WIRELESS SENSOR NETWORK FOR LONELY ELDERLY PEOPLE WELLNESS

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Abstract- Wireless sensor network based home monitoring system for elderly activity behavior involves functional assessment of daily activities. Here we estimate the wellbeing condition of elders based on usage of household appliances connected to various sensing units. This paper describes monitoring of elder person's activities and gives their wellness at any time in home with the use of wireless sensor network. The developed system defines new wellness functions to determine the status of elderly on performing essential daily activities. The developed system was tested at the homes of elderly person living alone and the results are encouraging in determining wellness of the elderly.

Keywords- Wellness, Home Monitoring, Elder Care, Activities of Daily Living, Wireless Sensor Network.

I. INTRODUCTION

Elderly people desire to lead an independent lifestyle, but at old age, people become prone to different accidents, so living alone has high risks and is recurrent.

A normal person performs daily activities at regular interval of time. This implies that the person is mentally and physically fit and leads a routine life. This tells us that the overall well-being of the person is at a certain standard. If there is decline or change in the regular activity, then the wellness of the person is not in the normal state. Nowadays, we don't have time to take care of elders often. So, take-care person are appointed to take of the wellness of elders. In present work, an intelligent home monitoring system based on ZIGBEE wireless sensors network has been designed and developed to monitor and evaluate the well-being of the elderly living alone in a home environment. Wellness of elderly can be evaluated for forecasting unsafe situations during monitoring of regular activities. By this developed system the person taking care the elder is benefited. The developed system is intelligent, robust and does not use any camera or vision sensors as it intrudes privacy. Based on a survey among elderly we find that it has a huge acceptability to be used at home due to non-use of camera or vision based sensors.

The developed system overcomes the problem of using camera. In this system we use non vision sensors (PIR sensors, pressure sensors, vibration sensor). Also we gather the activity data by having known patterns of PIR sensors.We place the various sensors in living room, bed room, kitchen, rest room, dining table, etc. and elder's activity is captured through these sensors. These data are then uploaded to net through ZIGBEE module. Now the care taker can LOGIN the website to monitor and evaluate the activity of elder alone.

A variety of systems for monitoring and functional assessment for elderly care have been proposed and developed in recent times. Monitoring activities of the person based on camera based sensors are reported in [1, 2] where the images of the person are taken and analyzed. In real practice applications such as surveillance and security make full use of camera based system but for home monitoring activities it lacks a huge acceptability among the elderly.

If many sensors can be installed for the monitor of all appliances used by the elderly in a newly constructed house and daily human behavior in an intelligent house is observed with motion detectors [3]. The number of sensor states is reduced by a vector quantization method; the state transition probability and the transition duration time distribution are used as the templates of daily human activity.

The validity of those templates is evaluated by detecting unusual human behavior in three sets of different human behavior data.

There are a number of projects available on wearable health devices [4, 5]. A novel method [6] to recognize user activities of daily living with accelerometers and RFID sensor. This method uses BLUETOOTH based wireless TRI-AXIAL accelerometers and i-Grabber which is a glove type RFID reader. The experiments show that this method can be applicable to a real environment with strong confidence.

The applications of ZIGBEE technology for disease monitoring, personal wellness and personal fitness monitoring [7] . It also presents the details based on three different scenarios: service provider scenario, In-home scenario and Consumer scenario.

Other than camera, we developed an automated behavior analysis system using infrared (IR) motion sensors to assist the independent living of the elderly

living alone. An IR motion -sensor-based activity monitoring system was installed in the houses of the elderly subjects to collect motion signals.

The support vector data description (SVDD) method was used to classify normal behavior patterns and to detect abnormal behavioral patterns. The results suggest that the monitoring system utilizing the IR motion sensors and abnormal-behavior-pattern detection with SVDD are effective methods for home healthcare of elderly people living alone.

Systems like remote human monitoring using wireless sensor networks [8, 9] were introduced in recent times. The purpose is to integrate the technologies of wireless sensor networks and public communication networks to construct a healthcare system for senior citizens at home without interfering their daily activities. This system provides an interconnection platform and a service management platform to support large scale data interconnections and real-time activity and health state reports to related persons(e. g. doctors or nurses, elder-self, elder's relatives)via all communication approaches, such as telephone call, SMS or Email etc.

Also, monitoring and modeling of elderly activities of daily living were incorporated [10, 11]. A sensor based smart system automatically trained to recognize the activities in their home.

[10] Presents and analyzes a method for recognizing the indoor everyday activities of individual. The proposed method is accurate ,very flexible and adaptable to a dynamic environment such as the "SMART HOME" and we believe that it deserves further attention.

