

## Senior Citizen Independent Living

C. Suganthini<sup>1</sup>, K.Sandhya<sup>2</sup>, R.Elavarasi<sup>3</sup>

<sup>1</sup> Assistant Professor, <sup>2</sup> Students, Dept of Computer Science and Engineering

<sup>1,2,3</sup>Velammal Institute of Technology, Anna University, Chennai, India

<sup>1</sup>[chinna246@gmail.com](mailto:chinna246@gmail.com), <sup>2</sup>[k.sandhya0@gmail.com](mailto:k.sandhya0@gmail.com), <sup>3</sup>[rg.elavarasi@gmail.com](mailto:rg.elavarasi@gmail.com)

### ABSTRACT:

The people in old age or disabled people will have to stay at home, though their health exacerbates every day. The global population of people over the age of 65 is expected to more than double from 375 million in 1990 to 761 million in 2025. As the problem of aging and disability are converging, the smart home based health monitoring has become a key research area of ubiquitous and embedded computing system. The telehealth service has been widely implemented and used to help one (refers to elderly or individual with a disability) to live independently at home. The problems to be focused on, to improve the independence of old age people are their health, safety and reducing user assistance. These hurdles were the motivation factors for proposing the system. The main objective of this paper is to investigate techniques for using smart home technologies to monitor the day-to-day chores of old age people. The objectives are as follows: 1) identifying the problems faced by elderly people, 2) detecting difficulties in current data, and 3) designing a system which is senior citizen friendly. This paper is a solution that currently supports a set of functions that help home alone senior citizens to live independently. The idea of this project is to develop an intelligent and versatile home safety environment that could help the elderly and individual with disability live independently in their own home. The primary features of this project are Medicine Reminder and Scheduler, Programmable Remote, Health monitor, An enhanced fall detection system. This system offers the best features for improving the independent life of older population which includes providing a cost effective system for personal care and minimizing the financial burden upon the healthcare system.

**KEYWORDS:** Embedded systems, independent living, telehealthcare, Fall Detection System, Elderly Monitoring, Heart Rate Monitoring, SCIL system.

### I. INTRODUCTION:

In recent years, many types of consumer electronics devices have been developed for home network applications. consumer home network usually contains various types of electronic devices, e.g. sensors and actuators, so that home users can control them in an intelligent and automatic way to improve their quality of life [1]

Peripheral Interface Controller(PIC) is suitable for consumer home networks because various sensors can be deployed to collect home data information and compare them including self-organizing methods with relatively low power. Some typical applications include home automation, home activity detection (like fall detection), etc.[2].

Kinsella and Phillips found that the population of 65-and-over aged people in the developed countries will approach 20% of total population in the next 20 years and will obviously become a serious healthcare issue in the near future. In China alone, the population over the age of 60 years old is 133.9 Million[5].

Among the elderly, the fall events can be an unpredictable and dangerous event. Statistics show that one among three 65-and-over aged person falls every year [6]. Among these fall events, 55% occur at home and 23% occur near the home. In 2003, the global number of deaths caused by fall events was approximately 391,000 and

specifically 40% of the falls were from people over 70 years of age [7].

Thus, a well founded senior citizen based system required to be drafted and assessed for its functionality which will be commercially deployed for the world's senior citizens. The main factor to be considered is cost which relies on response time and delivering signals to the specified operator for immediate consideration [8]. Healthcare systems and resources are under the pressure of high-quality services associated with fast ageing population [1].

In this context, wireless sensor networks (WSNs) technology is being used in order to reduce the strain on the healthcare sector and at the same time improve the quality of life of elderly citizens. In this respect, there are several scenarios in which WSN-based solutions can help. Some examples are the detection of daily activity patterns, the identification of anomalous behaviours, the monitoring of physical condition on a long-term basis or after treatment or surgery, the location of people with orientation disorders, the detection of accidents such as falls, or even the reduction of people's isolation. This paper describes a WSN-based cyber-physical system intended for elderly citizen's support that enables continuous monitoring, alerting, and assistance. It allows caregivers to access and evaluate vital signs, answer emergency calls, localize persons, and detect conditions where a person needs assistance. The SCIL system can easily communicate with caregivers using wireless transmitter and receiver or cellular connection. The experience of team in the development of wireless sensor

network-based assisting systems, for a variety of scenarios is described in [2].

