Volume 1, Issue 5, Pages 131-136, June 2017

IoT Help for Independent Living Elders

D.Chandra Teja[1] and Pallavi[2]

[1]UG Student, Department of ECE, MVJ College of Engineering, Bangalore, India. Email: dchandrateja@gmail.com
[2]Assistant Professor, Department of ECE, MVJ College of Engineering, Bangalore, India. Email: adke.pallavi@gmail.com

Article Received: 18 May 2017 *Article Accepted: 04 June 2017* *Article Published: 07 June 2017*

ABSTRACT

The interaction between the devices around us is made possible with the help of internet of things. Which made our life simple mainly in the home applications. The main aim of this paper is to develop a fall detection and consciousness monitoring system for the elderly people who are intended to live independently. This type of environment would help the caretakers know any situation of the user. Here the fall detection system deploys services such as the voice assistant, camera monitoring EEG (electroencephalogram) monitoring to determine the consciousness of the user and to maintain a personal server for the EEG values to take any future precautions. This type of system could allow older adults to interact with the system without concern of learning.

1. INTRODUCTION

The main concern of the older adults living independently has been their safety within the home and accessibility to help in case of any accidental injuries. The accidental injuries such as to get into unconsciousness while resting or any during fall [3],[4].

The EEG which is based on the brain computer interface provides a good scope for many of physically challenged people to control the devices around us [1]. With the use of the EEG we would be able to determine the consciousness of the user which helps the caregiver to provide an extra care through the system.

A survey on the fall related injuries mentioned that, it is the leading causes of deaths in older adults [4].[5]. As well as the deaths of elderly people which are mainly due to the unconsciousness of the older adults which lead them to death which also becoming the leading cause [3]. Many of these injuries occur within the home [3], [4] and the risk of major health decline due to falls and the unconsciousness can be reduced with a home aid assistance technology.

For monitoring the consciousness of the user the brain waves are continuously monitored with the help of EEG [1]. This consciousness monitoring can be done in a cost effective manner by using the electrodes which are in contact with the scalp that are embedded in a casual looking cap.

The use of IOT is to maintain the communication between the devices around us. With the use of IOT we are able to provide the voice assistance approach and camera live. monitoring to the users which help to determine the real fall, whether assistance is required or not and to provide a live footage of the user we are using attention that is EEG[2]. To overcome the limitations of the fall detection and in determining the consciousness of the user we joined the hands of IOT and Brain computer interface that is EEG so that an effective system can be implemented.

The proposed system in this paper continuously monitors the consciousness of the user if the brain signals reach the unconsciousness threshold then the help is contacted immediately or if a fall is detected then the voice service assistant interaction service is activated to distinguish whether the fall is true or false based on the response the help is contacted. As well as the monitored EEG values are stored in the private server to take extra care in the mere future.

2. RELATED WORKS

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) created by German inventor Wilhelm Hormann [10]. The medical home alert system was a dedicated phone line for the sick and elderly to contact someone for help. Hormann called the system “Hausnotruf,” which translates to “home alert” in English. This idea was shortly thereafter improved upon by California based company American International Telephone Company who created the “Emergency Dialer,” which added more portability via a pendent that is worn around the neck [10].

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 [11]. 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, the detection was non-specific to who was in the room and was in need of care in the case of a fall. A larger 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 2014, research primarily out of Nanjing University of Information Science & Technology in China produced an enhanced fall detection

Volume 1, Issue 5, Pages 131-136, June 2017

system for elderly people [12,13]. The system detects falls by employing an accelerometer and a cardio tachometer to record acceleration, tilt position and heart rate. 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, cardio tachometer, etc.) communicate either to a base station or fixed access point. Fixed access points are in place to relay signals to a base station. Base stations are used to communicate to the outside world for alerting caregivers, relatives and the ambulance in case of a dire fall. This fall detection system achieved a high accuracy of 97.5%, a sensitivity of 96.8% and a specificity of 98.1%. However, the limitation of the system appears to be in the heavy reliance on ZigBee communication. Although ZigBee is a very low power transmission protocol, it cannot transmit signals through standard construction walls. Therefore, multiple access points and base stations are needed to deploy a multiple room setup, which adds a great deal to the number of components within the system.

