IoT based Context-Aware Smart Home Caregivers System for Monitoring Elderly People

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Abstract— In pervasive computing, the area of context-awareness is considered as an important technology and also plays a major role in the area of healthcare environments. In this paper we propose a system for elderly people signs monitoring and critical health conditions which is sends to the caregivers to identify the daily activities by using internet of things (IoT) this can be done in real-time. For example the elderly people who are not well in daily activities like current health status is “normal” or “critical” and the caregivers can give the early suggestions to the people who are in nearby. We have build a fuzzy logic from the beginning of data acquisition, processing of the data namely filtering, aggregating it into contextual information and reasoning to identify the elderly people health condition. Variety of connected devices can modify the remote characteristic, real-time monitoring, measuring and transmitting numerous body health parameters for making the decision and medication. The goal of this paper is to introduce the approach Context Aware Smart Home Caregivers System (CASHCS) to identify the normal and abnormal conditions of the people health status so that doctor can cure the problems in early stage without any complication. So this can be used to build a framework for context-aware healthcare applications.

Keywords - Context-aware; Internet of things; smart home caregivers system (SHCS); Fuzzy logic.

1. Introduction

The term Internet of Things was used by Kevin Ashton [1] in 1998. The IoT allows things and people to be linked Anytime, Anyplace, Anything and Anyone using any network and service with best way possible. Context aware systems have more enthusiastic much concentration from researchers in recent years. Numerous context-aware systems have been developed to illustrate usefulness of this technology. In many applications, the internet of things and context aware systems plays an important role in healthcare. Different data on the elder people and patient’s physical, psychological and behavioral state could be captured. data collection automation reduces the risk of human error. In this healthcare section, the caregivers can get the authentic information about the elder people monitoring and error rate of the negligible so this will improve the quality of the elder people monitoring and avoid the negative information [2, 3]. In order to prevent unnecessary costs with a doctors, an elder peoples can maintain a home monitoring system which allows people and doctors to keep up interact with and personal healthcare. In this paper, we present the comprehensive healthcare architecture of CASHCS with a focus on monitoring system based on the web. The CASHCS systems main components are Elder people home monitoring system: This is intended to help elderly people live independently at home. The system includes a web camera that can be used to monitor and intercommunicate between the elderly and the caregiver.

Clinical Monitoring System: This is reliable for the remote control of the BAN and the constantly monitoring of the elderly’s physiological signals through the internet. In addition data acquired from BAN in real time are recorded on the server for further examination and analysis. In this work, we propose a system for monitoring healthcare at home that offers multiple uses. It helps the elderly person to ar ray out the activities individually in their own lives and simultaneously facilitates the tracking of residents by family members and care providers.

According to figure 1, the systems have a common architecture and a set of properties. This is consisting of two levels like services and applications which is used to collect and analyze the sensory data from the elder people. The general healthcare architecture is represented in Fig 1.

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The system has diverse kind of sensors to monitoring the elderly people and it will empower the fully and securely control the elderly patient care. In this approach each section is processed and analyzed with particular techniques, based on the fuzzy rule techniques a data can be directed. The aim of this work is to take advantage of the above-mentioned IoT capabilities and form an intelligent system with real-time monitoring and interaction for the personalized healthcare of the elderly at home. The proposed model not only provides elderly care with the medical care, as well as takes care of their delights and offers opportunities.

This is formed as follows in section 2 explains about the related work about the healthcare systems and its history. In section 3, proposed the system architecture. Healthcare methods like fuzzy, rule based models and Context aware smart home care giver system can be explained in section 4. The research will get finish with concluding remarks in section 5.

2. Related Works

In this paper patient can monitor through the sensor in the basis of fuzzy logic technique and handled by the algorithm to make decisions about the elder people living alone in home. If we have to set the alarm level as an output if so sends a collected data to server [4]. Research in mobile health applications has been increasingly viewed in past few years as a fuzzy logic system for home elderly people. The key success of systems is context-aware mobile environments and it will completely support the people with medical conditions in their daily lives. In this paper the author uses three various sensors to create a system for in-home elderly people monitoring those who are living in alone in their home. The sensors are microphones, infrared and physiological sensors. EMUTEM architecture is presented for monitoring and the fuzzy logic decision module strengthens the secure detection of misery events and the location of older people. This approach makes it easier to combine data with other sensors [5].

In this paper the proposed vital sign monitoring system for mHealth is intended to help clinicians by illustrating the trace of critical physiological parameters, generating early warnings / cautions and signifying any important changes in data. In the monitoring and delivery of healthcare interference, mobile healthcare (mhealth) applications are becoming progressively important and patient monitoring and diagnostic systems based on mHealth virtually anywhere like home, hospital and outdoor [6]. In this paper, author evaluates the number of older people’s who are affected by chronic illnesses, disabilities and functional limitations. Moreover, a large number of elderly people need ordinary support for their daily lives and healthcare, most of which are encouraged by family, friends or caregivers [7]. Healthcare organization can monitor the elderly overall health in real-time and provide observation and support from remote facilities [8]. The focus in the proposed framework is on the application of healthcare.