More recently, a request for the development of a system to help localize hospitalized patients was the trigger for the development of a modular hardware platform [3], which has been used as the basis of . It should be noted that the system presented in this paper is novel and has not been presented elsewhere. Nevertheless, some details on the used hardware platform [3] are included in this paper in order to allow the understanding of the architecture and implementation of the system. The aim of this paper is thus to provide an insight on the various issues involved in the development of the WSN-based solution such as requirements, functionality, hardware architecture, software architecture, implementation options and performance.

Consequently, the main contribution of the paper is the development, presentation and discussion of a completely new, operational cyber-physical system/application for healthcare support, comprising scalable monitoring, sensors, smart phones, and/or other wireless mobile devices, and its trial evaluation.

## II. BACKGROUND

The proposed enhanced fall detection method is based on three common changes which happen during accidental falls: impact magnitude, trunk angle, and after-event heart rate.

Hence, a triple-threshold for the previously fall related event in chronological order is proposed in this paper. A flowchart of the proposed method is illustrated in Fig. 6.

The embryonic guesstimate of the movement of senior citizen body can be calculated from the Signal Magnitude Vector (SMV) defined as:

$$SMV = \sqrt{Accx^2 + Accy^2 + Accz^2} \quad (1)$$

where Accx, Accy and Accz indicate x-axis, y-axis and z-axis respectively. Since it is difficult to forecast the direction of possible falls, it is unsuitable to use only one output of the axis. The advantage of using equ. (1) is that it is sensitive to all directions of falls. At the beginning, acceleration due to gravity, g, is in the z direction. The acceleration changes in correspondence with movement of the senior citizen body, Furthermore, vibration becomes significant when the fall happens. Acceleration threshold had been set to 1.9 g as in the literature [9].

A typical fall event ends with the person lying on the ground or leaning on walls, or furniture that will cause a significant change in truck angle. In this case, it is desirable to consider changes on the truck angle to detect whether the detected acceleration was due to a fall event. Trunk angle,  $\theta$ , can be defined as angle between the SMV and positive z-axis and can be calculated by inverse trigonometric function as equ. (2). The threshold for  $\theta$  has previously been given as: 0 to 60° classified as upright and 60 to 120° classified as a lying posture [19].

$$\Theta = \arccos \left( \frac{Accz}{SMV} \right) \quad (2)$$

The emergency case can then be classified into four levels:

1. Caregiver level: When the system is setup, it will check whether the SMV is over threshold. If not, it would continually check the heart rate. Once the heart rate gets over a preset value, the system will assume an emergency event has happened and would contact the caregivers to check out the elderly's condition.

2. Relatives level: Once the system convinced the acceleration is over threshold in the first decide loop, the system will then examine the value of heart rate. If it does not get higher than the preset threshold, then relatives will be contacted to request the relatives contact the elderly person's home.

3. Caregiver and relatives level: In addition, in case the acceleration and heart rate value both get higher than the preset thresholds, then system can contact the caregivers and relatives irrespective of the trunk angle as a distinct floating in heart rate coupled with high acceleration is a significant warning.

4. Ambulance level: If all three thresholds, SMV, heart rate, and trunk angle, are higher than normal, the system as assumed that an accidental fall has happened. The system will contact the emergency center immediately requiring an ambulance.

## III. SCIL SYSTEM

The Senior Citizen Independent Living (SCIL) system should support the following requirements:

- Keep track of heart beat rate and body temperature and alert in case of abnormality.
- Detect fall of the user and alert the assistance for the same.
- Remind about users medicine schedule and medicine stock.
- Provide elder friendly system.
- To produce system that tirelessly work 24X7 without the need for replacement.
- Light- weight system so that the user can carry it for long time.