Learning and recognizing human activities of daily living is very useful and essential to build home monitoring system. [11] describe a fuzzy logic system for recognizing activities in home environment using a set of sensors: physiological sensors, microphones, infrared sensors, debit sensors and state-change sensors. Motivated by the fact that fuzzy controllers have been successfully embedded within billions of dollars in commercial products, the characteristic of data providing from each sensor, the fusion of the different sensors has been performed by using fuzzy logic.

Activity recognition and wellness determination are two important functions to be done in a timely manner rather than offline. Hence, real –time processing of data is must for recognizing activity behavior and predicting abnormal situations of the elderly. To deal with issues such as monitoring the daily activities, performance tracking of normal behavior and well-being of elderly living alone a system which is non-invasive, flexible, low cost and safe to use is designed and developed.

An initial decline or change in regular daily activities can be identified by the home monitoring system and trigger messages to the appropriate care provider about the changes in the functional abilities of the elderly person.

II. SYSTEM DESCRIPTION

The system consists of a processing unit (LPC2148) and a communication module ZIGBEE for capturing the data from different sensors mounted in the respective rooms for collecting the data. The whole system can be categorized as processing, data capturing, activity capturing. Activity capturing consists of different sensors like PIR sensors, pressure sensor, vibration sensor. With respect to the co-ordinates of the activity capturing unit, the collected data are studied for patterns. The ultimate aim of the system is to identify the pattern of no activity, full activity, partial activity, intrude activity, progress activity, false activity. The system has various sensors being connected to the ZIGBEE module to collect the captured from sensors to be transmitted through the internet to the care taker. The major task of our work is to recognize the essential activities of daily living behavior of the elderly through sensor fusion by using minimal sensors at home. The ZIGBEE connected to the sensors at various places at our home communicate with a common ZIGBEE with the computer system.

III. IMPLEMENTATION

A. Data acquisition

The sensed data is captured and collected, then continuously transmitted to the user at the receiver. Captured data are continuously monitored and compared to have different patterns.

Issues like storage requirements for continuous flow of data streams and processing of data to generate patterns/abnormal events in real time were effectively dealt in the current system.

Event monitoring collection of data has enormous benefit over continuous flow collection of data in terms of the amount of data storage and processing of data in real-time applications like home monitoring.

B. Activity annotation

Activity annotation process will help the monitoring system to recognize the various behaviors of the elderly at different instant of time. This process is done based on the collection of sensor identity from the sensor fusion of various sensing units connected to different house-hold appliances.

Appropriate time slot size is considered for labeling the activity based the sensor id and time of the day. It provides sufficient information for doing data analysis.

Even if the sensors are active for multiple times during a particular time slot, activity labeling is done according to the definition specified in the system. We experimented with models that used time slot sizes of one hour, three hours, four hours duration and for a day Table.1.shows the various sensors placed at different places in home. If multiple times of sensor are active during a particular time slot the event is annotated with defined activity as breakfast, lunch, dinner, etc. Obviously an event like preparing breakfast, lunch or dinner