Most recently in 2016, collaboration between Beijing University of Technology and Beijing Engineering Research Centre 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 [13]. 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. Using a smartphone also allows the leverage of its GPS service. 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. Although the results from the Beijing research proved very well, the system largely relies on the smartphone as its centre of processing.

This is a potential issue as many older adults above 65 may not know how to operate a smartphone and as a result may not keep track of the phone. Further, allowing the phone to run out of battery power disables the entire system.

All of these systems mentioned have some level of integration of sensing and wireless technology. However, none offer a solution for an IoT enabled smart home fall to the central hub via HTTP request. The EEG TGAM module is used keep the track of consciousness when unconsciousness is detected the EEG module communicates over the HTTP request to the hub. Upon the requests above determined the hub launches the interaction module such as speaker, using text-to- speech environment, particularly with a voice interface and consciences monitoring. 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 and also brain computer interface such as EEG to continuously monitor the consciousness of the user.

3. PROPOSED IOT AND EEG SYSTEM

The main of this system is to obtain a fall and consciousness detection of the elderly people with integration of EEG and IOT. This system works primarily for a local Wi-Fi network. As many of the IOT systems are embedded with the hub where all the data processing, decision making and relay of messages take place. The central hub will act as intermediately between all components of the system.

The components of the system include

- Server/hub
- Fall detection device
- Google home
- Speaker
- Webcam
- EEG module
- Particle photon

Here in the EEG system the brain activity is observed. Generally the brain emits frequency of range 1-20Hz which are subdivided into alpha(8-15Hz), beta(16-31Hz), theta(4-7Hz), delta(<4Hz) [1]. Where the unconsciousness is confirmed when theta or delta waves are detected. The fig 1 depicts the view of different frequencies that can be observed by EEG. These signals can be amplified and can be made to use by using the TGAM module which is developed by the Neurosky labs.

A raspberry pi model B+ is being used as the central hub of the system which hosts the an HTTP server that communicates with all the wireless components that are used in the system. The peripheral components consists of Tiva C launch pad which is equipped with a WIFI expansion board and an accelerometer to act as the fall detection device, a wired speaker, an Google home for voice processing, a Logitech c920 webcam, a EEG TGAM module for monitoring the attention of the brain and a particle photon which is used to implement a private server. The Tiva C launch pad houses the fall detection algorithm for the system and communicates a detected broadcasting. Here the Google home is capable of voice reorganization and determining the action based on verbal input. The integration of the both EEG and IOT can reduce the false positive rate as a whole. Fig 2 depicts the system proposed.

