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# A social cause on Real Time Implementation of Automatic Fall Detector and Location Tracking System Using LSM for elder age peoples

[1]T. Senthil Kumar, [2]S. Sivasankari, [3]Dr. A. Sundar Raj

***Abstract:***

*Considering a social cause for elder people may encounter problems if they are living alone with their poor health condition at their old age. In this project, a prototype of elderly fall detection and location tracking system is developed by using the Global Positioning System (GPS), Global System for Mobile communications (GSM), Wi -Fi and Ardino technologies. The proposed system is software equipped with cellular network and Wi-Fi connectivity for sending an emergency alert in multiples ways such as Short Message Services (SMS) and email in case of fall detected. The Coding is written by the use of Python. The location coordinate is extracted from a GPS module and sent together with emergency alerts in the form of Google Map link to caretaker for immediate action. The prototype is tested. It sends emergency SMS and Email via GSM and cloud server respectively, if a fall is detected. Moreover, the proposed system stored the fall event details on cloud server and display on a webpage.*

***Keywords:*** *Location Tracking System, Automatic Fall Detector, LSM*

## I. INTRODUCTION

In this modern and fast-moving world, the elder's safety and security have become an important issue. In 2015, there were 12.3 percent population aged 60 and above globally and it is the fastest growing population at a rate of 3.26 percent per year. A fall is characterized by a sudden rapidly descending then subsequently laying on the ground for a period of time. Fall is one of the critical incidents for senior who is living alone as it causes serious injuries. According to the World Health Organization (WHO) report, about 32 percent of people aged 65 fall each year, while the percentage grows up to about 40 percent for those aged 70 and above. The emergency impact that occurs among the elderly people may not be noticed timely by the caregivers, such as falling down to the ground in the washroom. To reduce the worries about elderly who live alone at home, Elderly Fall Detection and Location Tracking System (EFDLTS) is required for continuous monitoring. In this research, a prototype of EFDLTS using heterogeneous

[1] Associate Professor, Electronics and Communication Engineering, E.G.S. Pillay Engineering College, Nagapattinam
[2] PG Student, Electronics and Communication Engineering, E.G.S. Pillay Engineering College, Nagapattinam
[3] Assistant Professor, Electronics and Communication Engineering, E.G.S. Pillay Engineering College, Nagapattinam

wireless networks is developed. The proposed system contains fall sensor, Global Positioning System (GPS), Global System for Mobile Communications (GSM), WiFi and Arduino technologies.

# II. LITERATURE SURVEY

## 2.1 RELATED WORK

### 2.1.1 Review on Location Tracking System

Children location monitoring system (CLMS) proposed by Sunehra et al.used to fight against crime in school going children. This system enables parents to track their kids' location (Google map link) through Short Message Service (SMS).

### 2.1.2 Review on Women and Children's Security Based Location Tracking System

Another similar system is a portable Location Based System (LBS) presented by Velayutham et al. LBS consists of GPS, GSM and a microcontroller. It is designed for women and children. In emergency case, user can trigger the system by pressing an on-board button for enabling the GPS module to get the location information and send an SMS in every five minutes to helper's mobile phone attached with a Google map link. It is a personal tracking system (PTS), integrates both GPS and GSM technologies to detect and track the location of the target. This system intention is to implement GSM technology as tracking gateway whenever GPS technology failed.

### 2.1.3 Review on Vehicle Tracking Device

Vehicle tracking device (VTD) proposed by Alzahri and Sabudin help the users to track their vehicle. The function of this system is to send information of the vehicle coordinates to a mobile phone each time the user requests for it. A vehicle tracking system with geofencing on android platform which creates a virtual geo- fencing in server. Any of the targeted android-based smartphone is located outside the virtual geofenced area will then report back to the server and the server will then forward the information and reports to anyone that has the right to monitor the targeted phone location.

### 2.1.4 Review on Student Tracking System

The student tracking system proposed by Agarwal, is a system that allows campus admin to remote monitoring student location through their android-based smartphone location. The student smartphone location will be sent to central server via an app module and the admin of the system can monitor and view the history of the student locations to track the student during college hour.