IV. PREPARE YOUR PAPER BEFORE STYLING

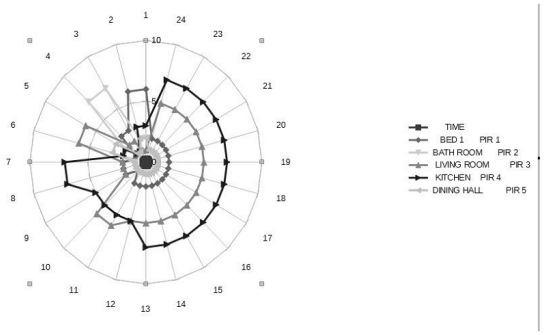

Fig.3.pressure sensor

C. Identify the Headings

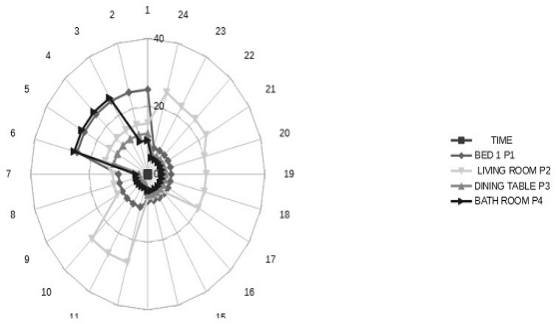

Fig.4. PIR sensor

D. Figures and Tables

Fig.1.vibration sensor

CONNECTED TO APPLIANCE	BED ROOM CORNER	BATH COR	LIVING ROOM CORNER	KITCHEN CORNER	DINING HALL CORNER	KITCHEN TABLE	LIVING ROOM TABLE	BED ROOM 1 ON BED	BED ROOM1 PILLOW	LIVING ROOM SOFA	DINING CHAIR	BATH ROOM TOILET
TYPE OF SENSOR	PIR MOTION DETECTION SENSOR (PIR)					VIBRATION SENSOR (V)			PRESSURE SENSOR(P)			
RUN DATA TIME	PIR 1	PIR 2	PIR 3	PIR 4	PIR 5	V1	V2	V3	P1	P2	P3	P4
06 00 00 AM	6	2	1	3	2	8	7	15	25	15	12	10
06 02 30 AM	6	2	1	3	2	8	7	15	25	15	12	10
06 05 00 AM	3	7	2	1	1	8	7	15	25	15	12	26
06 07 30 AM	3	7	2	1	1	8	7	15	25	15	12	26
06 10 00 AM	1	2	6	2	3	8	7	15	25	15	12	26
06 12 30 AM	1	2	6	2	3	8	7	15	25	15	12	26
06 15 30 AM	2	1	2	7	1	13	6	7	10	12	3	4
06 17 00 AM	2	1	2	7	1	13	6	7	10	12	3	4
06 20 30 AM	2	1	2	5	1	13	6	7	10	12	3	4
06 22 00 AM	1	1	6	5	1	13	19	7	10	27	3	4
06 45 30 AM	2	1	6	5	1	13	19	7	10	27	3	4
06 47 00 AM	2	1	5	5	1	13	19	7	10	27	3	4
06 50 30 AM	2	1	5	7	1	16	6	7	8	7	6	5
06 52 30 AM	2	1	5	7	1	16	6	7	8	7	6	5
06 57 30 AM	2	1	5	7	1	16	6	7	8	7	6	5
07 00 00 AM	2	1	5	7	1	16	6	7	8	7	6	5
06 25 30 AM	2	1	5	7	1	16	10	7	8	20	6	5
06 27 30 AM	2	1	5	7	1	16	10	7	8	20	6	5
06 30 30 AM	2	1	5	7	1	16	12	7	8	20	6	5
06 32 30 AM	2	1	5	7	1	16	10	7	8	20	6	5
06 35 00 AM	2	1	5	7	1	16	11	7	8	23	6	5
06 37 30 AM	2	1	5	7	1	16	12	7	8	23	6	5
06 40 30 AM	2	1	5	7	1	16	10	7	8	23	6	5
06 42 30 AM	2	1	5	7	1	16	10	7	8	25	6	5

Fig.2.complete final table

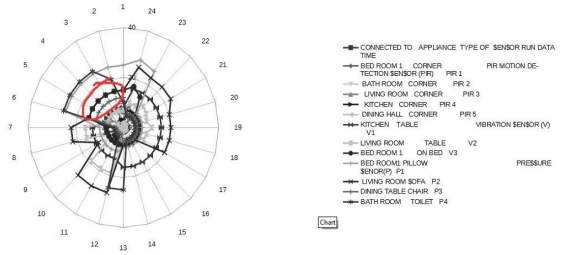

Fig.4. With error

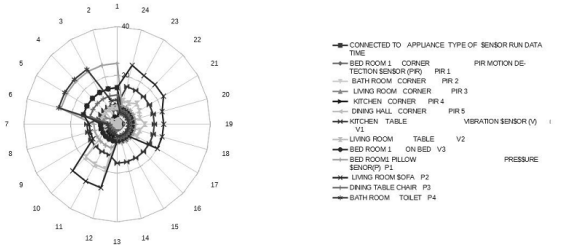

Fig.5. without error graph

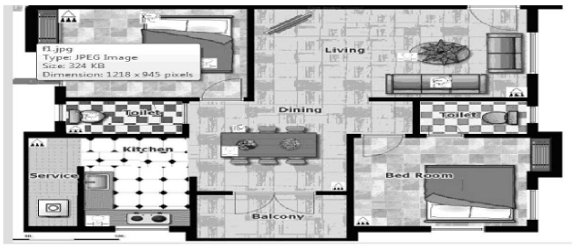

Fig.6. Full home layout

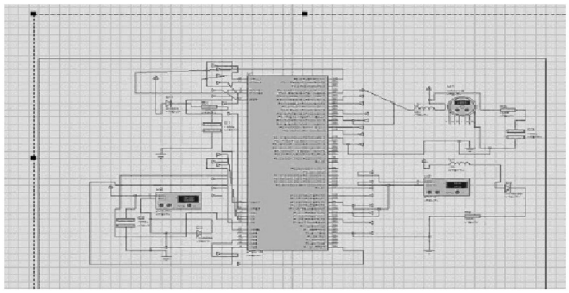

Fig.7. PROTEUS diagram

c. wellness determination of elderly

Fig.2.table denotes the various sensors like PIR sensor, Pressure sensor, vibration sensor activity. Obviously an event like preparing breakfast, lunch or dinner doesn't happen at same time everyday, but it is usually happened within a specified time interval. PIR sensors are placed inside the room in order to capture the movement of the elder. These PIR motion sensors are used to sense the movement inside the room by having a set of coding values like Threshold value. If the PIR sensed value is above a threshold value (say 5) then the motion value inside the room is captured. Else there is not movement detected. Similarly we have vibration and pressure sensor having connected to table, sofa, bed, pillow, etc. To capture the various activities of the elder.

