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CSE3009 INTERNET OF THINGS

Embedded Project J Component

Fall Semester 2020-21

Slot: A1+TA1 Professor K.Deepa

IoT Project on Fall Detection

19BCE2249 19BCE2250

Siddharth Chatterjee Ishan Sagar Jogalekar

ABSTRACT

Connecting everything in our life could bring fast benefits to society. If we take a simple device, add 'computational intelligence' to it, and connect it to the Internet, then the device becomes integrated into the 'Internet of Things' term. Besides, enhancing functionalities of the basic principal design, the 'smart' device tends to be portable and a cheaper, more efficient alternative with the scope of adding extra features to it in the future.

IoT is transforming our homes to fulfil the wants and needs of an individual. Me and Ishan have noticed that there is a great value in IoT devices to promote healthy independent living for older adults. Our project IoT-based fall detection system for smart home environments' motive stays akin to this but with greater scope of enhancing it's utility. Such a device would not only send out alerts in case of fall-related injuries in older people but can also be used for detecting falling of expensive items during transportation as well as in shops where lavish and deluxe items are kept for customer display.

This prototype can also be integrated to learn interaction models quite common these days in IoT devices, such as voice assistance and camera monitoring. Such connectivity could allow older adults to interact with the system without concern of a learning curve, while in case of transportation and customer display; the owner can be notified if no damage has occurred to the expensive item because of tumbling. An alert goes out in case the IoT device attached to the thing, goes out of a particular radius via GPS connectivity.

The IoT Fall detection project device that we are going to build works similar and we are going to make it more affordable. Currently in market such fall detecting IOT devices are very expensive, so we decided to make it at least affordable for elderly. As ,mentioned earlier we are also going to use this device for fall detection of delicate materials in industries like glassware. Sometimes during transportation of delicate and expensive materials like glassware, tubes destroyed or damaged. So, for this issue we can fix IOT device on delicate materials to trace when the material is actually damaged accordingly the owner or transport company can resolve further problems.

Analysing previous Journals and Papers published on our prototype

A 2016 IEEE Journal titled 'IoT-Based Fall Detection for Smart Home Environments' by Shalom Greene, Himanshu Thapliyal, and David Carpenter of Department of Electrical and Computer Engineering from University of Kentucky, Lexington focuses on the need to reduce falls through home aid assistance technology. Many fall related injuries in older people happen within the home and the risk of major health decline compounds to an increasing problem.

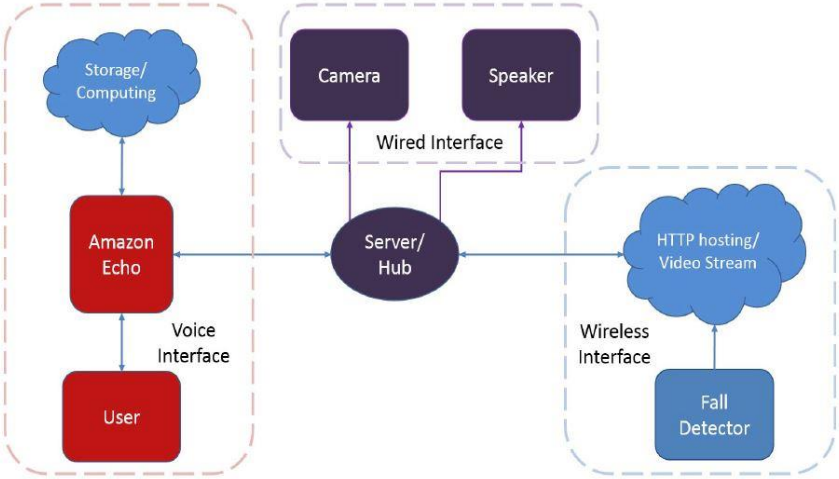


Fig. 1: Overview of Proposed Fall Detection System
Blocks in red represent components of the system's voice interface. Blocks in purple represent all components physically connected to the server/hub. Blue shapes represent wireless components of system. Blue arrows represent two-way communication, while purple arrows represent one-way communication.

Attached below are some paragraphs and learnings we analysed from this journal.

"IoT-based fall detection system can be integrated within smart home environments and smart cities to increase safety and quality of life of older adults [7], [8]. The use of smart devices such as smart cameras, smart wristbands and voice activated devices can greatly enhance the convenience and effectiveness of a fall monitoring system. As discussed in the related work section, there are several existing fall detection systems available commercially and in research. However, to the best of our knowledge. The existing fall detection system is not available as a separate module to be integrated with an existing smart home environment. Further, they are primarily not voice controlled which can result in significant amount of learning curve, does not allow remote monitoring, and can generate significant false positive calls to the primary caregivers. Integrated within a smart home environment, the proposed IoT-based fall detection system can improve the quality of life among older adults."

Our Project team noticed that the paper is organized as follows: Section II presents related work to the research presented in this paper. Section III presents the proposed IoT-based fall detection system; it's components and overview of it's operation. Section IV focuses primarily on the fall detection module of the proposed system. Section V presents the interaction model launched after a fall has been detected. This section focuses primarily on the voice interface of the system. Section VI discusses future work related to making the system more robust and better suited for a full scale solution. Section VII concludes the paper.

Section II. RELATED WORK

Medical home alert systems developed to assist older adults within their own home date as far back as the early 1970s with the advent of the first personal emergency response system (PERS)[4]. Hormann called the system "Hausnotruf," which translates to "home alert" in English. This idea was shortly thereafter improved upon by California based American International Telephone Company who created the "Emergency Dialer," which added more portability via a pendent that is worn around the neck [4]. Several illustrative examples from

the past 20 years are discussed in this section. For example, in 2004, a combined effort between InfraRed Integrated Systems, Ltd. (IRISys) and the University of Liverpool developed a smart, non-contact sensor for fall detection [5]. The system used infrared imaging to detect activity and inactivity. What was good about the system was that it did not require the person to wear any special equipment. However, a large issue in the system was that it had a high false negative rate, missing 64.3% of the falls that should have been detected.

In 2006, a European Community driven project with collaboration between universities in Spain, France, and Greece produced an automated fall detection system with a reported 90% confidence in reliability. In 2009, a cohort of researchers from UCLA designed a smart fall detection system called SmartFall based on a previously designed SmartCane fall detector [9]. Results from the testing of the system range from 93.3% to 100% based on fall type. The system uses ZigBee devices (which are RF based wireless devices) placed in several areas around the home to calculate position based on which device is closest to the wearable fall detector. According to the reported results, the fall detection algorithm employed has an accuracy of 88.62%, precision of 88.6%, sensitivity of 95.63%, and specificity of 73.5%. It utilizes consumer home networks such as IEEE 802.11, Bluetooth and ZigBee to communicate between devices on a mesh network. Sensor nodes (i.e. accelerometer, cardiotachometer, etc.) communicate either to a base station or fixed access point. This fall detection system achieved a high accuracy of 97.5%, a sensitivity of 96.8% and a specificity of 98.1%. Most recently in 2016, collaboration between Beijing University of Technology and Beijing Engineering Research Center for IoT Software and Systems has brought about an automated fall detection system based on inertial sensors (3D accelerometer and 3D gyroscope) geared toward older adults [12]. In addition to the inertial sensors, the system included software running on a smartphone which connected via Bluetooth to the inertial sensors and used 3G wireless data to provide call and SMS messaging. The system was able to obtain accuracy in fall detection ranging from 94 to 100 percent based on the four fall experiments that were conducted across 15 adults ranging from ages 20 to 45. All of these systems mentioned have some level of integration of sensing and wireless technology. The novelty of the proposed solution for fall detection in this paper will be to provide modularity and a voice interface in addition to internet connectivity

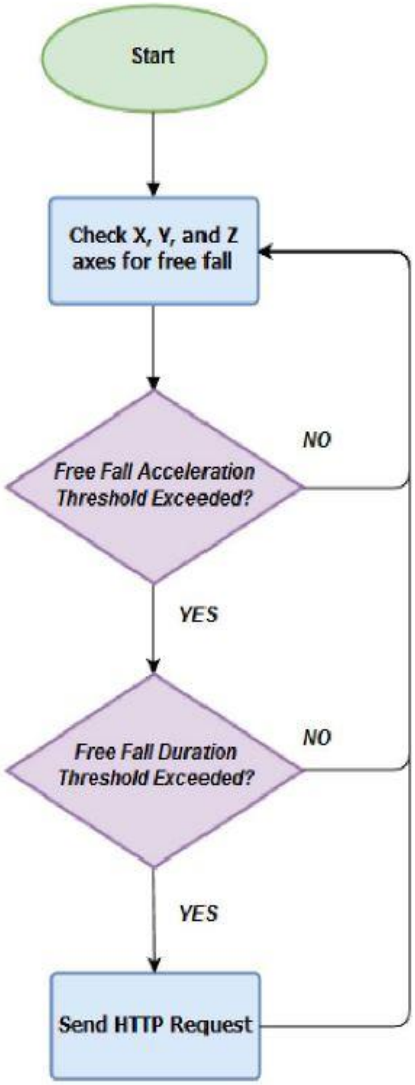
Section III. PROPOSED IOT FALL DETECTION SYSTEM

The goal of this system is to integrate fall detection into a smart home environment in efforts to create a more robust intervention and safety model to aid older adults. This system would work primarily from a local wifi network. This system is designed with a central hub for communication that will perform data processing, decision making, and relay of messages. This central hub will act as an intermediary between all components of the system. The components of the system include the following (See Fig. 1 for the layout of the system components):

-Server/hub - Fall detection device -Amazon Echo -Speaker -Webcam

Section IV. FALL DETECTION MODULE

The goal of our system is to provide a proof of concept for an IoT integrated fall detector within a smart home environment. By developing an internet connected device capable of detecting falls, a smart home is enabled to become a critical part of home aid assistance. Due to the aforementioned statistics on fall-related deaths and other health decline [1], [2], [3], enabling a smart home with an IoT fall detector can be revolutionary in terms of the longevity of older adults living at home. The main objective is to add a layer of safety to a home environment that allows the older adult to live more independently, while also easing the concerns of caregivers and loved ones when they are away.