### 2.1.5 Review on Fall Detection System

All the existing fall detection systems can be primarily categorized into three types which are wearable sensor based, ambiance sensor-based and camera-based. Wearable device-based means that the user under monitoring has to be wearing a developed smart sensor system for data collection. The system is often attached to the human body or worn in their garments, clothes or personal ornament. Some examples of the wearable sensor are accelerometer, gyroscope, magnetic sensor, RFID etc. Besides, the smartphone is also considered as a wearable sensor. The ambiance sensor-based method is a non-wearable sensor method where wearing sensors are not required when elderly undergoing monitoring by their children. To track elderly fall location and automatically send alert messages with location information through both Short Message Service (SMS) and Email to their caretaker if the fall is detected. The proposed system is equipped with heterogeneous wireless networks to guarantee the message is successfully delivered to caretaker.

## III. PROPOSED METHODOLOGY

The proposed system consists of an accelerometer sensor, a Global Positioning System (GPS), a Global System for Mobiles (GSM), a Wi-Fi module and a microcontroller. Figure 1 shows the architecture of the system. The accelerometer sensor is used to detect the fall events. If a fall is detected, the system sends alert messages to caretaker via SMS and email with the location information which obtained by using a GPS module. Moreover, the emergency messages are also uploaded to a dedicated cloud server for caretaker to monitor or check the recorded fall history through a web application. The recorded information includes date, time and location with Google map link. This system has an on-board button that can serve as panic emergency button. Elderly can manually activate the system to send alert messages by pressing this button if necessary. The hardware is controlled by Arduino Uno which acts as a central controller of the proposed system.

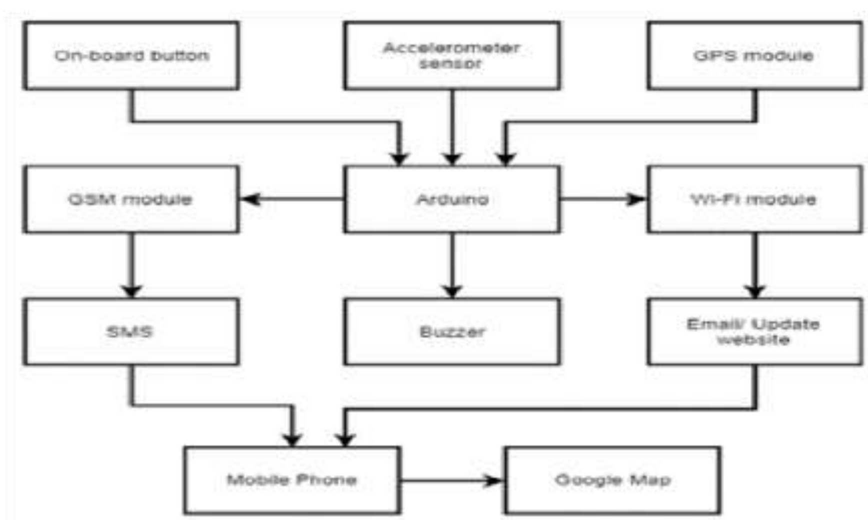


FIGURE 1: Architecture of the proposed system.

The accelerometer sensor measures the acceleration, most likely due to the motion of the body in an accurate manner. In this project, a 3-axis accelerometer sensor ADXL335 is used for detecting the fall. The proposed system can be activated by pressing the on-board button after wearing on the waist, this helps set a baseline reading of the 3-axis accelerometer. There is a LED indicator to show that the

system is in active mode. Any radical acceleration force (g) shifts will cause the sensor output reading $|R|$ greater than the predefined threshold, 2g as in [16], the proposed system takes the corresponding action such as send SMS, Email alerts and toggle on the buzzer to attract attention from nearby people. The $|R|$ value is expressed in Equation. Where x, y and z represent accelerometer outputs of axis-X, axis-y and axis-z, respectively. The fall detection algorithm presented in [16] is applied in this work. The on-board button also serves as an emergency button when the EFDLTS is activated. If fall event happens but alerts action did not get the trigger, press the on-board button for one second to toggle all the alerts actions manually.

