International Journal of Latest Engineering Research and Applications (IJLERA) ISSN: 2455-7137

Volume – 02, Issue – 01, January – 2017, PP – 44-49

AN INTELLIGENT SENSING NETWORK FOR HEALTH CARE

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Abstract: In this paper we represent a design and development of Intelligent Sensing Network (ISN) tools using Internet Of Things(IOT) for observing biological health parameters such as heart sound, body temperature and Pulmonary functions has been established. The structure consists of Sensing network together with IOT technology forms an 'Intelligent Sensing Network" (ISN) tools to keep an eye on human health parameters. Intelligent Sensing Network is mostly based on ambient intelligence conditions in which the sensor in the surroundings captures and records the activities and behaviour patterns in a database. Any changes in patterns beyond normal condition are captured as potential signs of changing health. This system can be used for preventing, notifying, and improving wellness and health state of human. ISN tools such as health management tools and health reminders allow the human to take care of their heath conditions. In this paper, we are summarizing the IOT technologies, state of the art ISN tools and techniques. In this paper, positive case studies and installed systems will also be explored.

Index terms: ISN tools, IOT, Pulse, Predictive Assessments, Respiration, and Wireless N/W.

I. INTRODUCTION

Nowadays, Human healthcare has become an essential research topic. Intelligent Sensing Network(ISN) systems provide the facility to automatically gather information about a human's everyday activities without imposing any kind of restrictions on their day to day routines. Arthritis, Asthma, Cancer, Diabetes and Viral diseases such as hepatitis C and HIV/AIDS are the commonly seen chronic diseases which affect the people and which gives the symptoms like increase in body temperature, blood pressure and heart beat etc. Modern developments and innovations in medicine field allow people to live long, compared to the earlier generations. Aging brings many problems to adults due to their intellectual weakening, chronic age based Problems, and confines in vision, hearing and physical progress. Many aged people die unnecessarily in their sleep because of life-threatening diseases like heart attacks and unfavorable respiratory events, such as OSA (obstructive sleep apnea syndrome). This increases the risk of death in people in large number in and around the country. Therefore, it is necessary to continuously monitor the body temperature, heart rate, respiration is specifically important for people with severe diseases and also for aged people. The architecture of Human Health Monitoring System (HHMS) with ISN tools is shown in the fig 1.

Human Health Monitoring systems measure all the above constraints and send all the related details to the related persons like caretaker, nurses, physician, and healthcare providers and also to the patients for reference, to monitor and to take actions. The system includes the role of patients, physicians, nurses, and healthcare providers for effective results in the healthcare.

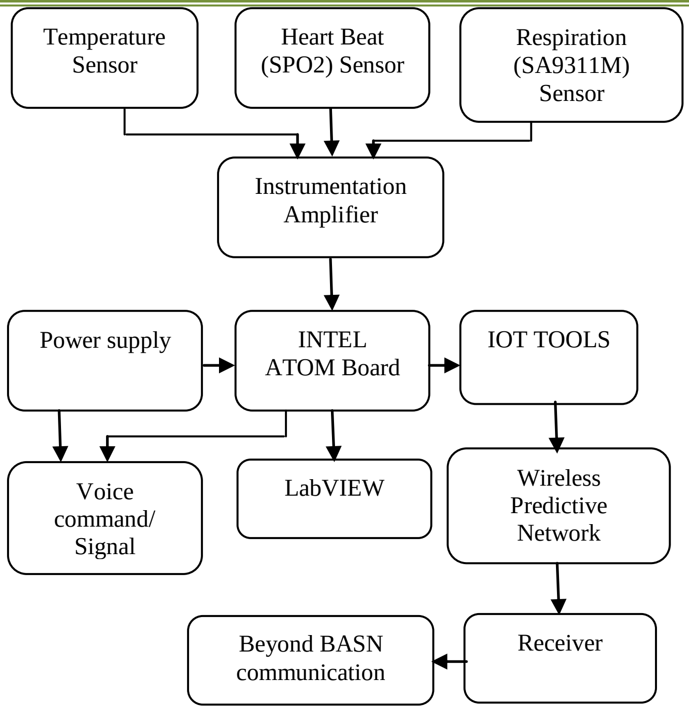

FIG 1: ISN system Architecture of Human Health Monitoring System

The system consists of a pulse oximeter, respiration measurement sensor and a temperature sensor. SPO2 sensor is a recognized pulse oximeter, used to measure the blood oxygen level and also the pulse rate from human body. It is also be used to detect hypoxemia, oxygen deficiency in arterial blood directly. The progression of respiration detection sensor is similar to the operation of strain gauge but the technology does not use a real strain gauge for respiration measurement. The respiration sensor (SA931A) is a wearable sensor which is worn on the chest or on abdominal part of the human body. The SA931A sensor measures the respiration by the upward and downward movement of the chest or abdominal part.