The main end users of this framework are the old age people who are home alone and bed sick. This framework helps in improving the standard of life and independent living of senior citizens. Senior citizens can live independently, using a monitoring and alerting device called Senior citizen independent living system (SCIL) with them. People assisting senior citizens can update the medicine schedule and get alert messages in case the senior citizen falls off the bed or faces any danger. In chance of any abnormalities in body temperature and heart beat rate, the health specialist will be at home to check the senior citizen. The framework imparts functions like Medicine Reminder and Scheduler, Programmable Remote, Health monitor, an enhanced fall detection system. These are briefly presented below

### A. Medicine Reminder and Scheduler

Many times the aged people would forget to take medicines in time. Also sometimes forget to keep a stock of the medicines before they finish. So this device would be able to remind all these needs.

In addition to real-time monitoring, the system has the ability to store the gathered data in the system database (specific details concerning the data format are provided in the implementation section). This allows the future analysis of collected data, either for immediate notification to caregivers or self care of daily chores.

### B. PANIC BUTTON: LIFE SAVER

In certain health situations the aged people may not be able to speak or move. This device will have a Panic button to send data to near and dears on their Wireless Medium & start an audio alert with voice to inform the passersby to help them. The device is used for aged people to avoid the burglary at home alone time.

Alarm management enables one or more variables to be under observation. An alarm can be configured by defining a set of rules or, for some variables, by just selecting a checkbox. If an alarm condition occurs, caregivers are alerted via an SMS message sent to a pre-defined set of mobile phones, by notifying the condition in the system web interface.

The system allows the user to set up alarms in case of emergencies. In most cases, alarms are configured by specifying a set of rules for each parameter under observation.

Alarms on parameters such as movement index and heartbeat require the definition of personalized thresholds. Despite the existence of sophisticated techniques that dynamically adjust those thresholds according to each person's historic data, in our case the thresholds are defined with the help of the

patient's doctor. The system enables to define rules according to the period of the day to cope with the diversity of daily activities. This approach was, in fact, a request from the institution that commissioned, and has the advantages of lucidity, flexibility, as the collected data is under the complete control of the person's doctor.

To maintain the proper operation of the system, it is important to alert on EMD low battery condition and when the central management cannot communicate with an EMD for a predefined amount of time. Alarms can be activated for all these conditions by selecting the respective checkboxes. All the details concerning triggered alarms are saved in a database in case they are needed for future analysis.

### C. Health monitor

This paper attempts to provide better healthcare facilities to the senior citizens of the world. It demands developing a system to sense vital health parameters such as Heart rate and Temperature of the user and communicate the same to doctor without user's intervention in deferred real-time. This maintains a medical history of the user and thereby assists the doctor to take action if any unusual case is observed.

Using the SCIL system will record real time data regarding heartbeat, body temperature and room temperature. The data is made available to the users through LCD display. The EMD unit also sends internal state information, allowing the monitoring of the system operation.

In order to make the system easy to operate, auto configuration capabilities are supported, allowing the

automatic addition of a new caregiver's notification number to the system. The basic idea is that when the system is turned on it informs the system of its presence and characteristics. As a result, the system registers the device in the person's doctor database. Naturally, the system also provides an interface for easily monitoring end-users health.

### D. Programmable Remote

It might be a difficult task for the aged people to again and again getup to fetch remotes for different applications such as DVD, TV, House Lighting etc. So this device would be able to help them in this. The device has small menu using this feature the device would be able to control the appliances through wireless communication.

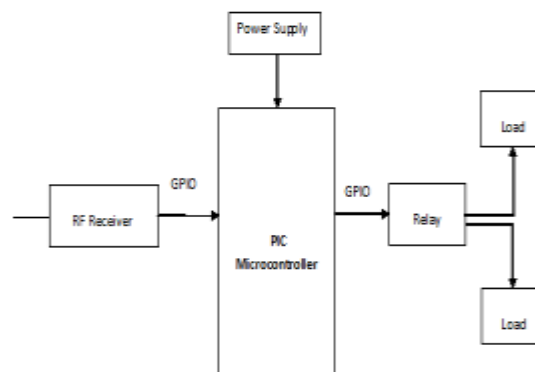


Fig 1: A Programmable Remote.