On the other hand, by pressing the same button for five seconds to turn off the system. GPS location will be gathered from the GPS Module every ten minutes and stores in the main control unit. This is for tracking and recording the user or elderly location. However, if a fall is detected, the longitude and latitude information will be obtained through GPS Module once again to ensure the location of the fall is the latest and will be processed as Google map link and sent to caretaker via SMS and Email. The GPS module may not be able to obtain the latest location if a fall happened inside the building such as home, shopping mall and bathroom. In such case the latest recorded location information will be sent out to caretaker. The GSM module enables the proposed system to send alert messages to caretaker's mobile phone via Short Message Service (SMS) with a Google map link for location information through the cellular network. Wi-Fi module sends alert messages through Email services such as Gmail and update location, date and time to a cloud server. Caretaker can check the exact location on Google map by clicking on the provided Google map link (URL). Figure 2 shows the process flow of the proposed system. First, the user presses the on-board button to activate the system. The main control unit will set the baseline of the 3axis accelerometer reading automatically and collect location coordinate from GPS module. Then the proposed system falls into standby mode and collects location coordinates in every ten minutes through GPS module. The collected location longitude and latitude will be stored in the main control unit memory. Any radical acceleration force shifts which causes the accelerometer reading beyond the threshold value will trigger the EFDLTS alert mode. Alert mode can also be triggered manually by pressing the on-board button. During alert mode, the system sends alert emails and SMS together with Google map link contains GPS location information to caretaker. The caretaker contact number and email are set in the cloud server. User can update their caretaker contact details by login to the online cloud webpage. The system also triggers the on-board buzzer to attract attention of nearby peoples. Press and hold the on-board button for five seconds will turn off the EFDLTS.

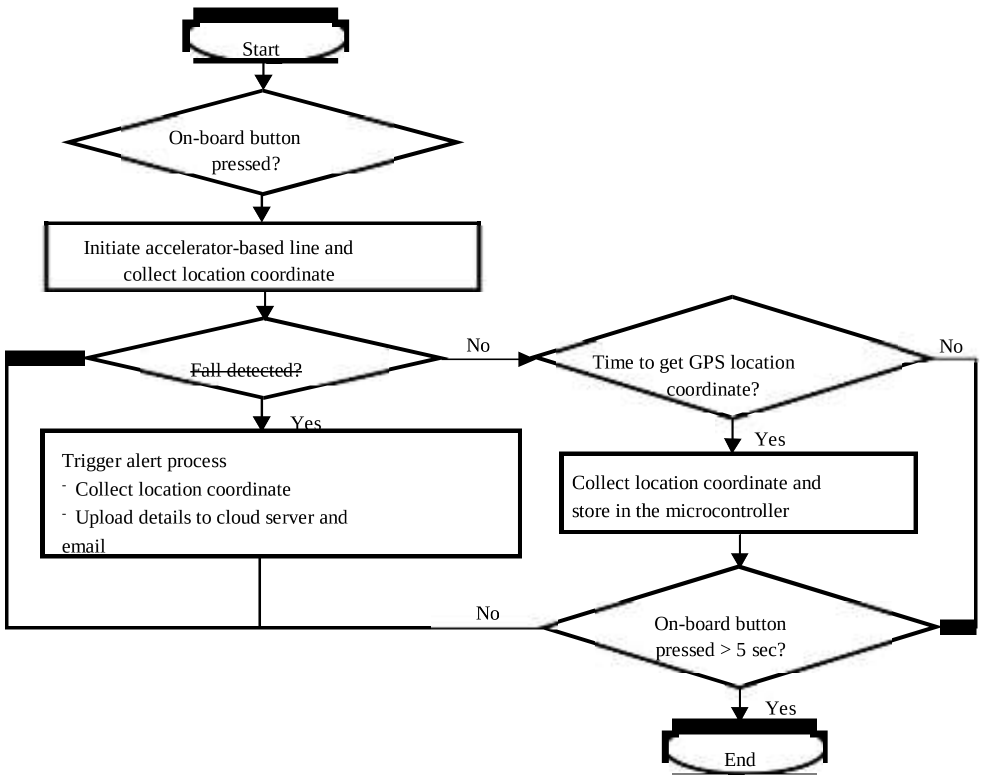


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FIGURE 2: Flowchart of the proposed system

