxide in the presence of electrolyte. carbon is acting as reducing agent.

Figure 2: Battery

4.1.2 Node MCU

Node MCU is based on ESP8266 which can connect objects and data transfer occur using the Wi-Fi protocol. It is a low cost, small sized module. It has 11 digital pins and 1 analog pin. It has 17 GPIO pins which can be assigned to various functions such as I2C, I2S, UART, PWM. Input voltage limit is 4.5-10v.It contains flash memory of 4Mb.

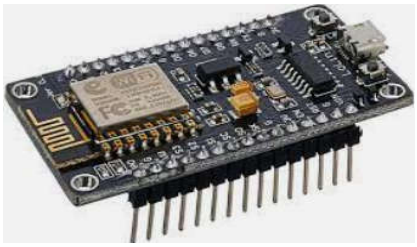


Figure 3: Node MCU

4.1.3 MEMS Sensor

MEMS sensor is an electromechanical device that measures the force of acceleration due to gravity. It can be used in various applications involving tilt sensing. This measures acceleration along X, Y and Z axis and gives analog voltage output proportional to the acceleration along the 3 axis. Microcontrollers process this voltages by converting them to digital signals using ADC.

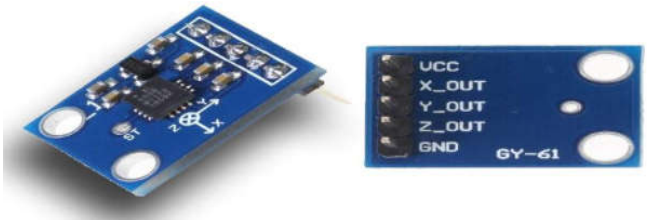


Figure 4: MEMS Sensor

4.1.4 GPS Module

The GY-GPS6MV2 module is a board containing the U-blox NEO-6M GPS receiver system. The tile also includes RTC backup battery, antenna connector, voltage stabilizer and UART signal outputs. GPS receiver module gives output in standard NMEA string format. This NMEA string output from GPS receiver consists of different parameters separated by commas like longitude, latitude, altitude, time etc.

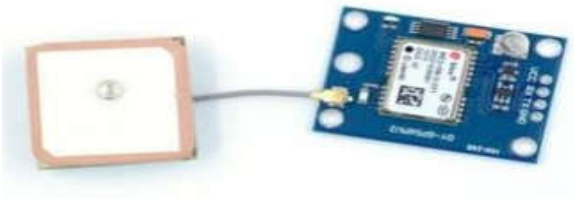


Figure 5: GPS Module

4.1.5 Buzzer

A buzzer is an audio signaling device, which is mechanical, electromechanical or piezoelectric. Typical uses of buzzers include alarm devices, timers and conformation of user input such as a mouse click.

Figure 6: Buzzer

4.2 Software Requirements

4.2.1 Embedded C

Embedded C is popular programming language for developing electronic gadgets. It is a set of language extensions for the c programming language by the C Standards Committee done to address commonality issues that exist between C extensions for different embedded systems. It includes a number of features that are not available in normal C, like fixed-point arithmetic, named address spaces and basic I/O hardware addressing. Embedded C uses most of the syntax and semantics of standard C.

4.2.2 IFTTT Application

If This Then That is a web-based service through which we can create Applets. Applets are chains of conditional statements. Using these applets, we can send Emails, SMS, notifications, etc. In this project, we are using IFTTT to send SMS notifications to the caregiver when the system detects a fall.

4.2.3 Algorithm

Step 1: Arduino IDE installation
Step 2: Establish connection between Node MCU and components
Step 3: Check that the MEMS sensor is in active state after giving power supply
Step 4: Go to next step if fall is detected. If not detected go to step 3
Step 5: Buzzer is turned on and count is incremented.
Step 6: If the count is greater than 5 go to next step. If not go to step 3
Step 7: Identify GPS location and trigger Node MCU
Step 8: Node MCU is connected to IFTTT application and Text message is send to caregiver.

4.2.4 Flowchart

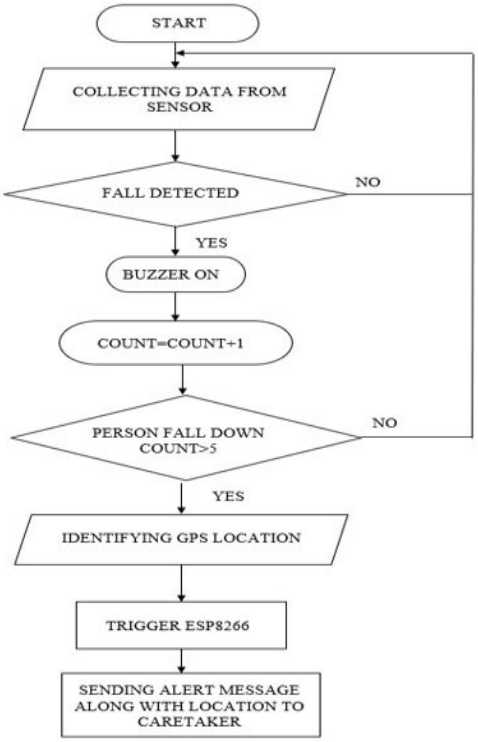


Figure 7: Flow chart of Proposed system

5. RESULT AND DISCUSSION

In developing this system, it is important that we should be able to determine whether the system meets the specifications and whether the obtained output is correct or not. The process of testing and verification is shown below:

- The overall interfacing of MEMS sensor, GPS, Battery and switch with Node MCU as shown below.