The temperature sensor used in this system is LM35 series are based on accuracy integrated-circuit sensors, which produce an output voltage linearly proportional to the °C temperature. As a result LM35 has a benefit over linear temperature sensors which are calibrated in ° K, by means of the user is need not to subtract a large constant value from the o/p to acquire suitable Centigrade scaling. The LM35 is valued to function over a value of −55°C to +150°C temperature range.

This system is also equipped with voice command and response system which respond over users command and also for the data signal from the prognostic health network to take necessary prediction.

II. INTELLIGENT SENSING NETWORK

Supported living tools are related to ambient intelligence are called Intelligent Sensing living (ISN) technologies. ISN can be used for medicinal, preventing and refining wellness and healthiness of aged adults. ISN tools such as medicine reminders and medicine management permit the adults to take care and control of their heath conditions. ISN technologies can also provide more safety for the elderly, using mobile emergency response systems, fall detection systems, and video surveillance systems. Further ISN tools provide help with day-to-day actions, based on intensive care activities of habitual living (AHL) and issuing reminders, as well as helping with mobility and automation.

TOOLS AND TECHNOLOGIES

Recent advancements in several technological areas have helped the vision of ISN to become a reality. These tools consist of assistive robotics, smart home environment, smart office, mobile and wearable sensors. Most smart homes utilize such knowledge for automation and providing more comfort for the residents, as well as for assessing the cognitive and physical health of the residents.

A. INTARNET BASED ELDER CARE HEALTH RECORDS

Sensor networks, telehealth and internet based HHRs have emerged in the last decade as possible solutions to older adult health monitoring. Elderly monitoring using sensor networks has traditionally evolved from home security solutions and it mostly involves motion detectors. The proposed IEHHR system interconnects the existing wireless sensor network (WSN) with a telehealth network (THN) and a personalized electronic health record (EHR).

An overview of the architecture of the proposed IEHHR system is shown in Fig. 2

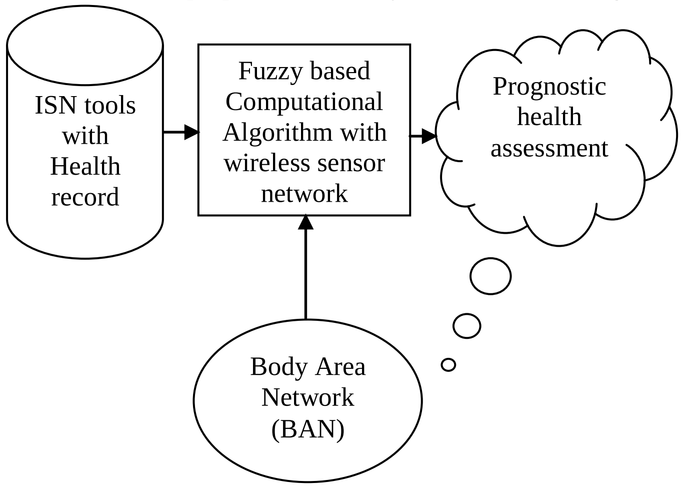

Fig 2: Overview of the IEHHR system

The WSN captures external behavioral information about the monitored person and contains various wireless, non-wearable, sensors. As part of the WSN, each resident included in the sensor network study has a data logger in his/her apartment that collects data from various wireless sensors. The data logger date-time stamps the data, and sends it to a database on a secure server via a wired network connection. The EHR and THN health data are used for providing contextual information and ground truth for algorithm development. Information about current diagnoses, medication and hospitalizations is factored into the algorithm development process.

Our computational approach is based on the assumption that early illness will translate into changes in behavior, such as abnormal sleep or room motion patterns that can be captured by the environmental sensors. An integrated electronic HHR system allows the development of predictive health assessment algorithm such as fall risk assessment, high blood pressure detection or mood assessment. These algorithms integrate the values provided by various sensors, telehealth devices and medical conditions to alert the nursing personal when a dangerous level of a certain condition is reached.