Section V. SYSTEM INTERACTION MODEL

One large hurdle with fall detection algorithms is the balance between specificity and sensitivity. Specificity is the measure of how many true negatives are avoided by the system, while sensitivity is the measure of true positives detected. An ideal system would have very high specificity and sensitivity. However, naturally, high sensitivity brings about false positives, which further brings about an annoyance to the system's users. Though our system is not specifically geared toward producing the most efficient fall detector, it will add a layer of confirmation to reduce false positives.

Section VI. DISCUSSION

The fall detection module uses a simple algorithm which we hope to expand upon to become more robust and reliable. The objective of the system was to integrate fall detection into a smart home environment. Next steps in development will include implementing of a full-fledged fall detection module that will include more robust features such as tap detection and inactivity monitoring.

Section VII. CONCLUSION

Although recent advances in technology may seem to widen the gap between the young and the old, much of it can be used to benefit all ages. The internet of things for home innovation has great potential to be of much more utility to older adults. With about 75% of older adults 45 and older wanting to stay at home as they age [15], the demand for home aid assistance is high. This is a perfect opportunity for smart home technology to fulfill some of the needs of this "aging in place" population. As a smart fall detection system, the system described here has the potential to significantly improve the quality of life of millions of older adults who wish to live more independently within their own homes.

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Fall-induced deaths among older adults: nationwide statistics in Finland between 1971 and 2009 and prediction for the future. Injury, 44(6), 867-871.
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Analysing previous Journals and Papers published on our prototype

Research Article

Development of a Wearable-Sensor-Based Fall Detection System

FalinWu,1 Hengyang Zhao,1 Yan Zhao,1 and Haibo Zhong2*1School of Instrumentation Science and Optoelectronics Engineering, Beihang University*

Attached below are some paragraphs and learnings we analysed from this journal.

1. Introduction

Falls of the elderly always lead to serious health issues as the decline of their physical fitness [1]. Fracture is the most common injury in fall of an elderly and there is also a certain possibility to get coma, brain trauma, and paralysis. At most fall situations, the fall process is the main source of injury because of the high impact. But sometimes the late medical salvage may worsen the situation [2]. That means the faster the salvage comes, the less risk the elderly will face. Progress of technology brings more possibilities to help us protect the elderly. Low power consumption components make it possible to realize wearable monitoring device. MEMS (microelectro mechanical systems) sensors have simplified the design and implementation of sensor system. Location based service (LBS) makes it more convenient to locate the elderly in health monitoring. Beside these, mobile computingmakes remote health monitoring easier to realize.

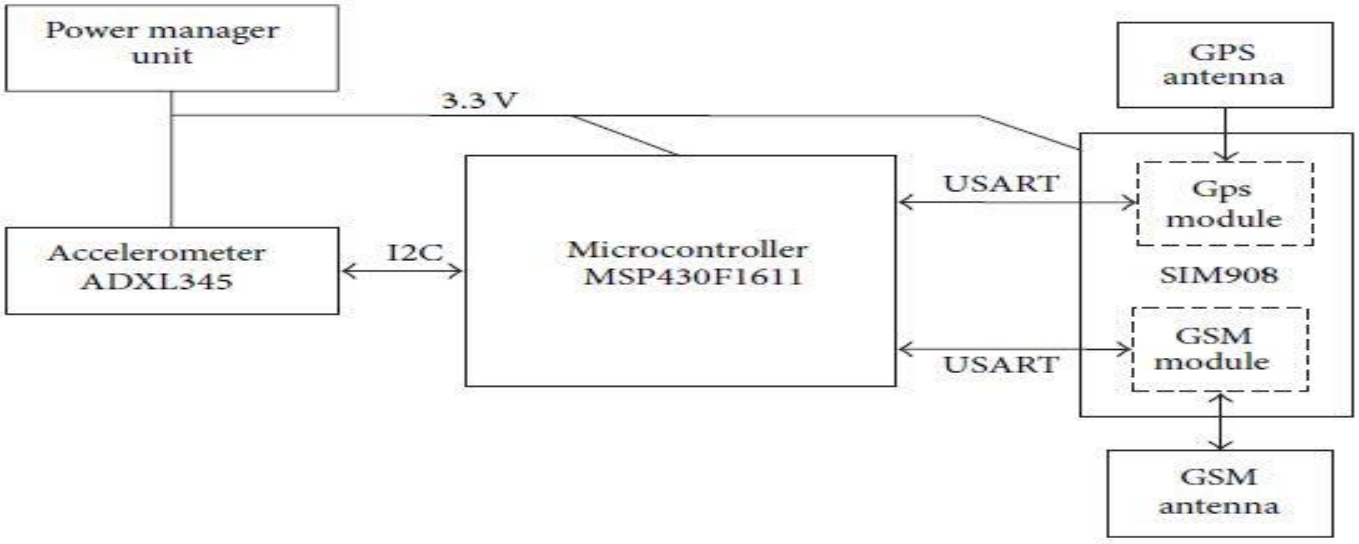


FIGURE 6: Basic hardware structure.

2. System Design

The architecture of the developed system is described already in the paper's 1st figure. A wearable device is placed on human's waist. The system can detect the elderly's falling by acceleration analysis. Then it will get the elderly's geographic position and send fall alarm short message to caregivers. So the elderly who has fallen can get timely help to minimize the negative influence.

3. Implementation

4.1. Hardware. ADI's digital triaxial accelerometer ADXL345 is the motion sensor used in this system.TheGPS service and GSM communication function are integrated in SIMCom's SIM908 module. TI's 16 bits MCU MSP430F1611 is used to control the whole system and imply the detection algorithm

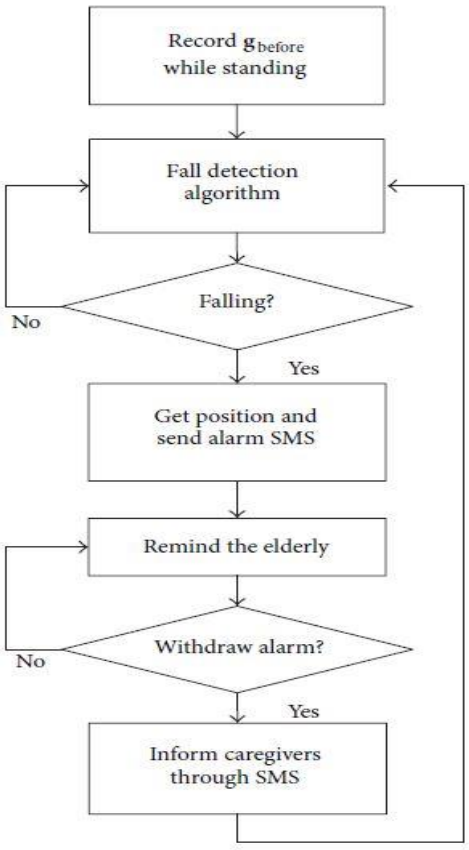


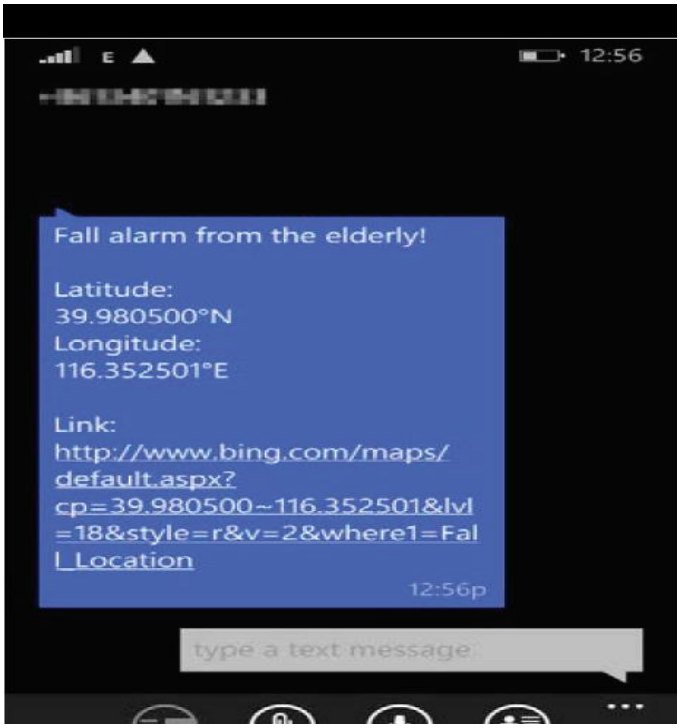
FIGURE 8: System software flow diagram.