# IV. HARDWARE REQUIREMENT

## 4.1 ARDUINO

### 4.1.1 INTRODUCTION

Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online. You can tell your board what to do by sending a set of instructions to the microcontroller on the board. To do so you use the Arduino programming language (based on Wiring), and the Arduino Software (IDE), based on Processing. Arduino was born at the Ivrea Interaction Design Institute as an easy tool for fast prototyping, aimed at students without a background in electronics and programming. As soon as it reached a wider community, the Arduino board started changing to adapt to new needs and challenges, differentiating its offer from simple 8-bit boards to products for IT applications, wearable, 3D printing, and embedded environments. All Arduino boards are completely open source, empowering users to build them independently and eventually adapt them to their particular needs. The software, too, is open-source, and it is growing through the contributions of users worldwide. Arduino also simplifies the process of working with microcontrollers, but it offers some advantage for teachers, students, and interested amateurs over other systems: Inexpensive- Arduino boards are relatively inexpensive compared to other microcontroller platforms. The least expensive version of the Arduino

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module can be assembled by hand, and even the pre-assembled Arduino modules cost less than $50 Cross-platform- The Arduino Software (IDE) runs on Windows, Macintosh

OSX, and Linux operating systems. Most microcontroller systems are limited to Windows. Simple, clear programming environment- The Arduino Software (IDE) is easy-to-use for beginners, yet flexible enough for advanced users to take advantage of as well. For teachers, it's conveniently based on the Processing programming environment, so students learning to program in that environment will be familiar with how the Arduino IDE works. Open source and extensible software - The Arduino software is published as open source tools, available for extension by experienced programmers. The language can be expanded through C++ libraries, and people wanting to understand the technical details can make the leap from Arduino to the AVR C programming language on which it's based. Similarly, you can add AVR-C code directly into your Arduino programs if you want to. Open source and extensible hardware - The plans of the Arduino boards are published under a Creative Commons license, so experienced circuit designers can make their own version of the module, extending it and improving it. Even relatively inexperienced users can build the breadboard version of the module in order to understand how it works and save money.

### 4.1.2 Arduino Mega 2560

The Mega 2560 is a microcontroller board based on the ATmega2560. It has 54 digital input/output pins (of which 15 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started. The Mega 2560 board is compatible with most shields designed for the Uno and the former boards Duemilanove or Diecimila. The Mega 2560 is an update to the Arduino Mega, which it replaces


FIGURE 3: Arduino Mega 2560

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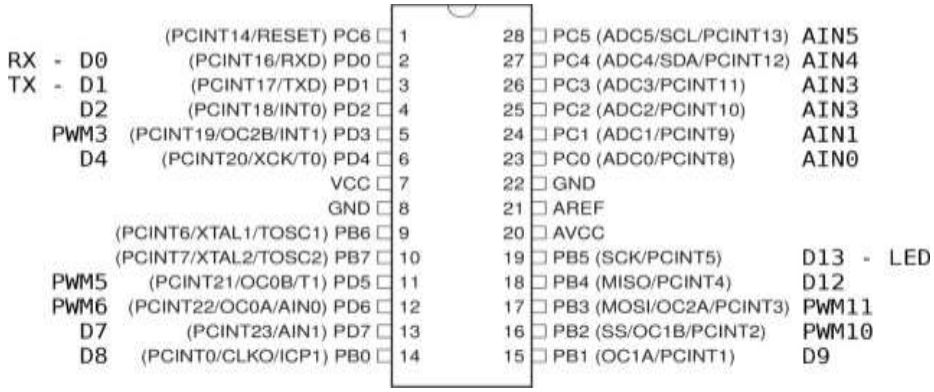


FIGURE 4: Pin diagram of Arduino Mega 2560

**Power:** The Arduino Mega2560 can be powered via the USB connection or with an external power supply. The power source is selected automatically. External (nonUSB) power can come either from an AC-to-DC adapter (wall-wart) or battery. The adapter can be connected by plugging a 2.1mm center-positive plug into the board's power jack. Leads from a battery can be inserted in the GND and Vin pin headers of the POWER connector. The board can operate on an external supply of 6 to 20 volts. If supplied with less than 7V, however, the 5V pin may supply less than five volts and the board may be unstable. If using more than 12V, the voltage regulator may overheat and damage the board. The recommended range is 7 to 12 volts. The Mega2560 differs from all preceding boards in that it does not use the FTDI USBtoserial driver chip. Instead, it features the Atmega8U2 programmed as a USB-toserial converter. The power pins are as follows:

**VIN:** The input voltage to the Arduino board when it's using an external power source (as opposed to 5 volts from the USB connection or other regulated power source). You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin.