SENSORS AND WEARABLES IN DIGITAL HEALTH

As technology matures, and wearable's and sensors are further miniaturized, more novel applications for healthcare will be developed.

We will increasingly witness integration of medical sensors into consumer electronics that will enable home-based medical data gathering and support remote care and preventive digital health programs.

Most of the present-day applications of sensors and wearable's can be classified into the following five categories:

- Health and Wellness Monitoring
- Safety Monitoring
- Treatment Efficiency Assessment
- Early Detection of Disorders

B. RESPIRATION DETECTION

A lot of respiration detection systems has been proposed and established. Moody et al. proposed a signal handling system to acquire respiratory waveforms as of ordinary ECG sensors and electrodes. The ECG derived respiration (EDR) system is based on 1) tiny differences of the ECG morphology in the breathing cycle, differences that arise because of variation in movement of the heart position and lung dimensions and 2) movement relative to the electrodes.

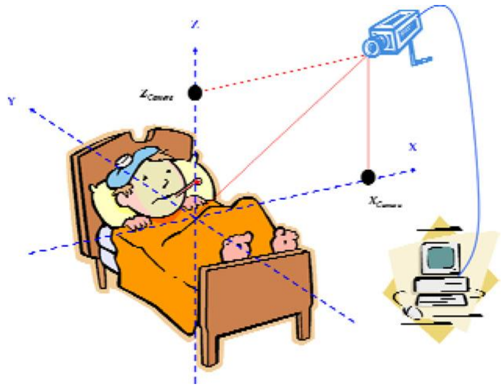

Fig 4: Position of monitoring camera with respect to the bed

The respiration frequency can be measured from the EDR signal. A method that uses Photo Plethysmo Graph (PPG) signals. But PPG is a contact device which is not comfort for the patients and elders. So we used simple wearable sensor based respiration measurement system.

III. ISN ALGORITHMS

ISN tools are supported by various algorithms and computational techniques such as motion recognition, context modeling, location identification, preparation, and difference detection.

- Sensor based motion recognition
- Vision based motion recognition

A. SENSOR BASED MOTION RECOGNITION

MOTION RECOGNITION

One of the most significant mechanisms in ISN structures is "human motion recognition" component or HMR. The Motion recognition mechanisms having considerably a number of challenges in implementation, design and evaluation of activity system. A HMR module is responsible for identifying the human activity outlines through a number of low-level sensor data. We can get different types of data produced from the different sensors. Such as, data from the wearable sensors are in the form of time series, cameras and thermo graphic devices records visual data such as images/ videos. Numerical or categorical data from ambient sensors such as motion sensors,

MOBILE MOTION RECOGNITION

Data from most mobile sensors such as accelerometer and gyroscope are in the form of time series. A time series is a sequence of data points typically measured at regular periods. Most simple actions such as walking, jogging, and running can be represented in the form of distinct, periodic time-series patterns. Recognizing such activities can be useful in many applications, for example, for detecting physical activity level, for promoting health and fitness, and for monitoring hazardous events such as falling.

In general, processing time-series data from sensors such as accelerometer and gyroscope is a multistage process, as shown in Fig. 3 First, sensor data are recorded at a specific frequency,

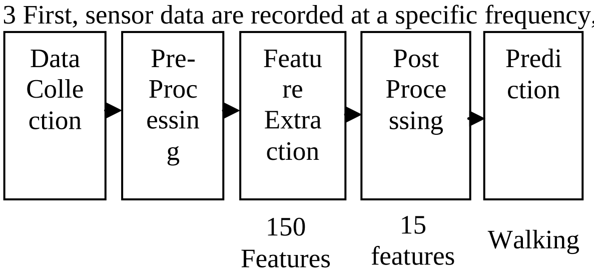

Fig 3: Processing activity time-series data

The postprocessing step reduces the number of features by applying feature selection and dimensionality reduction techniques. Finally, the classification step predicts the class of activity according to the features. If on-chip processing is required, then efficient techniques should be used because of limited computational resources.

For example, extracting Fourier and wavelet features can be implemented on-chip using fast algorithms such as FFT.