### E. An enhanced fall detection system

The system design consists of a tri-axial accelerometer sensor and a RF module that embedded in the handheld device. If a fall is suspected, a notification is raised to require the response of the caregiver. If the senior citizen is injured hardly and cannot respond in time, the system immediately sends an alarm message to his pre-specified guardian or Healthcare unit via wireless communication. With the variation in the angle of the body of the senior citizen, falls can be detected in the home environment. By using data collected from Tri Axis MEMS Accelerometer the alert message will be sent to the caregivers.

## IV. IMPLEMENTATION :

There are three modules in SCIL system which helps the senior citizen to live independently. The modules are as follows:

### A. Handheld Device:

The handheld device will be with the senior citizen. The handheld device contains the following sensors. PIC microcontroller, Keypad & Display, Audio Chip with Speaker, Tri Axis MEMS Accelerometer, Heart Rate Sensor, Temperature Sensor, MHz 434 RF transmitter. PIC microcontroller is used for processing and controlling the entire smart device. Keypad & Display is the Primary input & output to the user with rich interface to be easy to use. Audio Chip with Speaker, an APR9600 with Speaker which

helps to generate Speech and serve an emergency vocal alarm in case the user is unable to speak or move. The APR96 0 device offers true single-chip for recording voice with non-volatile storage and playback capability up to 60 seconds. The audio chip enforces both random and sequential access. The audio rate is selected by user and can be varied based on users convenience. AGC circuits, microphone amplifier, and integrated output amplifier simplify the architecture of device. It is mainly used in portable voice recorders and many other consumer and industrial applications.

Tri Axis MEMS Accelerometer is used to sense the fall movements. Heart Rate Sensor is used to sense the heartbeat of the person. Temperature Sensor used to sense the temperature of the person. 434 MHz RF transmitter used to transfer the status of the person to the nearest health care unit and controlling the household applications. The data collected by the temperature sensor and heart rate sensor is updated into database automatically. The person's doctor will report to the person in case of any abnormalities. Using RF Transmitter, a message is sent to the caregivers if the senior citizen falls off the bed.

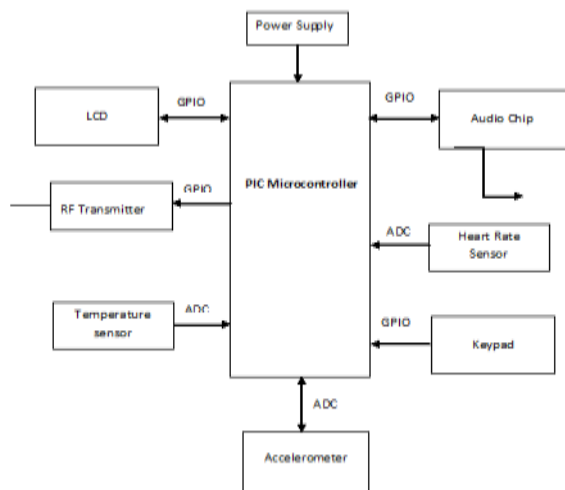


Fig 2: Handheld Device.

### Scanning a Matrix Keypad

There are many methods depending on how you connect your keypad with microcontroller. We make the columns as i/p and we drive the rows making them o/p. This method of scanning is used in SCIL system.

#### Acquisition Requirements for ADC:

To do an A/D Conversion, follow these steps:

1. Configure the A/D module:
  - At first, analog pins/voltage reference and digital I/O (ADCON1) is configured.
  - Select A/D input channel (ADCON0)
  - Select A/D conversion clock (ADCON0)
  - Turn on A/D module (ADCON0)
2. Configure A/D interrupt (if desired):
  - Clear ADIF bit

- Set ADIE bit
  - Set PEIE bit
  - Set GIE bit
3. Wait the required acquisition time.
  4. Start conversion:
    - Set GO/DONE bit (ADCON0)
  5. Wait for A/D conversion to complete by either:
    - Polling for the GO/DONE bit to be cleared (interrupts disabled); OR
    - Waiting for the A/D interrupt
  6. Read A/D Result register couple (ADRESH: ADRESL), clear bit ADIF if demands.
  7. For the next conversion, go to step 1 or step 2 as required. TAD is the definition term of the A/D conversion time bit.