TABLE 1: Test results for four kinds of falling and five kinds of ADL.

Motion type	Alarm times/test times	
	Proposed design	Acceleration threshold based design
Forward fall	60/60	59/60
Backward fall	56/60	54/60
Leftward fall	58/60	52/60
Rightward fall	59/60	55/60
Walking	0/60	4/60
Jumping	0/60	11/60
Squatting	0/60	0/60
Sitting	0/60	9/60
Resting	5/60	10/60

4. System Test

System test of the fall detection system has been conducted based on the system design described above. The sampling rate of accelerometer is set at 100Hz and the measurement range is 16 g with a maximum precision of 4mg. MCU will read raw measurements from sensor's inner FIFO and apply the detection algorithm.
System test contains five kinds of activities of daily living (i.e., walking, jumping, squatting, sitting, and resting) and four kinds of fallings (i.e., forward, backward, leftward, and rightward).



6. Conclusion

This paper developed a fall detection system based on a single triaxial accelerometer based wearable device.There is no special requirement of the device's mounting orientation because the algorithm does not claim the axes of accelerometer to be fixed strictly.The system has low power consumed hardware design and highly efficient algorithm which could extend the service time of the wearable device. Both the hardware and software designs are suitable for wearable and outdoor application.

References

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Analysing previous Journals and Papers published on our prototype

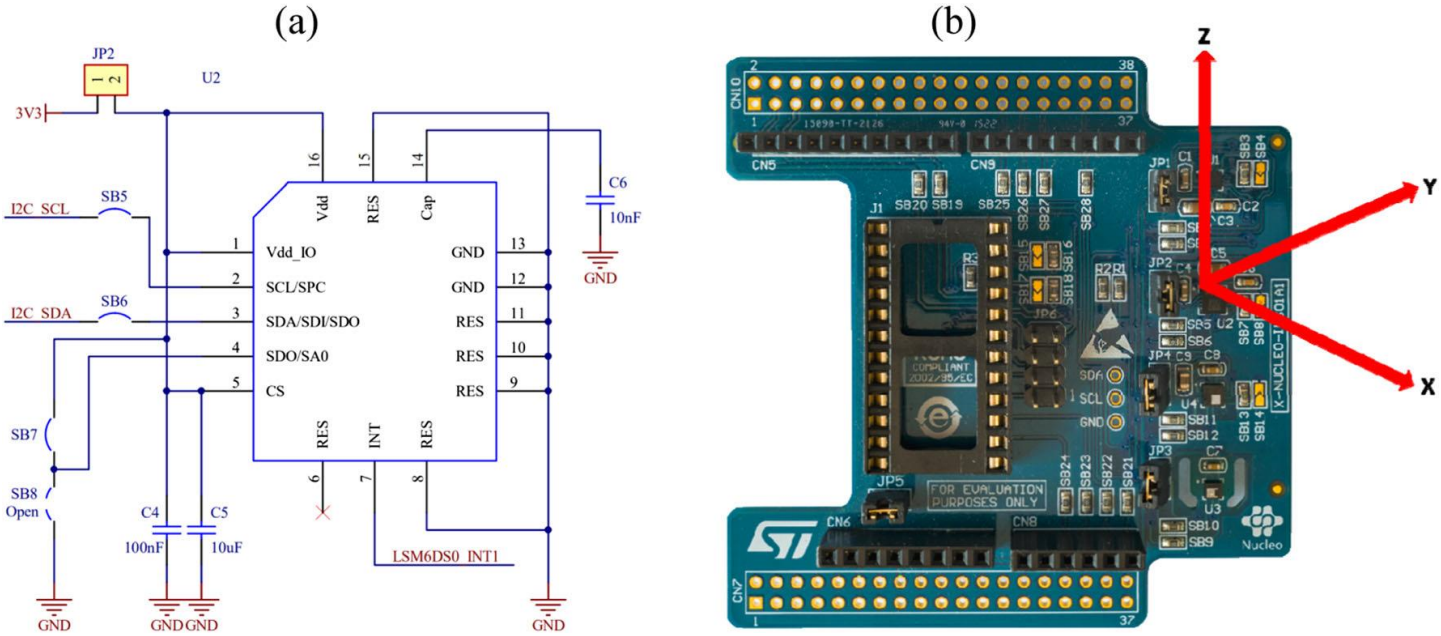
Fall detection system for elderly people using IoT and ensemble machine learning algorithm

Diana Yacchirema & Jara Suárez de Puga & Carlos Palau & Manuel Esteve

Received: 22 August 2018, Accepted: 14 December 2018, Published online:2 January 2019 Springer-Verlag London Ltd., part of Springer Nature 2019

Attached below are some paragraphs and learnings we analysed from this journal.

We propose IoTEFall system, an intelligent system for detecting falls of elderly people in indoor environments that takes advantages of the Internet of Thing and the ensemble machine learning algorithm. IoTE-Fall system employs a 3D-axis accelerometer embedded into a 6LowPAN wearable device capable of capturing in real time the data of the movements of elderly volunteers. To provide high efficiency in fall detection, in this paper, four machine learning algorithms (classifiers): decision trees, ensemble, logistic regression, and Deepnets are evaluated in terms of AUC ROC, training time and testing time.



Block diagram schematic and Hardware structure

Background and state-of-the-art analysis

At present, several solutions have been proposed for elderly fall detection. Such solutions are categorized into three main types according to the sensor-technology used: nonwearable-based systems (NWS), wearable-based systems (WS), and fusion or hybrid-based systems (FS). In particular, plenty of NWS systems that use vision-based devices such as [7–13] have been proven to be powerful and robust to detect falls. However, the main disadvantages of these systems are their high cost, in both equipment investment and computational resources for image processing, and the consequent lack of privacy for elderly people since these systems require cameras to be strategically distributed in the indoor environment in which they live.

Fall detection system using IoT and ensemble machine learning algorithm

The block diagram depicted in Fig. 1 defines the fall detection system stages identified in this research: feature extraction, training and testing, and validation. The sliding-windows and SMA techniques are used to extract the features that describe the raw signal of the elderly person's movements from a publicly accessible dataset. These features are stored in a new dataset, Motion-DT, which is used in the k-fold crossvalidation scheme to train and test four machine learning algorithms in order to find the best model for fall detection. The selected model is then validated with the acceleration measurements gathered from a MEMs accelerometer sensor with the purpose of obtaining the real performance of the fall detection system.

Features extraction

A suitable approach to training and testing fall detection systems is to use the historical knowledge coming from public datasets which consist of different past events (real or simulated falls, ADLs, or both) performed by a set of participants wearing different sensors located on various parts of the body. Historical knowledge is essential to understand what behaviour is expected. For example, using knowledge of the behavior of unexpected motion patterns that have occurred when an adult fall will enable alert and predict situations of risk when similar patterns of behavior occur. However, the historical knowledge must be previously processed to extract the features that represent the raw signal as possible.

Table 1 Falls and activities of SisFall used in this work

Code	Description	Trials	Duration
FF	Forward fall	5	15 s
BF	Backward fall	5	15 s
LF	Lateral fall	5	15 s
WA	Walking	5	15 s
SCA	Stairs climbing	5	15 s
SA	Sitting	5	15 s

Machine Learning Algorithms used

Table 2 The evaluation of the various classifier algorithms

Supervised learning classification algorithm	Average AUC	Training time (s)	Testing time (s)
Decision tree	0.9748	4.52	3.52
Ensemble	0.9951	5.75	3.48
Logistic regression	0.8487	5.4	4.80
Deepnet	0.9906	223.6	3.8

System overview

The proposed IoTE-Fall, shown in Fig. 4, consists of four main components: a wearable device, a wireless communication network, an IoT gateway, and Cloud services. Each component plays an important role in fall detection. The wearable device, interwoven with motion MEMs sensors, measures the acceleration (expressed in bits) of body movements of elderly people and transmits them to the IoT gateway using a low power wireless area network. The IoT gateway processes and analyzes the received data (using ensemble-RF classifier) at the edge of the network to rapidly detect falls and act accordingly by sending alert messages in real time to the healthcare professionals concerned.