**5V**: The regulated power supply used to power the microcontroller and other components on the board. This can come either from VIN via an on-board regulator, or be supplied by USB or another regulated 5V supply**.**

**3.3V:** A 3.3 volt supply generated by the on-board regulator. Maximum current draw is 50 mA.

**GND**: Ground pins.

**Input and Output:** Each of the 54 digital pins on the Mega can be used as an input or output, using pinMode(), digitalWrite(), and digitalRead() functions. They operate at 5 volts. Each pin can provide or receive a maximum of 40 mA and has an internal pull-up resistor (disconnected by default) of 20-50 kΩ. In addition, some pins have specialized functions: Serial: 0 (RX) and 1 (TX); Serial 1: 19 (RX) and 18 (TX); **Serial 2:** 17 (RX) and 16 (TX); Serial 3: 15 (RX) and14 (TX). Used to receive (RX) and transmit (TX) TTL serial data. Pins 0 and 1 are also connected to the corresponding pins of the ATmega8U2 USB-to-TTL Serial chip.

**External Interrupts:** 2 (interrupt 0), 3 (interrupt 1), 18 (interrupt 5), 19 (interrupt 4), 20 (interrupt 3), and 21 (interrupt 2).These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value. See the attachInterrupt() function for details.

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**PWM:** 0 to 13. Provide 8-bit PWM output with the analogWrite() function.

**LED:**13.There is a built-in LED connected to digital pin 13. When the pin is HIGH value, the LED is on.

**Analog Pin:** The Mega2560 has 16 analog inputs, each of which provide 10 bits of resolution (i.e. 1024 different values). By default they measure from ground to 5 volts, though is it possible to change the upper end of their range using the AREF pin andanalogReference() function. There are a couple of other pins on the board.

**AREF:** Reference voltage for the analog inputs. Used with analogReference(). Reset: Bring this line LOW to reset the microcontroller. Typically used to add a reset button to shields which block the one on the board.

**4.1.2.2 Communication:** The Arduino Mega2560 has a number of facilities for communicating with a computer, another Arduino, or other microcontrollers. The ATmega2560 provides four hardware UARTs for TTL (5V) serial communication. An ATmega8U2 on the board s one of these over USB and provides a virtual com port to software on the computer (Windows machines will need a .inf file, but OSX and Linux machines will recognize the board as a COM port automatically. The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the board. The RX and TX LEDs on the board will flash when data is being transmitted via the ATmega8U2 chip and USB connection to the computer (but not for serial communication on pins 0 and 1).

**Automatic Software (reset):** The auto-reset. Rather than requiring a physical press of the reset button before an upload, the Arduino Mega2560 is designed in a way that allows it to be reset by software running on a connected computer. One of the hardware flow control lines (DTR) of the ATmega8U2 is connected to the reset line of the ATmega2560 via a 100 nF capacitor. When this line is asserted (taken low), the reset line drops long enough to reset the chip. The Arduino software uses this capability to allow you to upload code by simply pressing the upload button in the Arduino environment. This means that the boot loader can have a shorter timeout, as the lowering of DTR can be well-coordinated with the start of the upload. This setup has other implications. When the Mega2560 is connected to either a computer running Mac OS X or Linux, it resets each time a connection is made to it from software (via USB). For the following half-second or so, the bootloader is running on the Mega2560. While it is programmed to ignore malformed data (i.e. anything besides an upload of new code), it will intercept the first few bytes of data sent to the board after a connection is opened. If a sketch running on the board receives one-time configuration or other data when it first starts, make sure that the software with which it communicates waits a second after opening the connection and before sending this data. The Mega contains a trace that can be cut to disable.