Volume 1, Issue 5, Pages 131-136, June 2017

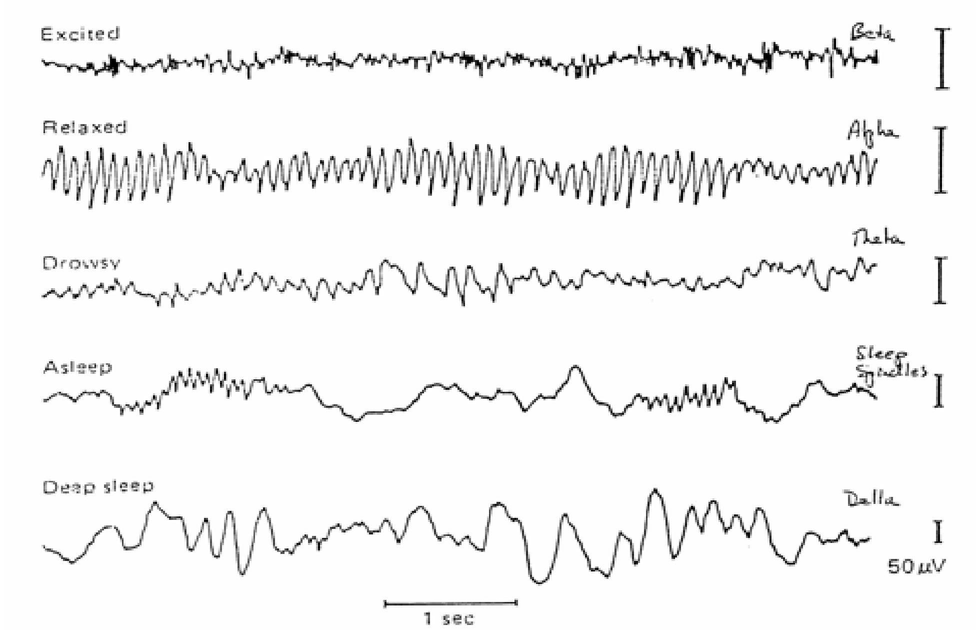


Fig.1 Different brain signals

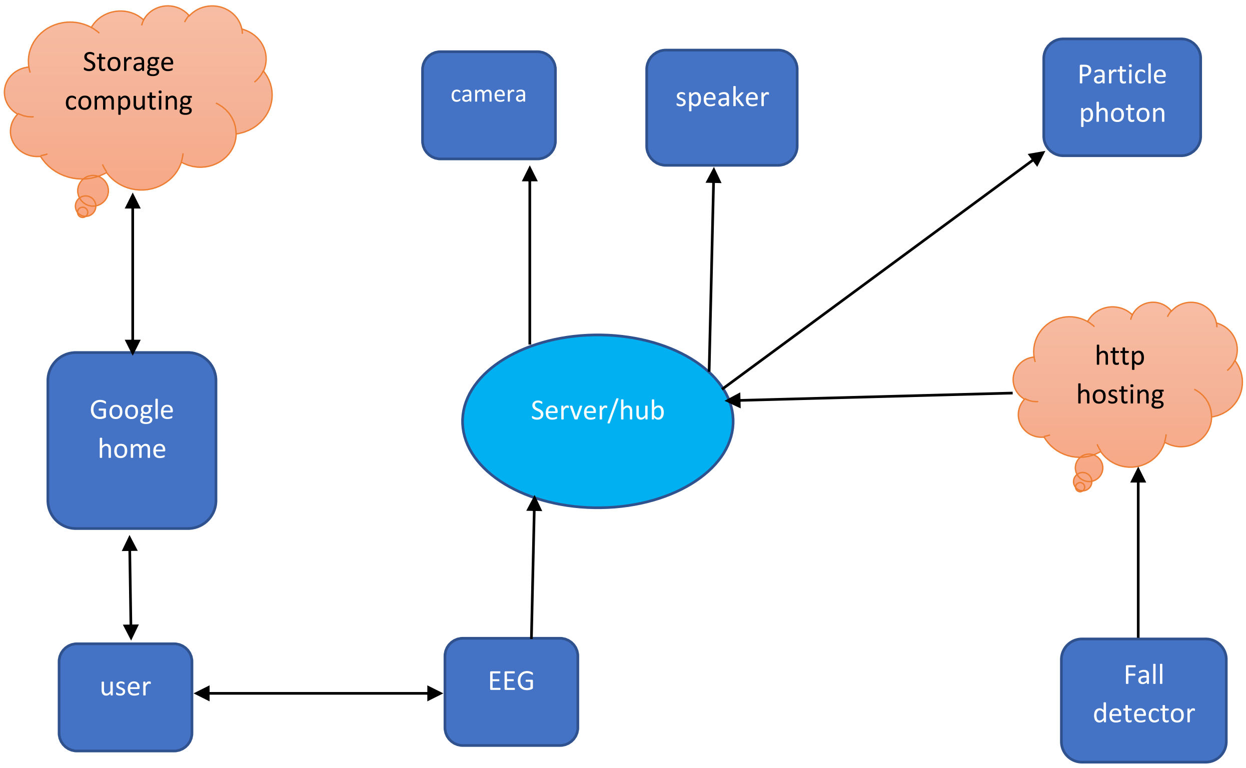


Fig.2 Proposed system

4. INTERACTION AND DETECTION MODULE

The main goal of our system is to develop an integrated IOT and EEG. Where we use the internet connected devices that are capable of detecting false and the consciousness of the user, thus a smart home is enabled to become a critical point of home aid assistance. Due to the statistics we discussed about the unconsciousness and fall related deaths and other health decline [4],[5] enabling

Asian Journal of Applied Science and Technology (AJAST)

Volume 1, Issue 5, Pages 131-136, June 2017

this type of system can be revolutionary in terms of longtivity of adults living at home independently.