Since IoT-enabled patients can be approached via the internet and other machines, a patient’s health condition can be monitored without interruption, enabling the immediate detection of critical diseases in order to take appropriate action either locally or remote [9]. The CARA e-Healthcare system presented to provides a solution from patients at risk when expert is not present. The system can measure physiological signals constantly and process the data locally at a base station in real-time to a remote location. All the communications are carried out using web technologies. The CARA application is the important technology for remote monitoring system of caregivers [10]. In this paper is a smart city-oriented infrastructure was presented to capture and manage data relating to the behavior of elderly people and paradigms of the Internet of Things and linked to open data to provide a scalable and flexible system capable of simultaneously providing services to multiple cities [12]. In this paper the author proposed a remote monitoring system based on fog for chronic neurological diseases. Then the system can collects and processes motion data on the edge gateways [13]. This paper presents the activity monitoring system which includes activity recognition model and
sensor. By comparing their performance, the authors demonstrate the potential of generative and discriminative models for activity recognition and Hidden Markov Model (HMM) also represented [14]. This paper describes ACTiVAGE (ACTIVE Ageing sErvices), a conceptual framework for the development of personalized services for the elderly who use big data analytics for context awareness in smart environments [15].

3. Proposed Architecture

![Fig 2. General Architecture of context-aware health monitoring](image)

The system architecture includes four types of layers and middleware namely data representation, analysis layer, context-awareness layer and service layer which is represented in Fig 2. The first layer is data representation it can get the healthcare data from sensors.

The second layer is analysis layer here context modeling is mentioned which includes data filtering, aggregating the data to change it as a context data and rule based modeling is used for elder people monitoring, based on the rules the data can be retrieved from the knowledgebase and then from the modeling the data is preprocessed.

Context aware reasoning can be used the data from knowledgebase for feature extraction. Context-awareness services that can be dynamically configured using the identity, location, time and understanding of day-to-day user activities to recommend customized user requirements.

In this part context and elder people activity is represented that is Daily Activity Living (DAL). The fourth layer is service layer, used to monitor the elder people in real-time and health condition monitoring, to identify the normal and abnormal conditions of the people health status. Here middleware act as a connection between context database and smart home caregiver system.

4. Fuzzy Inference System

Fuzzy rules use diverse parameter membership categories to track and determine the nature of the events. Therefore, instead of threshold parameters, we use fuzzy rules in our system. The concept of the auxiliary data set for fuzzy logic is shown in Fig 3. Following are the three stages utilized for the fuzzification.

Step 1: A range of the actual value obtained from the sensor, which forms a set of crisp values, i.e. a crisp set value \( x \in X \) (where \( x \) is set of all values that the sensor can read). Now, membership functions are created using knowledge-based experts. It can converts crisp raw data into fuzzy linguistic variables.

Step 2: Fuzzy inference engine is designed so that these fuzzified inputs can be inferred from the earlier stage using the IF premise, thus consulting the rule base and producing fuzzy output variables. The premise includes of fuzzy input variables which are connected by logical functions (AND, OR, NOT) and the consequent comprises of fuzzy output variable.

Step 3: In the end, these fuzzy output variables are converted by defuzzifies into a crisp set of values, to generate desired events and actions, these crisp values can be used. defuzzification is carried out using the centroid method in practice.
4.1 Automation sensors in home

We have to solve the significant problem of elder people’s privacy by using in-home healthcare monitoring. Movement’s related data can be collected twice per second and stored in appropriate file with the event time. Each movement can be noted along with the time and data are shown in the results of the automatic processing. A set of wireless ambient sensors is added to this subsystem, designed to monitor the patient's environment and environment by tele monitoring. It includes state - of - the - art sensors for the detection of active devices, contact sensors for the opening / closing of doors and windows, temperature sensors, fire sensors, flood sensors and light sensors.