Wireless communication network

The wireless communication between devices and the Smart IoT gateway is established by the low-power wireless IPv6 (6LowPAN) technology based on the IEEE 802.15.4 standard. 6LoWPAN is a technology designed for supporting the connectivity, interoperability, and compatibility of heterogeneous wireless sensor networks (WSNs) at a very low cost and with very low requirements, compared with other technologies such as Wi-Fi or Bluetooth.

Table 3 Acceleration resource and associated CoAP Path

Parameter	Description
Sensor	LSM6DS0
Resource	Acceleration
Resource path	GET [coap://[aaaa::b00:f6ff:2d3b:d2c4]:5683/sensors/acceleration

Fall prediction

For fall detection, the big data analyzer creates a local instance of the ensemble-RF within the IoT gateway through the REST API provided by BigML. By carrying the processing close to the data source (i.e., the 6lowPAN wearable device used by the older adult), the system reduces the latency and overheads in the network, and as a result, the long lie time is also reduced. Ensemble-RF predicts a fall or ADL by doing plurality vote over the models, i.e., it obtains a class vote from each tree, and then classifies using majority vote, taking as input data the information coming from the transformation module. If the result of prediction is a fall, the system invokes to the emergency alert handler.

Hardware implementation

The IoT gateway is the key component for fall detection designed with a STM32 microcontroller integrated with one expansion board based on the SPSGRF-915, and a Raspberry Pi 3 model B (RPI3) as execution environment, equipped with a 1.2 GHz Quad-Core ARM Cortex processor A53 CPU, 1 GB of RAM, 4 USB ports, and powered by a 3.7 V Lipoly battery. A 16 GB class 10 SD card powered by the Debian Stretch operating system is used to run all of the various functional modules of the system, which are written in Python.

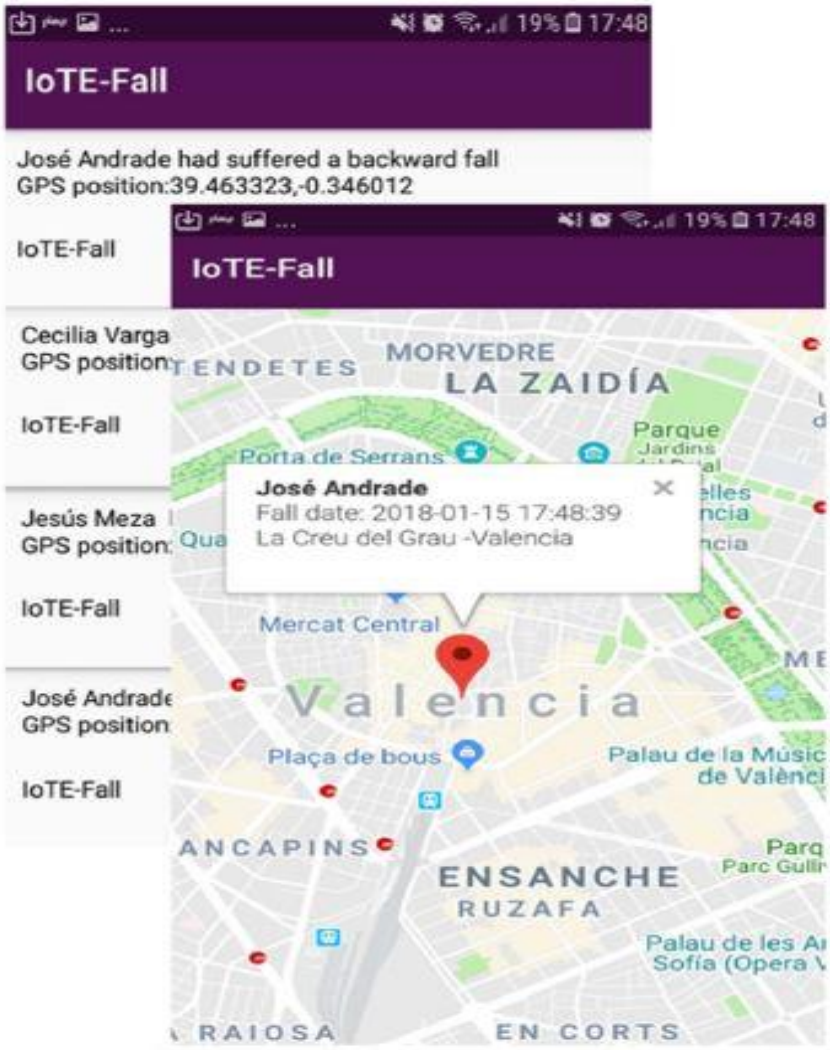


Fig. 7 Example of messages sent to healthcare professionals and family caregiver (back) and location of elderly person's house (front)

Conclusion

As a summary, this work presents a holistic solution for fall detection whose main advantages include the fast processing and detection at the edge of the network, the enhancement of the detection at each fall with the re-creation of the MLmodel, and the reliability provided by the IoT protocols involved in the communication**.**

References

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Hardware: -

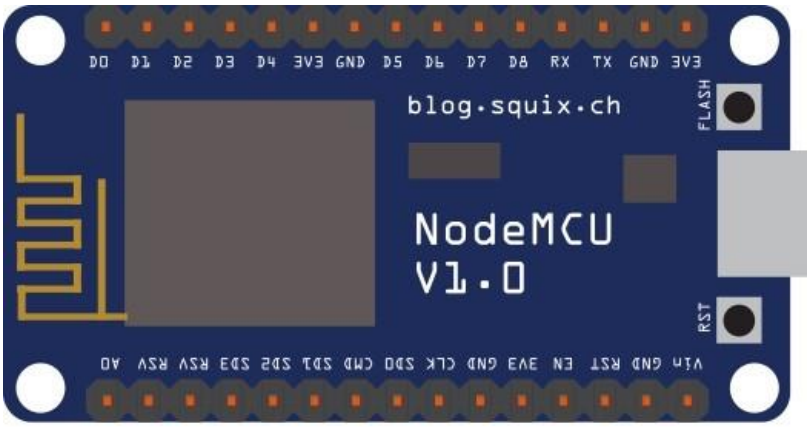
In this project we are going to use NodeMCU esp8266 as main communication device and MPU6050 as sensors to detect fall.

NodeMCU esp8266:

NodeMCU esp8266 is low cost open source IOT platform.. ESP8266 chip having 32-bit LX106 RISC microprocessor which operates at 80 to 160 MHz adjustable clock frequency and supports RTOS. It also has 128kb ram and 4mb flash memory, which gives easy connectivity and fast working.

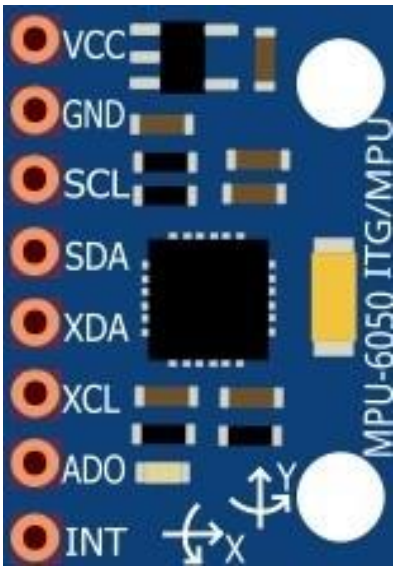
ESP8266 Integrates 802.11b/g/n HT40 Wi-Fi transceiver not only connect with network but also support self configuration for network. This make chip very versatile and it will connect according to wifi's configuration for protocols.

Sample image and layout:



MPU6050:

MPU6050 is six axis gyroscope plus accelerometer motion sensing device. In this device 3- axis combined to work as gyroscope and remaining as accelerometer. Due to 6-axis motion sensing it gives accurate information about motions like falling. It is compatible with many IOT chips like NodeMCU. MPU6050 is made for fast and slow both motions, so it gives precise information.



Softwares:-

1. Arduino IDE:

Programming for NodeMCUesp8266

Can be done by using arduino IDE and programming langauge.It is basicaly based on computer languages C,C++ and java.So in NodeMCU chip we are going to program using arduino IDE.

2. IFTTT:

IFTTT, If This Then That is freeware web-based service to create condition based applets which provides wireless communication over the web servers .It is easy to handle, modify and upgrade also.