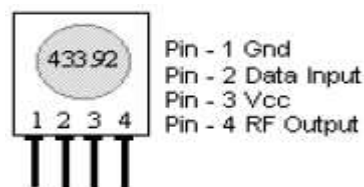
### B. Health care Unit:

In case of emergency scenarios of senior citizen, an automatic message is sent to the caregivers through RF transmitter from handheld device. The Health care unit receives the message using 434 MHz RF receiver. To bring in the notification of the caregiver a buzzer is used. The message can either be sent to Personal Computer (PC) or to mobile device. The PC or mobile device is connected o the controller through Universal Asynchronous Receiver and Transmitter (UART). UART - convert the transmitted bits between sequential & parallel form at each end of the link. Contains a shift register -fundamental method of conversion between serial & parallel forms. Used with RS-232 for embedded systems communications Low-cost chips exist to convert logic level signals to RS-232 level signals.

### C. Appliance Unit:

Relay with Load act as a switch for controlling Household applications as per preprogrammed instructions. The on and off conditions of the devices i.e. load is pre programmed. Battery Power/adapter used to power all the electronics in the system.

The TWS-434 transmitter accepts both digital and linear inputs, and can operate between 1.5 to 12 Volts-DC, which constructs a miniature hand-held RF transmitter. The size of TWS-434 is nearly the size of a standard postage stamp.



TWS-434 Pin Diagram

Fig. 3 illustrates the heart rate change before and after fall events. Participants under 30 years old have relatively small fluctuation when suffering a fall event. As to those over 30 years, the fluctuations are apparently high,



which are 18%, 21%, and 22% respectively. Therefore, if a fall event happened on an elderly person, the proposed heart rate (15) threshold will normally be triggered.

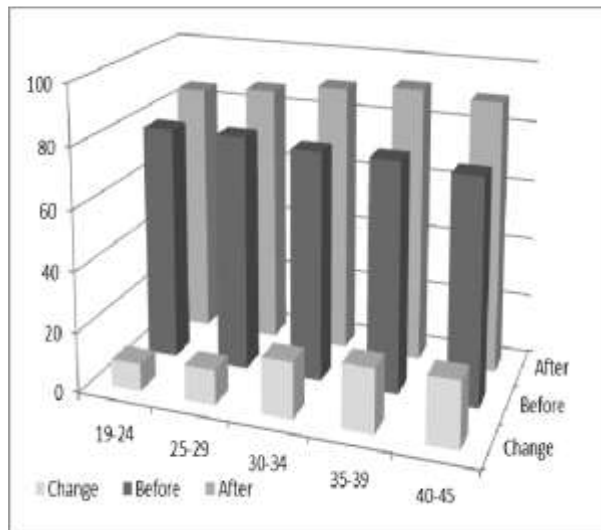


Fig. 3. Heart rate test results and changing ratio

advances in the field of embedded systems. The outdoor localization functionality is a main component of the system as it is essential to provide assistance in case any user requires it. The system displays the user location and information on its trajectory, using Google Maps.

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## V. CONCLUSION

The framework has been designed and developed. It consists of three devices which are the handheld device, monitoring unit and appliance unit. The handheld device and appliance unit will be used by senior citizen to detect the abnormalities in heart rate and body temperature along with controlling the electronic devices. The monitoring unit will be handled by caregivers to view the messages sent by the handheld device through RF transmitter and receiver. The future enhancements that can be done to the framework include extending the system into a wearable device at low cost. The life time of the microcontroller can be increased as the technology

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ANDRÉ RODRIGUES1, JORGE SÁ SILVA2 (Member,