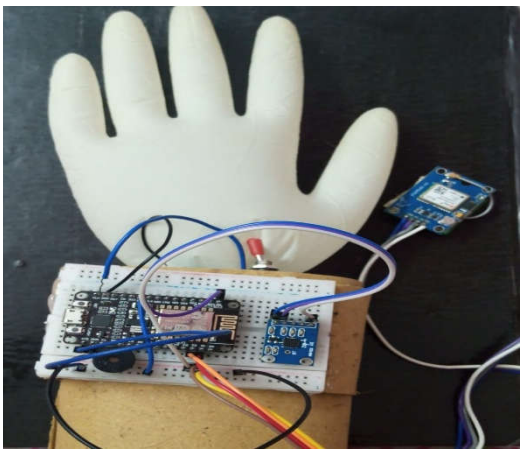


Figure 8: Implementation of Hardware

- Output shown on Arduino IDE serial monitor

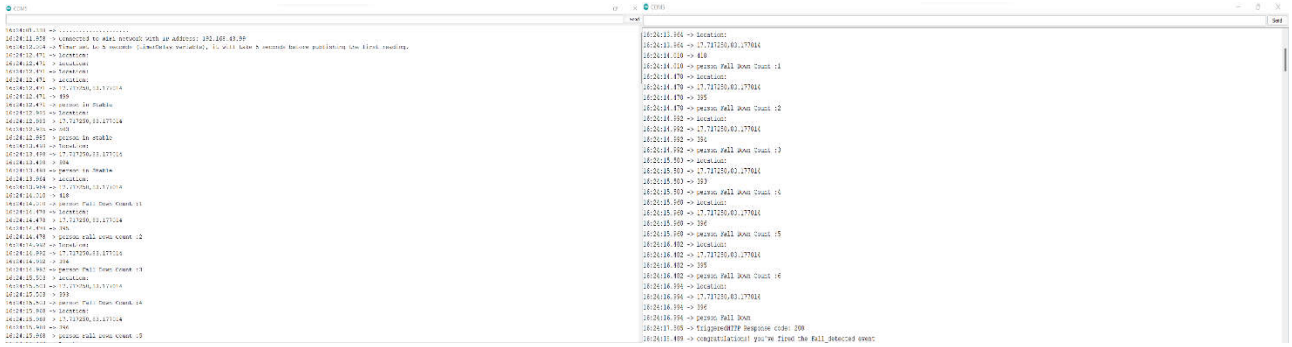
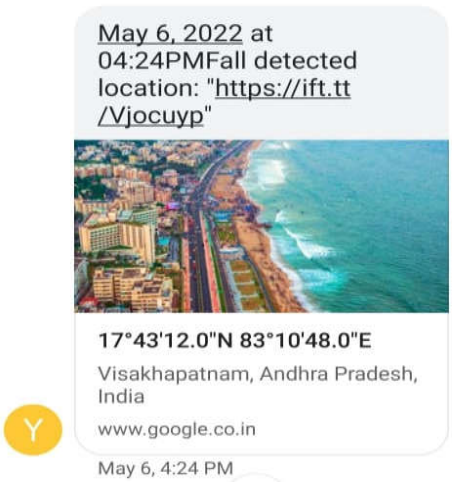


Figure 9: Output shown on Arduino IDE

Text message shown on caregiver's mobile



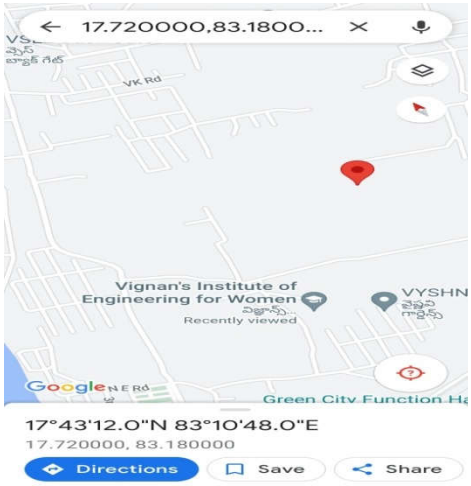


Figure 10: Text Message on caregiver's mobile Figure 11: Location

CONCLUSION

By creating this project, we have solved the limitations of the earlier methods, such as system complexity and indoor application exclusively. The apparatus functions as a monitoring system that keeps track of how the human body moves. When the acceleration goes beyond the critical threshold, a fall is recognized, and a message is sent to the career with a location. The implementation of the smart fall detection ensures that the career can respond as fast as possible by knowing the precise position of the fallen individual. The technology uses less energy, is effective at preventing false positives, and doesn't intrude on a person's privacy or daily routine. The concept may be expanded further by utilizing medical sensors such as ECG, heart beat sensor, temperature sensor. This can also be used along with rechargeable batteries or with solar panel. Other emerging technologies like Artificial intelligence can also be combined with this project.

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