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Table 1: Specification of Arduino ATmega 2560

**Summary**

| | |
|---|---|
| Microcontroller | ATmega2560 |
| Operating Voltage | 5V |
| Input Voltage (recommended) | 7-12V |
| Input Voltage (limits) | 6-20V |
| Digital I/O Pins 54 (of which 14 provide PWM | 54 (of which 14 provide PWM output) |
| Analog Input Pins | 16 |
| VDC Current per I/O Pin | 40 mA |
| DC Current for 3.3V Pin | 50 mA |
| Flash Memory | 256 KB of which 8 KB used by bootloader |
| SRAM | 8 KB |
| EEPROM | 4 KB |
| Clock Speed | 16 MHz |

### 4.2 GSM Technology and MODEM

**Cellular mobile system**

Cellular radio was devised in order to make better use of limited resource of Radio Spectrum. Each Megahertz of spectrum will only support a comparatively a small number of simultaneous conversations and the same frequency must be reused many times in order to meet the capacity needed for national or regional service. So, with the development in Political, Commercial and Industrial areas there arose a necessity for uniformity in cellular communication Cellular mobile communication has following generations:

➢ **First Generation**: Analog radio; mostly telephony only, virtually no data capability other than special device with analog modem.

➢ **Second Generation:** Digital radio and short messaging; this is now the main stream

system. Recently a variety of technique has been innovated and employed to enhance data capability of 2G systems. The data capability includes Internet access and picture sharing. These systems are called 2.5G systems.

➢ **Third Generation:** Digital system with multimedia services including video

phone and relatively higher speed (say up to 1 Mbps) Internet access. A slow roll off of 3G system has been started in advanced networks of developed and rapidly developing countries.

➢ **Fourth Generation**: Digital system with voice-over-IP (VOIP) technology (Note that the voice for G1, 2 and 3 are circuit-switched). That is, the services are integrated into all IP network. This is expected to be future network and not coming any time soon.

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**Table 2: Generations and their Features**

| Generation | Features | System |
|---|---|---|
| First Generation | • Analog<br>• Voice only<br>• No International roaming | NMT,AMPS,TACS |
| Second Generation | • Digital<br>• Voice and low speed data<br>• International roaming | GSM,CDMAone and American TDMA(Digital Amps) |
| Third Generation | • Packet switched data<br>• IP-telephony and Multimedia(upto 1Mbps)<br>• Global roaming | UMTS and others |
| Fourth Generation | •IP based network including telephony service | Yet to come |

### 4.2.1 GSM technology

One of the most important conclusions from the early tests of the new GSM technology was that the new standard should employ Time Division Multiple Access (TDMA) technology. This ensured the support of major corporate players like Nokia, Ericsson and Siemens, and the flexibility of having access to a broad range of suppliers and the potential to get product faster into the marketplace. After a series of tests, the GSM digital standard was proven to work in 1988. With global coverage goals in mind, being compatible with GSM from day one is a prerequisite for any new system that would add functionality to GSM. As with other 2G systems, GSM handles voice efficiently, but the support for data and Internet applications is limited. A data connection is established in just the same way as for a regular voice call; the user dials in and a circuit-switched connection continues during the entire session. If the user disconnects and wants to re-connect, the dial-in sequence has to be repeated. This issue, coupled with the limitation that users are billed for the time that they are connected, creates a need for packet data for GSM.