The sensors at home captures the activity of the elder and transmit these data to the care provider through the internet.

From Fig.2.table, we observe the sensor values for a time interval of one hour. Activity annotation is validated by cross checking with the grand truth.

Fig.6. represents the respective graph for the elderly activity behavior for a time interval of 24hours (a day) with the help of the sensor values in Fig.2.table.

V. EXPERIMENTAL RESULTS AND DISCUSSION

The experimental setup is as follows: WSN consisting of pressure sensor, vibration sensor, pressure sensor, ZIGBEE module are installed in the home to monitor elderly behavior and assist the elderly living alone if there is any irregular behavior at a particular time.

Along with WSN a laptop installed with the developed intelligent software connected with ZIGBEE module acting as coordinator is associated with WSN to capture, collect and transmit the data to net to monitor the elderly behavior. We have designed the transmitter section with a PC connected to ZIGBEE module of the ARM board(LPC2148). PROTEUS software is used to enable the schematic design of ARM board. The 3 sensors like PIR, pressure sensor, vibration sensor, are connected to the LPC2148 IC and it is enabled to the captured data to the PC. Real time activity status of the elderly can be easily seen on the front-end of the system. This interface enables the care provider to know immediately the present activity status of the elderly(i. e) whenever a house-hold appliance connected by a sensing unit is in use then the interface will highlight the icon indicating the location of the elderly. System can also simultaneously store the sensor activity information and analyze the wellness indices. The graph shown in Fig.6. indicates the uses of different sensors at 4 different subject hones.

Real-time sensor activity status at the corresponding hour of the day is recorded simultaneously in the respective files of the computer for data processing. Continuous sensor activity status is recorded in respective files of the computer for effective data processing. Fig.2. shows the various activity sequences performed by the elderly during one day trial run. It can be inferred from the figure that the bed is very important for the life of the elderly person.

During one day trial run maximum capture of data active duration of the appliances is given in table. Fig.2.
Fig.2. gives the pictorial representation of activity occurrence-based on data obtained from a running system.

These observations gives us the experimental results that elder daily activity behavior is a routine work.

Also we found error in capturing the sensed data. The captured data implies at a time interval of 4 to 5 pm is found as error ed.

The activity of the elder is detected at 2 places in the process. The presence of elder is actually been in hall, but the text data shows that the elder activity is also present in bedroom.

This error is rectified by collecting the data from sensor properly. The PIR sensor position must be done properly as to avoid the error in transmitting data. If it is placed such that it has no obstacles being present in midway, not at the back of doors. The PIR sensor is placed at the corner of the room in wall as because the pattern of sensing units covers the whole room without any interference with pattern of other rooms.

Thus, the wellness of the elder is determined by acquiring the daily activity behavior with the help of this experimental setup.

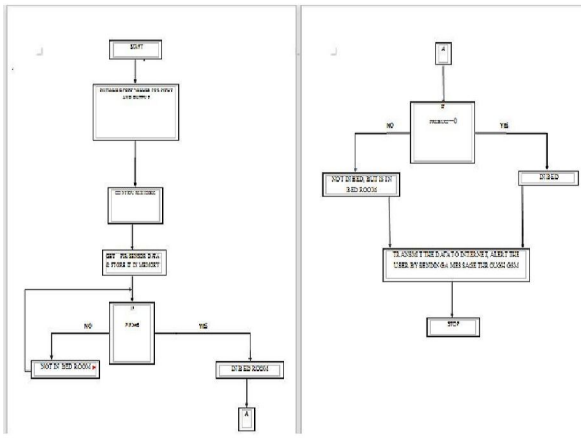

Fig.8.Flow chart

CONCLUSION

Wellness is a wide and multifaceted phrase. In this research Wellness is about Well-being of elderly in performing their daily activities effectively at their home. This will facilitate the care providers in assessing the performance of the elderly activities doing independently. The developed home monitoring system using WSN is low cost, robust, flexible and efficiently monitor and assess the elderly activities at home in real-time.

Real-time activity behavior recognition of elderly and determination of wellness function of the elderly using the activity of appliances was encouraging as the system was stable in executing the tasks for few weeks. If the system is executed for required number of months the optimal maximum utilization of the appliances used by the elderly will be derived. Also,

the efficiency of wellness functions to predict the abnormal behavior of the elderly in using the daily household appliances will also increase.

In the near future, the system will be augmented with the physiological parameter monitoring sub-system. This will supplement to get information about health parameters like body temperature, heart rate etc., so that elderly health perception and daily activity behavior recognition together can be assessed to determine the wellness of the elderly.

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