Literature Survey

IoT Project – 'Fall Detection'

Presented by

19BCE2249 Siddharth Chatterjee

19BCE2250 Ishan Sagar Jogalekar

S.No	Title	Authors	Year of Publication	Primary Findings	Disadvantages	Advantages
1	IoT-Based Fall Detection for Smart Home Environments	Shalom Greene, Himanshu Thapliyal and David Carpenter	2016	Integrated within a smart home environment, the proposed IoT-based fall detection system can improve the quality of life among older adults. We found out this system would work primarily from a local wifi network and is designed with a central hub (acting as intermediary) for communication that will perform data processing, decision making, and relay of messages.	Our project team found out that one large hurdle with fall detection algorithms is the balance between specificity and sensitivity. An ideal system would have very high specificity and sensitivity. However, naturally, high sensitivity brings about false positives, which further brings about an annoyance to the system's users.	We noticed that the research team accepted that their system is not specifically geared toward producing the most efficient fall detector; but it will add a layer of confirmation to reduce false positives, which is a good advantage, and an improvement over their predecessor prototypes
2	Development of a Wearable-Sensor-Based Fall Detection System	FalinWu, Hengyang Zhao, Yan Zhao, and Haibo Zhong	2013	This paper developed a fall detection system based on a single triaxial accelerometer based wearable device. There is no special requirement of the device's mounting orientation because the algorithm does not claim the axes of accelerometer to be fixed strictly. The system has low power consumed hardware design and highly efficient algorithm which could extend the service time of the wearable device. Both the hardware and software designs are suitable for wearable and outdoor application.	Fracture is the most common injury in fall of an elderly and there is also a certain possibility to get coma, brain trauma, and paralysis. Our project team found out that at most fall situations, the fall process is the main source of injury because of the high impact. But sometimes the late medical salvage may worsen the situation, where this prototype might fail to work.	A wearable device is placed on human's waist. The system can detect the elderly's falling by acceleration analysis. Then it will get the elderly's geographic position and send fall alarm short message to caregivers. So the elderly who has fallen can get timely help to minimize the negative influence. We also noticed the inclusion of system test* which contains five kinds of activities of daily living and four kinds of fallings.

S.No	Title	Authors	Year of Publication	Primary Findings	Disadvantages	Advantages
3	Fall detection system for elderly people using IoT and ensemble machine learning algorithm	Diana Yacchirema & Jara Suárez de Puga & Carlos Palau & Manuel Esteve	2018	After analyzing this journal we can say that this work presents a holistic solution for fall detection, the enhancement of the detection at each fall with the re-creation of the ML model, and the reliability provided by the IoT protocols involved in the communication**.** This is an intelligent system for detecting falls of elderly people in indoor environments using the ensemble machine learning algorithm. IoTE-Fall system employs a 3D-axis accelerometer embedded into a 6LowPAN wearable device capable of capturing in real time the data of the movements of elderly volunteers.	Some main disadvantages, we noticed are these systems are costly, in both equipment investment and computational resources for image processing. Also the consequent lack of privacy for elderly people since these systems requires cameras to be strategically distributed in the indoor environment in which they live.	Main advantages include the fast processing and detection at the edge of the network. There is feature extraction, training and testing, and validation. Motion-DT, which is used in the k-fold cross validation scheme to train and test four machine learning algorithms in order to find the best model for fall detection. MEMs accelerometer sensor

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CSE3009 Internet of Things

Embedded Project J Component

Fall Semester 2020-21

Slot: A1 Professor Deepa. K

Fall Detection IoT device

Review III

19BCE2249 Siddharth Chatterjee

19BCE2250 Ishan Sagar Jogalekar

FALL DETECTION

Project for IoT

CSE3009
Internet Of Things
J component

Fall Sem 20-21
Slot: A1+TA1

Using NODE MCU and Accelerometer Sensor

FACULTY-PROFESSOR K.DEEPA

19BCE2250
Ishan Sagar Jogalekar

19BCE2249
Siddharth Chatterjee

Abstract

IoT is transforming our homes to fulfil the wants and needs of an individual and we have noticed that there is already a great value in IoT devices to promote healthy independent living for older adults. This project is focused upon an IoT Fall detection device that works similar but is more affordable than its predecessors.

Currently in market such fall detecting IOT devices are very expensive, so we decided to research into a cheap alternative affordable for elderly. As, mentioned earlier the project also focuses on the use of this device for fall detection of delicate materials in industries like glassware. Sometimes during transportation of delicate and expensive materials like glassware, tubes destroyed or damaged. So, for this issue we can fix IOT device on delicate materials to trace when the material is actually damaged accordingly the owner or transport company can resolve further problems.

This prototype can also be integrated to learn interaction models quite common these days in IoT devices, such as voice assistance and camera monitoring. Such connectivity could allow older adults to interact with the system without concern of a learning curve, while in case of transportation and customer display; the owner can be notified if no damage has occurred to the expensive item because of tumbling. An alert goes out in case the IoT device attached to the thing goes out of a particular radius via GPS connectivity.

Literature Review

In the aforementioned reference papers and journals from leading organisations, we can notice how the idea of different IoT based Fall Detection modules have been deployed in the past in the same domain.

Our research work based on literature review establishes an important theoretical setting to the study of our Project and its consequent execution.

There are three main sections of the literature survey attached as snapshots (Primary Findings, Disadvantages, and Advantages).

The literature survey is a summary of the Literature Review on 5 different Research Papers and Journals that we have studied.

Analysing previous Journals and Papers published on our prototype was an integral part of our project, so we divided the studies on it into different sections while presenting Review I.

Review II was focused on Literature Survey and submitting manuscript for IoT research paper in the respective journal format.

Review III showed how we implemented both hardware and software tools and deployed our Fall Detection module to detect fall and send out an alert notification via IFTTT server.

Literature Survey

IoT Project – 'Fall Detection'[1]

Presented by

19BCE2249 Siddharth Chatterjee

19BCE2250 Ishan Sagar Jogalekar

S.No	Title	Authors	Year of Publication	Primary Findings	Disadvantages	Advantages
1	IoT-Based Fall Detection for Smart Home Environments	Shalom Greene, Himanshu Thapliyal and David Carpenter	2016	Integrated within a smart home environment, the proposed IoT-based fall detection system can improve the quality of life among older adults. We found out this system would work primarily from a local wifi network and is designed with a central hub (acting as intermediary) for communication that will perform data processing, decision making, and relay of messages.	Our project team found out that one large hurdle with fall detection algorithms is the balance between specificity and sensitivity. An ideal system would have very high specificity and sensitivity. However, naturally, high sensitivity brings about false positives, which further brings about an annoyance to the system's users.	We noticed that the research team accepted that their system is not specifically geared toward producing the most efficient fall detector; but it will add a layer of confirmation to reduce false positives, which is a good advantage, and an improvement over their predecessor prototypes
2	Development of a Wearable-Sensor-Based Fall Detection System	FalinWu, Hengyang Zhao, Yan Zhao, and Haibo Zhong	2013	This paper developed a fall detection system based on a single triaxial accelerometer based wearable device. There is no special requirement of the device's mounting orientation because the algorithm does not claim the axes of accelerometer to be fixed strictly. The system has low power consumed hardware design and highly efficient algorithm which could extend the service time of the wearable device. Both the hardware and software designs are suitable for wearable and outdoor application.	Fracture is the most common injury in fall of an elderly and there is also a certain possibility to get coma, brain trauma, and paralysis. Our project team found out that at most fall situations, the fall process is the main source of injury because of the high impact. But sometimes the late medical salvage may worsen the situation, where this prototype might fail to work.	A wearable device is placed on human's waist. The system can detect the elderly's falling by acceleration analysis. Then it will get the elderly's geographic position and send fall alarm short message to caregivers. So the elderly who has fallen can get timely help to minimize the negative influence. We also noticed the inclusion of system test* which contains five kinds of activities of daily living and four kinds of fallings.

S.No	Title	Authors	Year of Publication	Primary Findings	Disadvantages	Advantages
3	Fall detection system for elderly people using IoT and ensemble machine learning algorithm	Diana Yacchirema & Jara Suárez de Puga & Carlos Palau & Manuel Esteve	2018	After analyzing this journal we can say that this work presents a holistic solution for fall detection, the enhancement of the detection at each fall with the re-creation of the ML model, and the reliability provided by the IoT protocols involved in the communication. This is an intelligent system for detecting falls of elderly people in indoor environments using the ensemble machine learning algorithm. IoTE-Fall system employs a 3D-axis accelerometer embedded into a 6LowPAN wearable device capable of capturing in real time the data of the movements of elderly volunteers.	Some main disadvantages, we noticed are these systems are costly, in both equipment investment and computational resources for image processing. Also the consequent lack of privacy for elderly people since these systems requires cameras to be strategically distributed in the indoor environment in which they live.	Main advantages include the fast processing and detection at the edge of the network. There is feature extraction, training and testing, and validation. Motion-DT, which is used in the k-fold cross validation scheme to train and test four machine learning algorithms in order to find the best model for fall detection. MEMs accelerometer sensor

Project Approach

Indoor Environment (NodeMCU and Sensors will detect the fall of person or object)