FIGURE 5: Schematic diagram of simcom modem for arduino UNO controller

The digital nature of GSM allows the transmission of data (both synchronous and asynchronous) to or from ISDN terminals, although the most basic service support by GSM is telephony. Speech, which is inherently analog, has to be digitized. The method employed by ISDN, and by current telephone systems for multiplexing voice lines over high-speed trunks and optical fiber lines, is Pulse Coded Modulation (PCM). From the start, planners of GSM wanted to ensure ISDN compatibility in services offered, although the attainment of the GSM based Home Security System Using Arduino standard ISDN bit rate of 64 Kbit/s was difficult to achieve, thereby belying some of the limitations of a radio link. The 64 Kbit/s signal, although simple to implement, contains significant redundancy. Since its inception, GSM was destined to employ digital rather than analog technology and operate in the 900 MHz frequency band. Most GSM systems operate in the 900 MHz and 1.8 GHz frequency bands, except in North America where they operate in the 1.9 GHz band. GSM divides up the radio spectrum bandwidth by using a combination of Time- and Frequency Division Multiple Access (TDMA/FDMA) schemes on its 25 MHz wide frequency spectrum, dividing it into 124 carrier frequencies (spaced 200 KHz apart). Each frequency is then divided into eight time slots using TDMA, and one or more carrier frequencies are assigned to each base station. The fundamental unit of time in this TDMA scheme is called a ‘burst period’ and it lasts 15/26 ms (or approx. 0.577 ms). Therefore, the eight ‘time slots’ are actually ‘burst periods’, which are grouped into a TDMA frame, which subsequently form the basic unit for the definition of logical channels.

The development of standards and systems spans well beyond the technical realm and often into the political; this is best exemplified by what happened with GSM. Shortly after the suitability of TDMA for GSM was determined, a political battle erupted over the question of whether to adopt a wide-band or narrow-band TDMA solution. Whereas France and Germany supported a wide-band solution, the Scandinavian countries favoured a narrow-band alternative. These governmental preferences were clearly a reflection of the respective countries’ domestic equipment manufacturers as German and French manufacturers SEL and Alcatel had invested substantially into wide-band technology, whereas their Scandinavian counterparts Ericsson and Nokia poured resources into the narrow-band alternative. Italy and the UK, in turn, were the subjects of intense lobbying on behalf of the two camps with the result of frequently changing coalitions.

The culmination of this controversy between the two camps was a CEPT

(Conference des Administrations Europeans des Posts et Telecommunications) Meeting in Madeira in February 1987. The Scandinavian countries finally convinced Italy, the UK and a few smaller states of the technical superiority of narrow-band technology and left Germany and France as the only proponents of the wide-band alternative. Since CEPT followed purely intergovernmental procedures, however, decisions had to be taken unanimously, and Germany and France were able to veto a decision that would have led to the adoption of narrow-band TDMA as the technology underlying the GSM project. A unique feature of GSM is the Short Message Service (SMS), which has achieved wide popularity as what some have called the unexpected ‘killer application’ of GSM. SMS is a bi-directional service for sending short alphanumeric message in a store-and-forward process. SMS can be used both ‘point-to-point’ as well as in cell-broadcast mode. Supplementary services are provided on top of tele-services or bearer services, and include features such as, inter alia, call forwarding, call waiting, caller identification, three-way conversations, and call-barring.

## V. RESULT AND DISCUSSION

The prototype for the proposed EFDLTS had been built. Website for EFDLTS has been developed by using Microsoft Visual Studio ASP.NET. It can record the date, time and location of the fall from EFDLTS. That SMS is sent by GSM module when falls are detected. Google map link of the fall location is sent alongside with the alert SMS.

Once the google map link is clicked, Google map app will pop up the location of the fall as shown. It shows the email sent by system cloud server to caretaker. The accuracy of fall detection of the proposed system is not discussed because the performance of the fall detection algorithm has been discussed in.

In addition, experiments had been conducted to determine the accuracy of fall detection. The experiments were divided into four parts which are walking 100 steps, front falling events, side falling events and back falling events. Table I shows the results of the experiments. The proposed system has no false alarm occurred. Figure 8 shows the recorded experiment data when a person was walking. It shows that all the peak G-force are not exceeding 2G. Alarm triggers only when the Gforce is over 2G. The recorded data of front, back and side falling, respectively. The peak G-force value exceed 2G (indicated by red circles) when fall detected.

## VI. CONCLUSION

The fall detection system proposed in this project allows caretaker to reach out to elderly within golden time if there are accidents. The prototype is developed and tested. It proved that the proposed system is able to send emergency SMS and Email via GSM and cloud server, respectively. Moreover, the proposed system has stored the fall event details on cloud server and display on a webpage. The proposed system isbeneficial to elderly person who are living alone and need a constant monitoring in case any fall event happens. For future work, smaller prototype will be developed for real environment testing to evaluate the performance of the proposed system.

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