AMBIENT MOTION RECOGNITION

To recognize more complex activities, a network of ambient sensors is used to model resident activities in the environment, as a sequence of sensor events. The majority of ambient activity recognition algorithms are supervised, and rely on labeled data for training , including decision trees, neural networks, case-based reasoning, mixture models, and the popular graphical models. A graphical model uses a graph to represent the conditional independence among observed random variables (sensor observations) to infer about queried random variables (activities). Most graphical models are able to deal with the sequential nature of data, including Markov chains, Dynamic Bayesian network, and hidden Markov model (HMM), and conditional random fields (CRFs). HMMs are one of the most popular graphical models for activity recognition, and many extensions have been proposed such as the coupled HMM for recognizing multi resident activities, hierarchal HMM for providing hierarchal definitions of activities

VISION-BASED ACTIVITY RECOGNITION

Vision-based activity recognition techniques provide very detailed context information. However, they also face difficulties such as tremendous variations in natural settings, algorithmic complexity, and privacy concerns. Typically, data are first preprocessed by applying techniques such as foreground–background segmentation, and then activities are recognized from preprocessed video frames.

Vision-based activity recognition techniques consist of two general categories: single layer approaches and hierarchal approaches (see Fig. 2.2). Single-layered approaches recognize human activities directly from a sequence of images, and are more appropriate for recognizing gestures or simple actions. Hierarchical approaches represent high-level human activities in terms of simpler activities or actions; therefore, such techniques are appropriate for recognizing more complex activities.

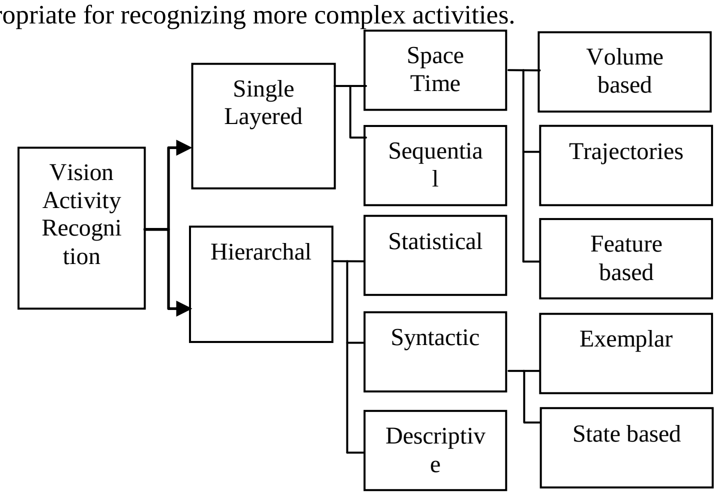

Fig 4: Vision-based motion recognition approaches

Single-layer approaches are further categorized into space-time approaches and sequential approaches. Space-time approaches view an input video as a 3-D (XYT) volume, while sequential approaches interpret it as a sequence of observations. Hierarchal approaches are also further categorized into statistical, syntactic, and description-based approaches. Statistical approaches construct statistical state-based models in a hierarchical fashion. Syntactic approaches use grammar syntax such as stochastic context-free grammar to model sequential activities, and description-based approaches represent human activities in terms of logical structures.

CONCLUSIONS AND FUTURE RESEARCH PATH

Healthcare Information Technology with IOT provides potential for improved healthcare and independent living. While there are major challenges such as price, competence, standardization and safety solutions are in sight. Here, it describes an integrated Electronic Health Record based on ambient intelligence paradigm system allows the development of novel computational approaches to context aware analytical health assessment. This paper proposed a Health analysis and Monitoring system and 'Intelligent Sensing Network" (ISN) tools which will provide clinical healthcare benefits especially for elderly patients with life-threatening chronic diseases and compromised respiratory systems.

This new technology has potential to offer a wide range of benefits to patients, medical personnel, and society through continuous monitoring in the ambulatory setting, early detection of abnormal conditions, supervised rehabilitation, and potential knowledge discovery through data mining of all gathered information.
Algorithms: Most current techniques such as bioradio measurement system, Human Health Record Systems and 'Intelligent Sensing Network" (ISN) tools still need to be upgraded and improved to become more trustworthy and more accurate for use in real-world settings. Also, some simplifying assumptions should be relaxed, such as the assumptions regarding single resident homes and availability of labeled data. Besides, there is a need for standard benchmark datasets.

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