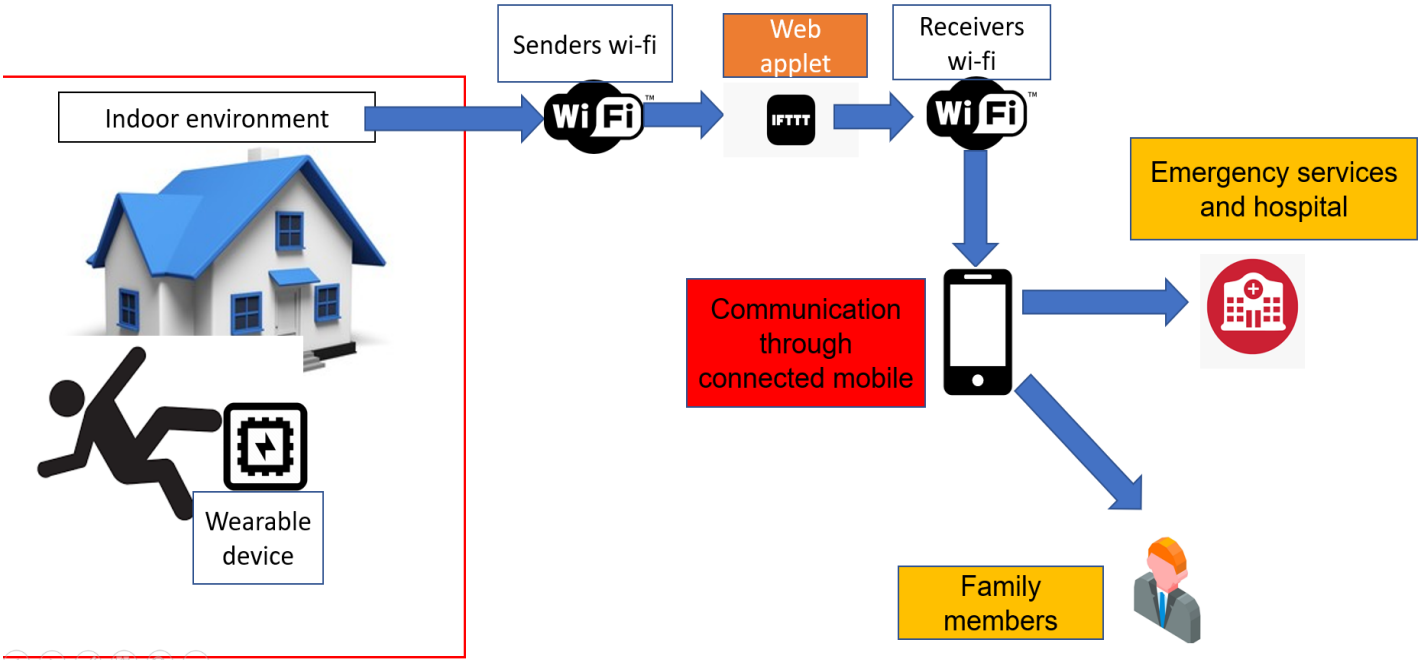
Using WIFI protocol , NodeMCU will communicate to API Server (IFTTT) to send message

IFTTT Server records the message through web hooks application

Web-hooks application triggers the message applet to communicate

Finally registered mobile numbers will get message (SMS) that is fall is detected

Hardware Implementation

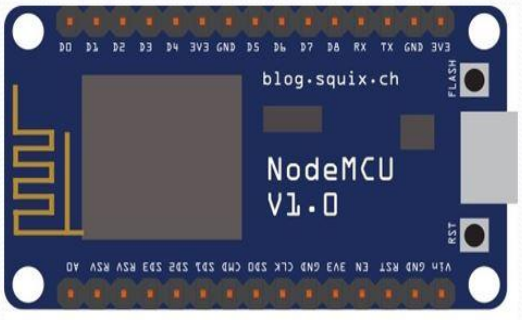


Project Components: Hardware

NodeMCU ESP8266

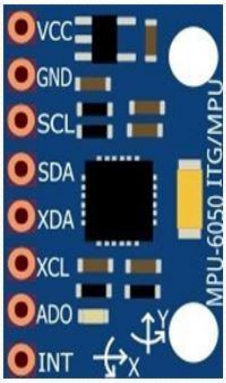
- NodeMCU ESP8266 is low cost open source IOT platform. ESP8266 chip having 32-bit LX106 RISC microprocessor which operates at 80 to 160 MHz adjustable clock frequency and supports RTOS. It also has 128 Kb ram and 4 MB flash memory, which gives easy connectivity and fast working.

- ESP8266 Integrates 802.11b/g/n HT40 Wi-Fi transceiver makes chip very versatile and it will connect according to wifi's configuration for protocols.



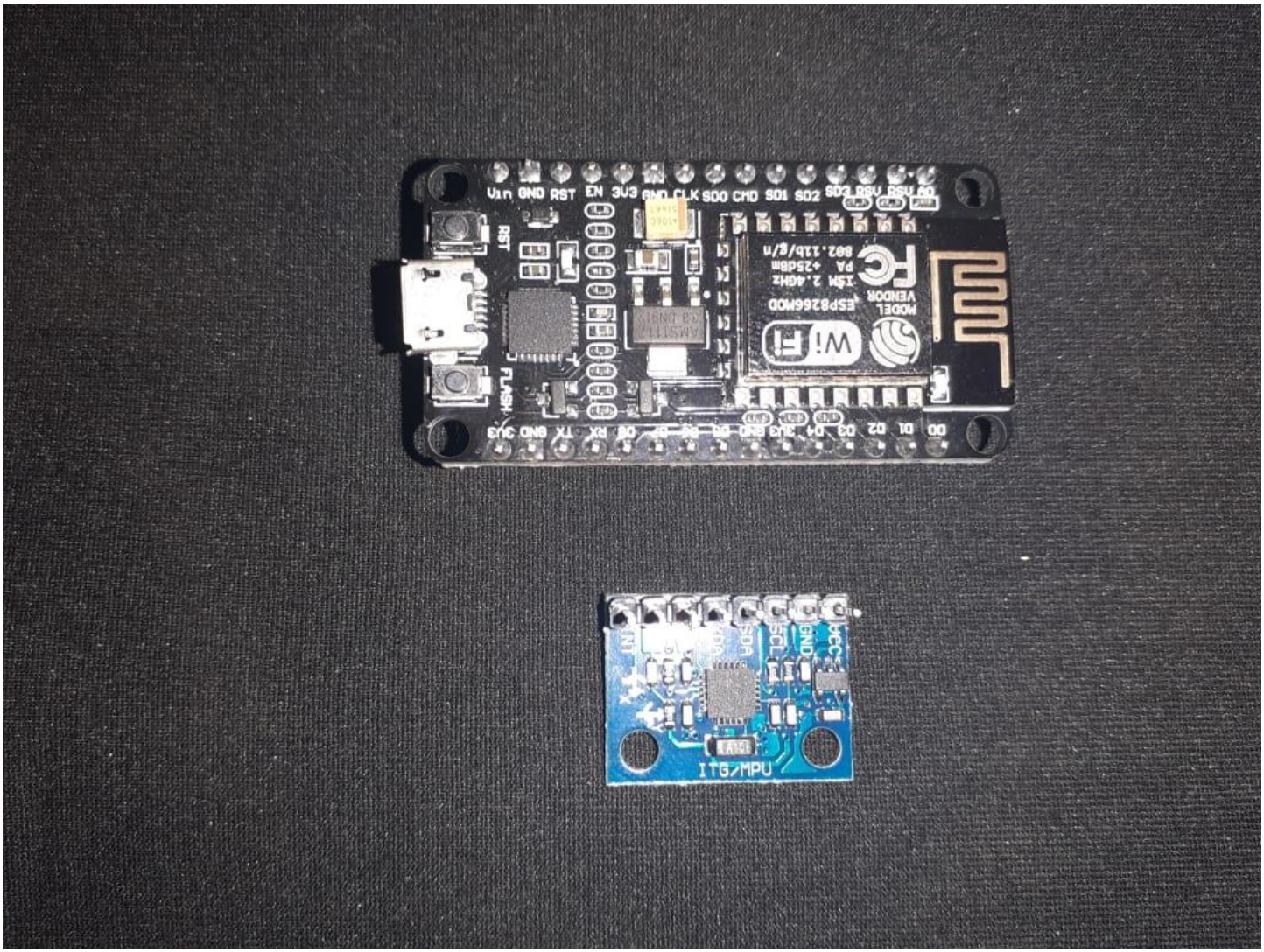
MPU6050

- MPU6050 is six axis gyroscope plus accelerometer motion sensing device. In this device 3- axis combined to work as gyroscope and remaining as accelerometer. It is compatible with many IOT chips like NodeMCU. MPU6050 is made for fast and slow both motions, so it gives precise information.