A good push in developing such system we are using a common development board, the Tiva C launch pad, via an extension board with a accelerometer attached to perform acceleration measurements. These acceleration measurements sense the motion and speed of the device.

To determine the consciousness of the user we are using the TGAM module which was developed by the Neurosky labs [9], via an extension with using non-invasive electrodes which are in contact with the scalp we are able to determine the consciousness level of the user.

In our system the algorithm is based on threshold based interrupts [8]. The thresholds are set for both the EEG and the accelerometer readings. When the EEG values are greater than the threshold then a HTTP request is sent. When the accelerometer measurements are greater than the threshold then once again EEG threshold is checked for a false positive rate. The fig3 describes the fall detection algorithm. Each and every time the EEG value is measured, these values are stored in private server for further health management.

The hurdles we may encounter in this system are, how many true negatives are avoided by the system and the true positives detected. The first hurdle is directly proportional to the sensitivity. All these hurdles can be overcome by using 2 layer conformations. Where one layer obtained by using the voice interaction module and the other layer is embedded with EEG, which determines the consciousness of the user.

In our system when unconsciousness is detected then the primary caretaker is informed with an SMS describing the user is unconsciousness and immediate attention is required. The SMS also consists of a link to obtain a live coverage. If a reply is received from the caretaker then the message is played. In other case when there is no reply then the distress number is contacted.