Table 1 Elder people Daily activities and body motion

<table>
<thead>
<tr>
<th>Elder people Activities</th>
<th>Elder people body motion</th>
</tr>
</thead>
<tbody>
<tr>
<td>enter home,</td>
<td>Walking,</td>
</tr>
<tr>
<td>Getting up, toilet,</td>
<td>standing,</td>
</tr>
<tr>
<td>watching TV,</td>
<td>laying,</td>
</tr>
<tr>
<td>Cleaning, bathing,</td>
<td>sitting,</td>
</tr>
<tr>
<td>cooking, planting,</td>
<td>exercising</td>
</tr>
<tr>
<td>hearing music,</td>
<td></td>
</tr>
</tbody>
</table>

5. Context Aware Smart Home Caregivers Systems (CASHCS)

For older people health care monitoring Smart Home Caregivers System can be used and for vital sign monitoring matlab simulation was used. The input variable includes, body temperature, ECG, blood oxygen, heart rate and respiration rate. Linguistic variables such as low, medium, high and very high symptoms are assigned for membership values. The older people data is stored in a database and information is obtained from the knowledge base by matching the symptoms and their harshness against the original part of the fuzzy rules. By the use defuzzification the fuzzy values can be defuzzified and finally the designed systems appear at a crisp decision for the diagnosis disease.

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Table 2 Input for the Fuzzy sets

<table>
<thead>
<tr>
<th>Membership Function</th>
<th>Structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ring tone</td>
<td>alarm, telephone ring, bell door, alarm clock</td>
</tr>
<tr>
<td>Speech</td>
<td>expression s and key words</td>
</tr>
<tr>
<td>Door sounds</td>
<td>key ring, door clapping, door knob</td>
</tr>
<tr>
<td>Object sound</td>
<td>Table, step foot, table, tear-turn paper</td>
</tr>
<tr>
<td>Human Sound</td>
<td>Laugh, cough, snoring, yawn, sneezing, cry, scream</td>
</tr>
</tbody>
</table>

Here we are using three fuzzy set input levels includes low, high, medium. Activity fuzzy sets are four levels like static, disturbance, normal and rest. Membership function of position is represented in two levels like sitting down and lying.

Health condition of fuzzy set is two includes well and not well and the sensor device either in turned on or turned off. The member function can be defined and associate with the activity is adapted to each motored elderly person. In our CASHCS can use the inputs are activity, position and health conditions. Membership function characterize the sensor as low, medium, high the fuzzy logic outputs can be obtained by some elderly people activities which is selected from table 1. they are getting up (GP), Sleeping (S), Toileting (T), Cleaning(C), Bathing (B), Resting (R), Watching TV (WTV), Standing up (SU), Sitting Down (SD), Washing(W), Talking in Mobile (TM), then the fuzzy inputs are represented in table 2.

According to the activities of the above membership function can be occur and secondly degree of similarity can be obtained [11]. Common performance of the older people activities can be recognized by the rules and the ability to
model the special cases. For instance of fuzzy alarm detection rule is

Rule 1: If (Elder person is Ring tone) and (Activity is Motion) and (sensor is high) and (getting up is high) and (walking is Normal) and (sensor device is turned on) Then (Elder person is attending the call)

Rule 2: If (Elder person is Sound) and (Activity is Motion) and (sensor is high) and (laying is high) and (Standing is high) and (sensor system is turned on) Then (Elder Person is in Cough).

Patient details can be monitored through the base station by the smart home care system and monitored by the doctors mentioned here as a medical monitor. In the event of an emergency, the medical monitor is used to obtain patient health information. From the Fig 4

![Diagram of CASHCS](image)

**Fig 4. Context Aware Smart Home Caregivers System (CASHCS)**

The sensor can collect context data for representation from the context database in order to predict the results we use context reasoning. Rule based modeling can create the rule for elder person about their daily live home monitoring and in case of any emergency situations in daily live the person can sent to the medical care and normal and abnormal conditions are saved in the database. For example, take a respiratory rate attribute, oxygen leakage, normal and abnormal breathing of elder person, the caregiver can collect all data via the base station and medical monitor too. It will be stored in the medical database for future reference from the medical monitoring then here middleware can acts as a bond between the context database and the context aware smart home caregiver system

6. Conclusion

In this paper, our research is focused on Context Aware Smart Home Caregivers System (CASHCS) based on IoT. Context awareness creates contexts for defined problems and translates to caregivers. In this paper we proposed a system for elderly people signs monitoring and critical health conditions which is sends to the caregivers to identify the daily activities by using internet of things (IoT) this can be done in real-time. We have build a fuzzy logic from the beginning of data acquisition, processing of the data namely filtering, aggregating it into contextual information and reasoning to identify the elderly people health condition. Variety of connected devices can modify the remote characteristic, real-time monitoring, measuring and transmitting numerous body health parameters for making the decision and medication. The goal of this paper is to introduce the approach Context Aware Smart Home Caregivers System (CASHCS) to identify the normal and abnormal conditions of the people health status so that doctor can cure the problems in early stage without any complication. This can be used to build a framework for context-aware healthcare applications. CASHCS is used to collects elder people health data and daily activities in real-time and normal and abnormal conditions of the person through the MQ6 sensor. The users can obtain the information either by wire or remotely via the REST web services.

References