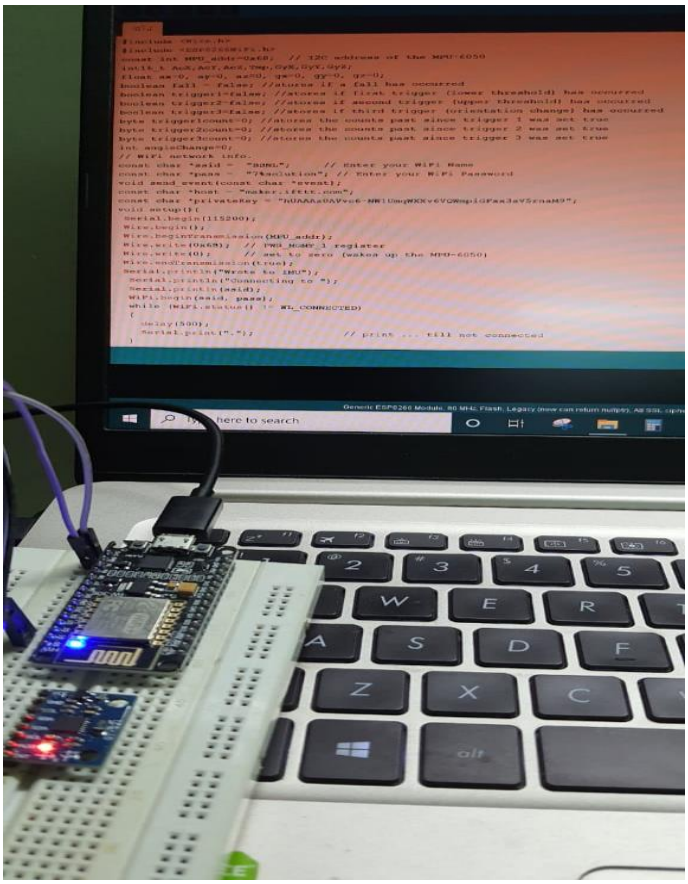
Jumper Wires

- There are male to male as well as male to female jumper wires for IoT modules to jump between headers on the board.
- We bought good quality jumper wires from Amazon; 200mm long and they come in a 'strip' of 40 (4 pieces of each of ten colours). They are in a 'ribbon strip' instead of individual wires.



Hardware components: NodeMCU ESP8266 (top) and MPU6050(bottom)

Soldering the MPU6050 legs onto the Project Breadboard

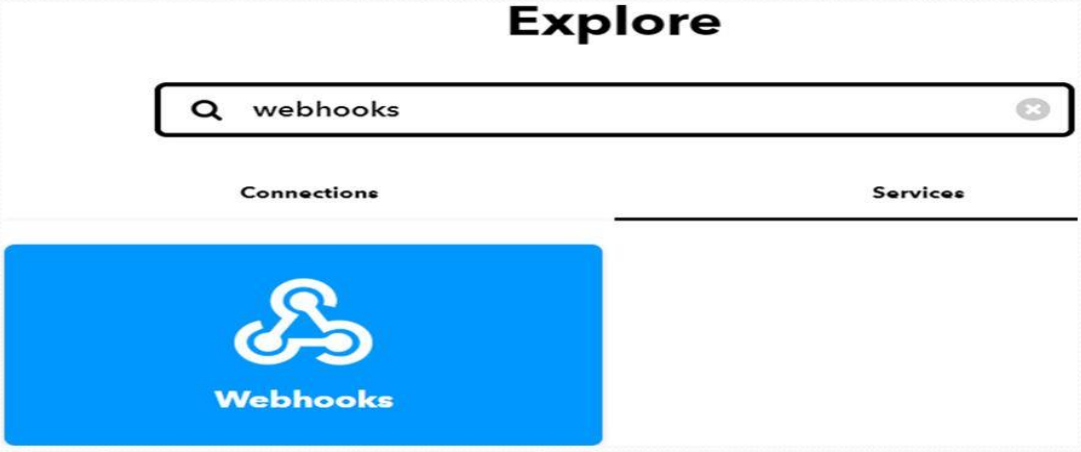


Software Implementation

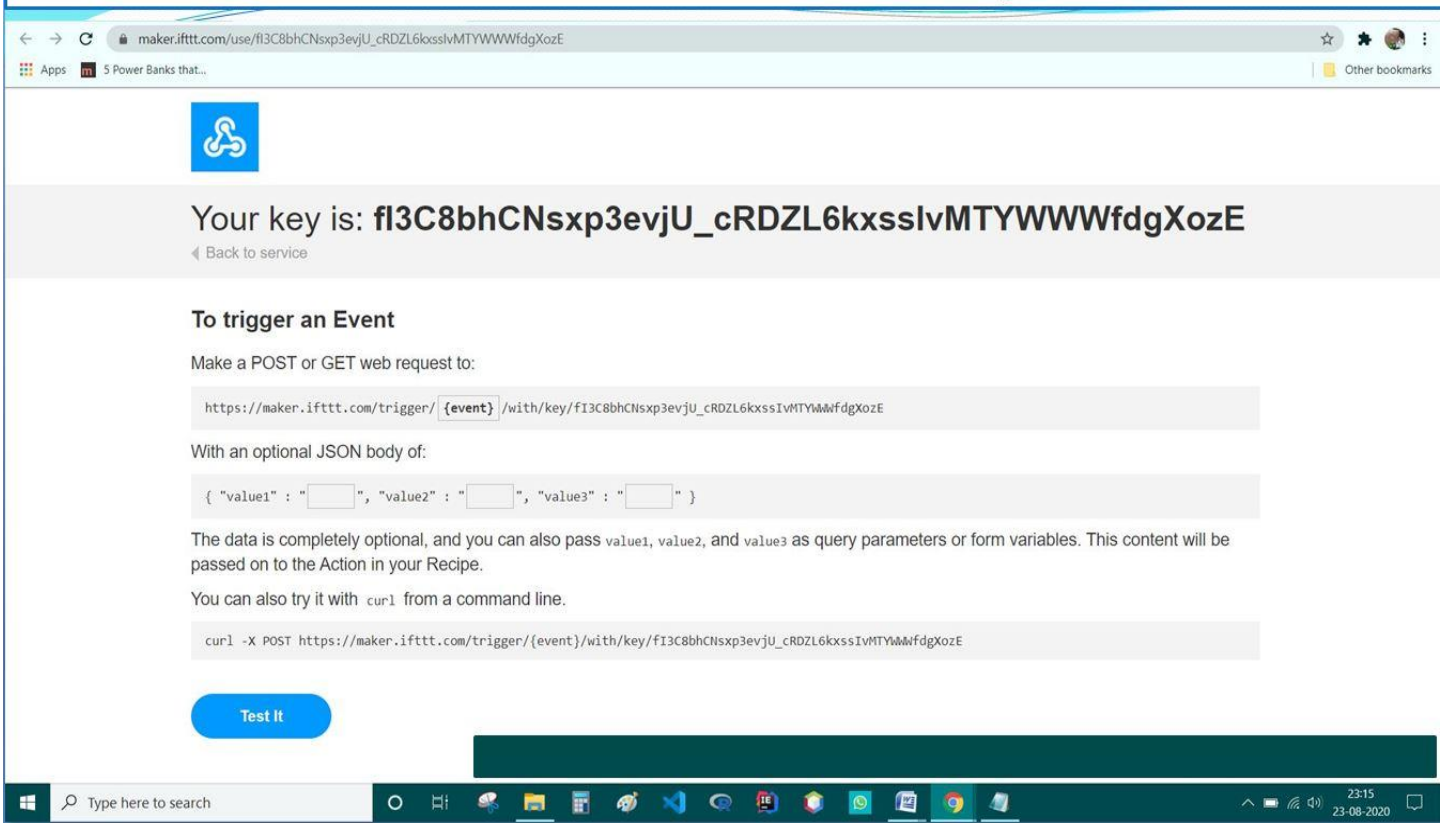
Project Components: Software

IFTTT Server

IFTTT (If This Then That) is a web-based service by which we can create chains of conditional statements, called applets.



WebHooks Window Key



'If WebHooks ' where 'This' = 'WebHooks'