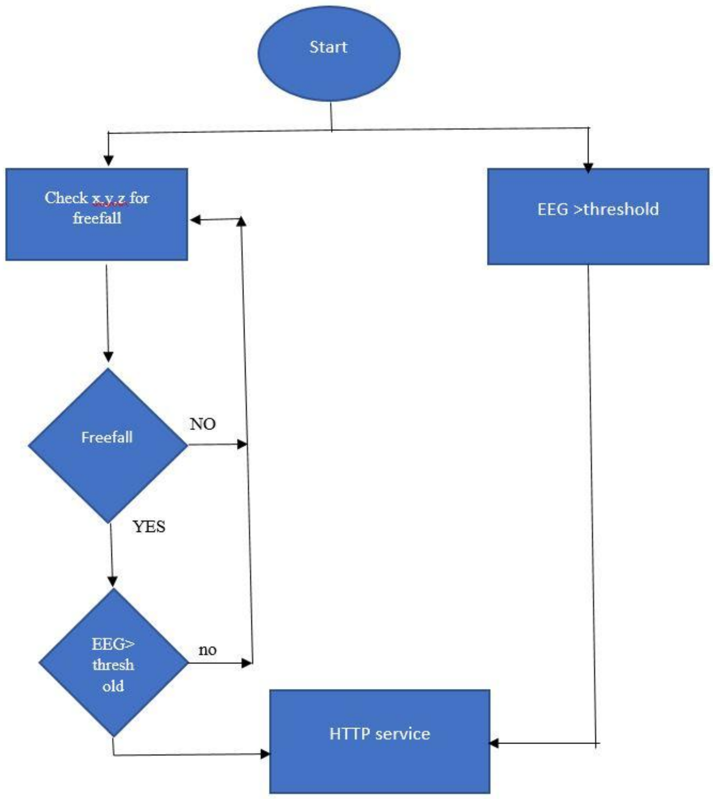
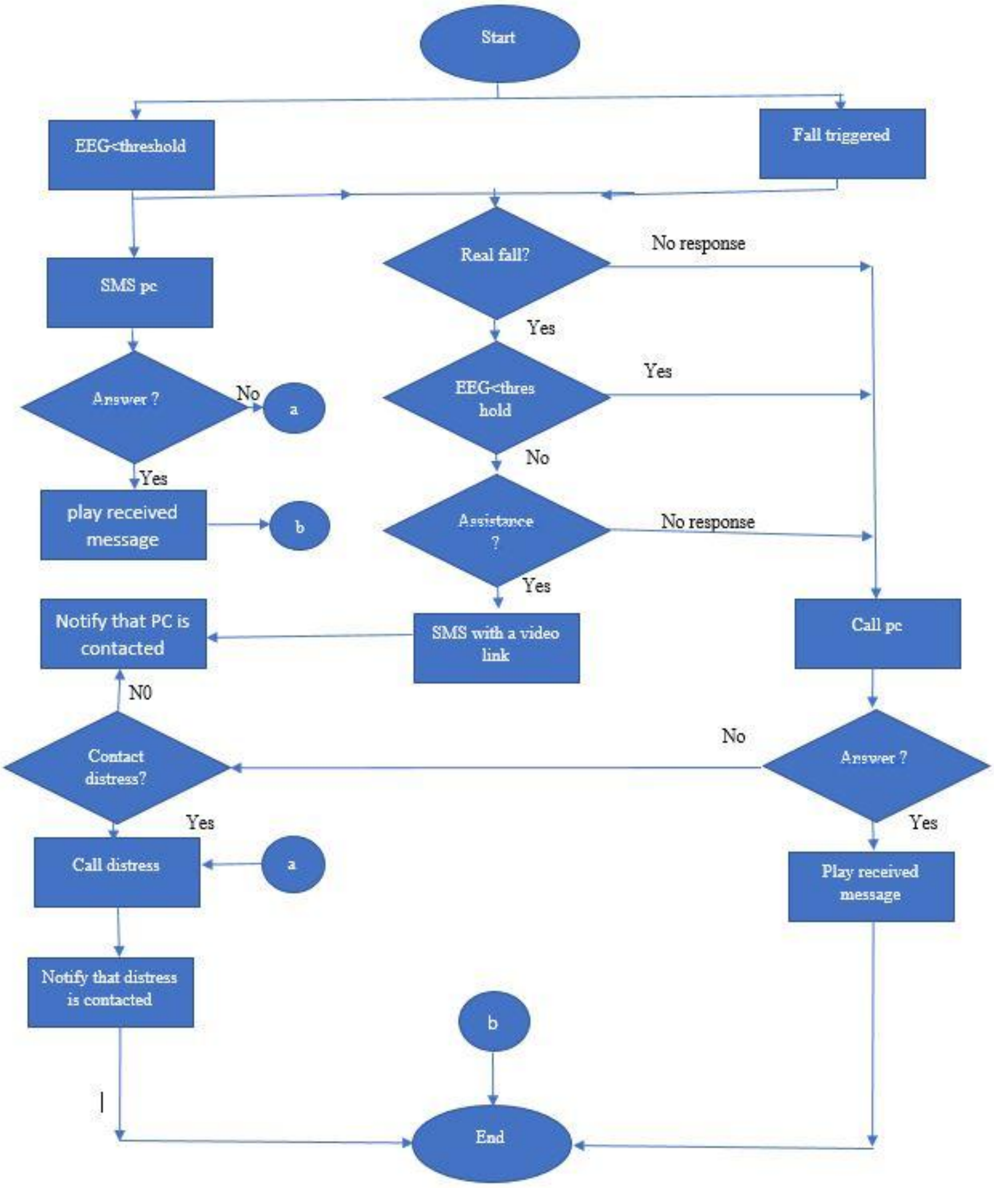


Fig.3 Fall detection algorithm

When a fall is detected it is confirmed using a voice assistant and different provisions are taken into account. As soon as the fall is detected the voice interaction module is launched, if there is no response from the user then a call is made to the caretaker about the fall intimating a confirmed fall and the user is informed that the caretaker is contacted. On receiving the response message from the caretaker the message is played to the user. If there is no answer then the distress number is contacted.

When the response from the user is received about the confirmation of the fall. Then the user is intimated whether any assistance is required after the confirmation.

Then primary caretaker is contacted about the fall. If assistance is not required then the caretaker is just contacted with a SMS about the fall and consciousness status of the user and the user is informed that primary care taker is contacted. The confirmation of fall leads to reduce unnecessary calls to local authorities regarding the incident, the distress number contacted if assistance is required when in case there is no response from the caretaker. The interaction model which is designed in this paper is designed in a manner so that complicated hardware/software setup does not bother the user. The fig4 depicts the flowchart of the proposed system.



PC = Personal caretaker

Fig.4 Flow chart of the working system

5. CONCLUSION

The proposed system in this module is still in development. The algorithm which we hope to expand upon more robust and reliable. The recent advances in technology widened the gap between young and old, much of it can be used to benefit all ages. The demand for home aid assistances is exponentially increasing. This is the perfect opportunity to integrate the developing technologies such as brain computer interface with IOT for improved performance of the system. The system main advantage is the use of Wi-Fi capability where the

Volume 1, Issue 5, Pages 131-136, June 2017

aid is provided where ever the user may be in the house with its long range capability. All this modules which are used in this propose system can be replaced with equivalent devices. This makes system more viable. Allowing the user to communicate is natural language is very ideal for older population, who may not be tech savvy.

REFERENCES

[1] J. d. R. Mill´an, F. Gal´an, D. Vanhooydonck, E. Lew, J. Philips, and M. Nuttin, "Asynchronous non-invasive brain-actuated control of an intelligent wheelchair," *in Proc. 31st Annual Int. Conf. IEEE Eng. Med. Biol. Soc.*, 2009, pp. 3361–3364.

[2] L. Tonin, T. Carlson, R. Leeb, and J. d. R. Mill´an, "Brain-controlled telepresence robot by motor-disabled people," *in Proc. Annual International Conference of the IEEE Engineering in Medicine and Biology Society EMBC 2011*, 2011, pp. 4227–4230.

[3] A survey of American neurologists about brain death: understanding the conceptual basis and diagnostic tests for brain death by *ARJ, NRA, JPD, ARD.*

[4] Korhonen, N., Kannus, P., Niemi, S., Palvanen, M., & Parkkari, J. (2013). *Fall-induced deaths among older adults: nationwide statistics in Finland between 1971 and 2009 and prediction for the future.* Injury, 44(6), 867-871.

[5] Chen, Leo. (2016). State of the Medical AlertIndustry.*http://www.consumersadvocate.org/medical-alerts/ state-of-the-industry.*

[6] Perolle, G., Fraisse, P., Mavros, M., & Etxeberria, I. (2006). Automatic fall detection and activity monitoring for elderly. *Proceedings of MEDETEL.*

[7] Centres for Disease Control and Prevention (CDC). (2011). Nonfatal bathroom injuries among persons aged 15 years–United States, 2008. *MMWR. Morbidity and mortality weekly report*, 60(22), 729.

[8] Jia, N. (2009, July). Detecting human falls with a 3-axis digital accelerometer. In Volume 43, Number 3, 2009 *A forum for the exchange of circuits, systems, and software for real-world signal processing (p. 3).*

[9] *Neurosky labs TGAM module reference. http://developer.neurosky.com/features/arduino/*

[10] Sixsmith, A., & Johnson, N. (2004). A smart sensor to detect the falls of the elderly. *IEEE Pervasive Computing*, 3(2), 42-47.

[11] Wang, J., Zhang, Z., Li, B., Lee, S., & Sherratt, R. S. (2014). An enhanced fall detection system for elderly person monitoring using consumer home networks. *IEEE transactions on consumer electronics*, 60(1), 23-29.

[12] He, J., Hu, C., & Wang, X. (2016). A smart device enabled system for autonomous fall detection and alert. *International Journal of Distributed Sensor Networks*, 2016, 1.

[13] Mohammed, M.A., Belal, A.K. and Ibrahim, D.A., 2016. Human Interaction with Mobile Devices on Social Networks by Young and Elderly People: Iraq a Case Study. *Indian Journal of Science and Technology*, 9(42).