If Then That

Choose action service

Step 3 of 6

android

Android Device

Android SMS

Complete action fields

Step 5 of 6

Phone number

Include country code e.g. 12024561111

Add ingredient

Message

The event named " EventName " occurred on the Maker service

Add ingredient

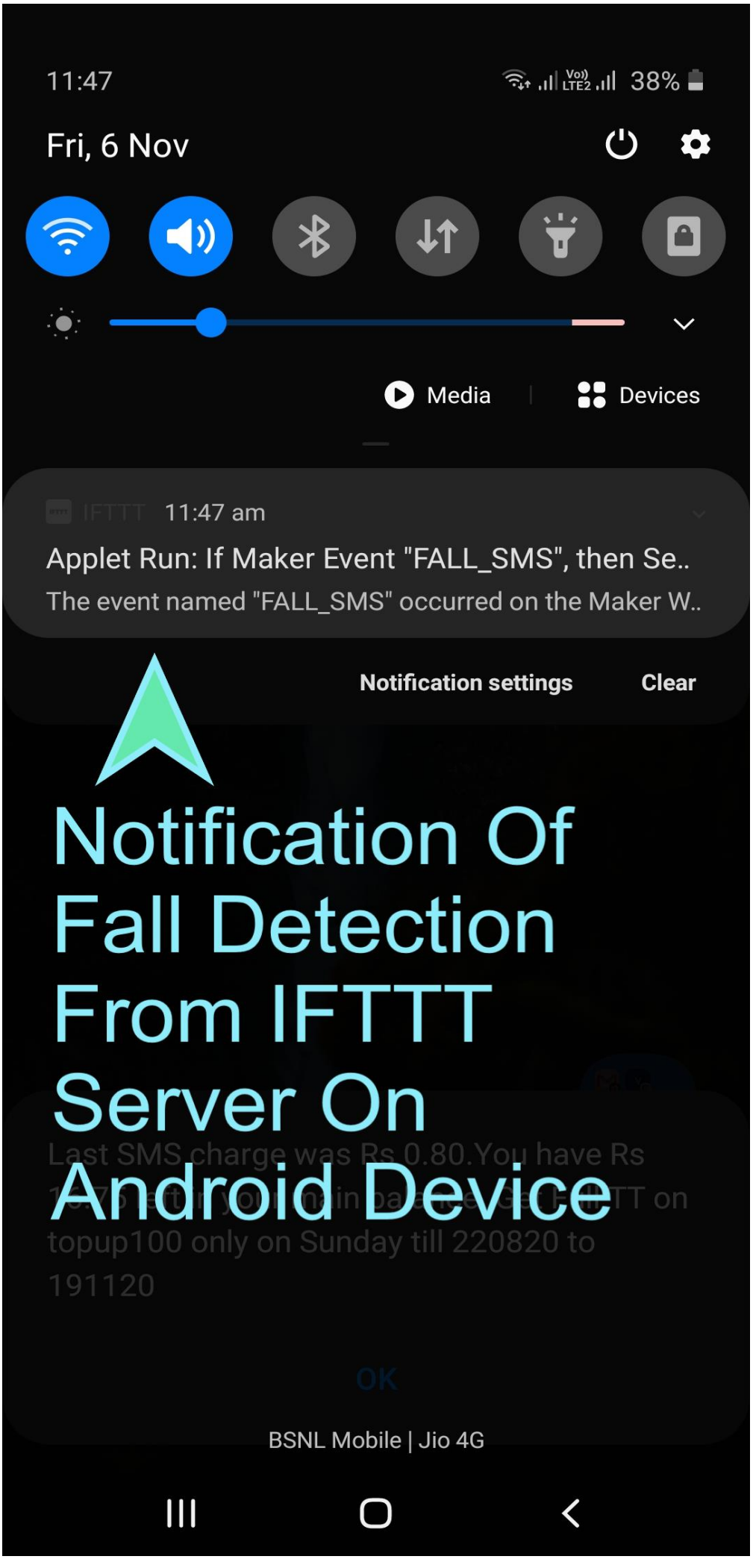
Create action

Review and finish

Step 6 of 6

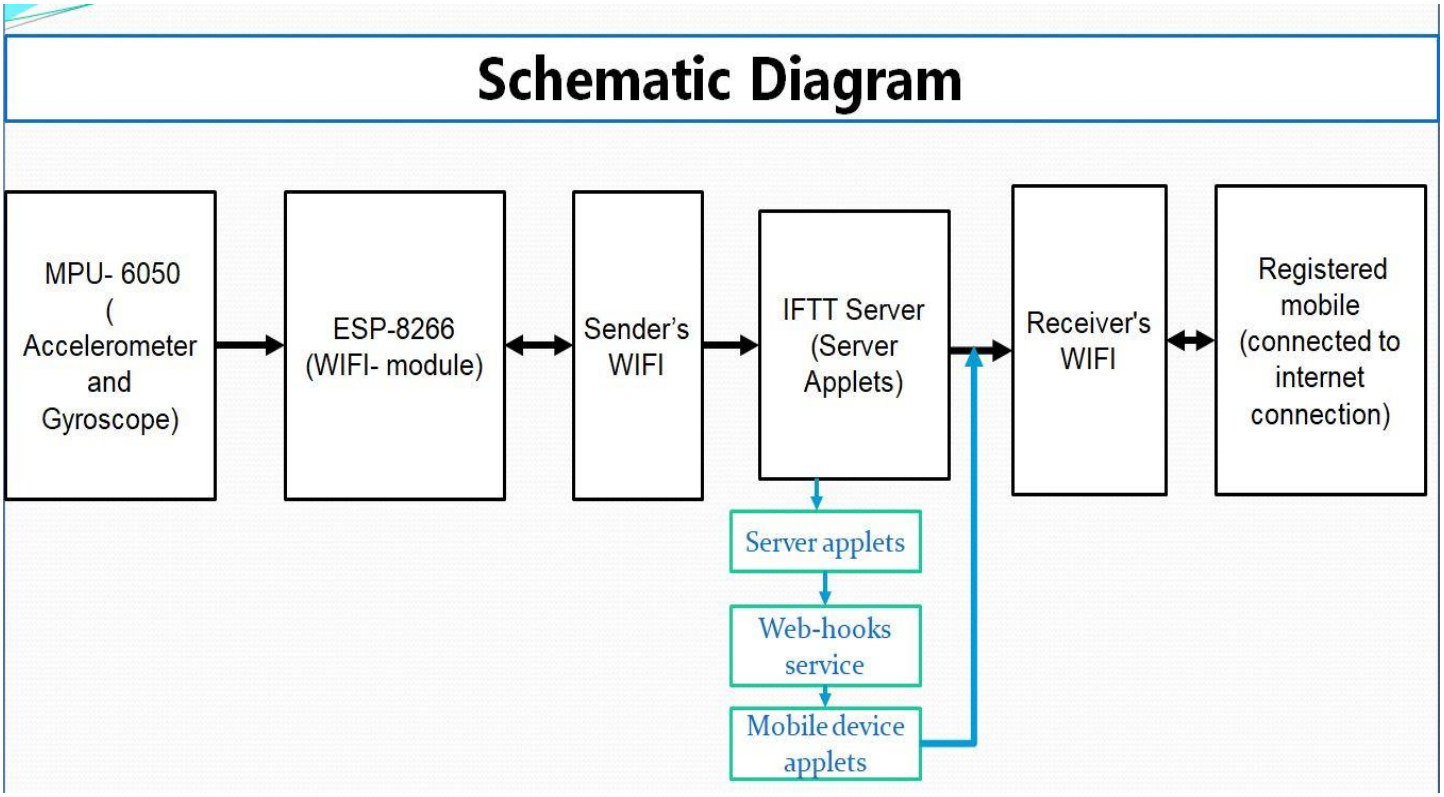
Receive notifications when this Applet runs

Finish


11:47
38%
Fri, 6 Nov
Media
Devices
IFTTT 11:47 am
Applet Run: If Maker Event "FALL_SMS", then Se..
The event named "FALL_SMS" occurred on the Maker W..
Notification settings
Clear
Notification Of Fall Detection From IFTTT Server On Android Device
Last SMS charge was Rs 0.80.You have Rs
topup100 only on Sunday till 220820 to
191120
OK
BSNL Mobile | Jio 4G


11:48
38%
Ishan
00917499501311
Friday, 6 November 2020
11:47 am
Fall detected
SMS Received After Fall Detection

Architectural Diagram



Our contribution and work

Our project's aim was to find a suitable yet cheaper alternative to expensive fall detection modules available in the market.

Currently in market such fall detecting IOT devices are very expensive, so we decided to make it at least affordable for elderly.

We built a device for fall detection of delicate materials in industries like glassware. Sometimes during transportation of delicate and expensive materials like glassware, tubes destroyed or damaged, so this can help detect the fall by sending a notification via IFTTT server to the registered mobile number.

If a fall is detected, an alert is activated immediately may it be a siren, buzzer or a specific song

The Results of experiments have shown high success rates in fall detection in terms of accuracy, precision and gain, which is because we have calibrated in x, y as well as z axes all the coordinates for a better configuration to detect fall.

Finally, the system can also be enhanced to provide services built on cloud. From medical perspective, there can be a storage service.

That would enable healthcare professionals to access to falls' data for perform further analysis.

We also worked upon integrating a blinking LED inside our breadboard when fall is detected

References

1. He W, Goodkind D, Kowal P (2016) U.S. Census Bureau, International Population Reports, P95/16-1, An Aging World: 2015. U.S. Government Publishing Office, Washington, DC
2. Yacchirema DC, Sarabia-Jácome D, Palau CE, Esteve M (2018) A Smart System for sleep monitoring by integrating IoTwith big data analytics. IEEE Access, p 1
3. Robie K (2010) Falls in older people: risk factors and strategies for prevention. JAMA 304(17):1958–1959
4. Practical fall detection based on IoT technologies: A survey author links open overlay Nassim Mozaffaric Javad Rezazadeh Reza Farahbakhsh Samaneh Yazdanic Kumbesan Sandrasegaranb (2019).
5. Fall detection system for elderly people using IoT and Big Data Author links open overlay Diana Yacchirema Jara Suárez de Pugaa Carlos Palaua Manuel Esteve (2018).