An Enhanced Fall Detection System for Elderly Person Monitoring using Consumer Home Networks

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Abstract: Nowadays healthcare technologies are slowly entering into our daily lives, replacing old devices and techniques with newer intelligent ones. Although they are meant to help people, the reaction and willingness to use such new devices by the people can be unexpected, especially among the elderly. A fall event is one of the main factors that influence the physical and psychological health of an elderly person. Injuries related to falls include physical damages like Heart attacks, bone fractures and general connective tissue lesions. A fall has also dramatic psychological consequences, since it drastically reduces the self-confidence and independence of affected people. Healthcare technology using wireless sensors has reached a high level of maturity and reliability and hence these devices are now being deployed in homes/nursing homes for use in managing people’s health.

Key words: health monitoring, MEMS, GPS, GSM, ARM controller.

1. INTRODUCTION

Now a day’s healthcare is a burden factor for systems are struggling with aging population, prevalence of chronic diseases, and the accompanying rising costs. In response to these challenges, researchers have been actively seeking for innovative solutions and new technologies that could improve the quality of patient care meanwhile reduce the cost of care through early detection/intervention and more effective disease/patient management. It is envisaged that the future healthcare system should be preventive, predictive, personalized, pervasive, participatory, patient-centered, and precise, i.e., p-health system. Health informatics, which is an emerging interdisciplinary area to advance p-health, mainly deals with the acquisition, transmission, processing, storage, retrieval, and use of different types of health and biomedical information. The two main acquisition technologies of health information are sensing and imaging. This paper focuses only on sensing technologies and reviews the latest developments in sensing and wearable devices for continuous health monitoring and accessing the information.

This invention relates generally to methods and systems for monitoring a person. The present invention relates to interoperability of medical devices. Medical devices are essential to the practice of modern medicine. Physiologic measurements like blood pressure and temperature, x-ray and ultrasound imaging, administration of intravenous medications, and support of critical life functions are all routine procedures that use medical devices. However, at present, each device is designed to stand alone as an island. It is difficult to bring together multiple devices into interoperable (inter-connected) systems to improve patient care.

To address this issue, the Institute of Electrical and Electronics Engineers Inc. (IEEE) is developing two new point-of-care medical device standards. IEEE P1073.2.2.0—Health Informatics—Point-of-Care Medical Device Communication—Application Profile—Association Control Function—will provide for the establishment, release and disconnection of an association between a medical device agent and a system acting as a manager. In medical device communications, manager systems indicate a set of desired capabilities when requesting an association. Agent systems respond by stating the capabilities they support across the connection. Once an association is established, mechanisms must be in place to break the link. IEEE P1073.2.2.0 is referenced by other application-profile mode standards within the ISO/IEEE 11073 family. The second standards project, IEEE P1073.2.2.1—Health Informatics—Point-Of-Care Medical Device Communication—Application Profile—Polling Mode—will define a method for retrieving application data with medical devices that communicate through polling protocols. IEEE P1073.2.2.1 will enable “plug-and-play” interoperability for simple medical devices that use for management systems to query devices for all information to be communicated.

There is a clear trend that the devices are getting smaller, lighter, and less obtrusive and more comfortable to wear. Although physiological measurement devices have been widely used in clinical settings for many years, some unique features of unobtrusive and wearable devices due to the recent advances in sensing, networking and data fusion have transformed the way that they were used in. First, with their wireless connectivity together with the widely available infrastructure, the devices can provide real-time information and facilitate timely remote intervention to acute events such as stroke, epilepsy and heart attack, particularly in rural or otherwise underserved areas where expert treatment may be unavailable. In addition, for healthy population, unobtrusive
and wearable monitoring can provide detailed information regarding their health and fitness, e.g., via mobile phone or flexible displays, such that they can closely track their wellbeing, which will not only promote active and healthy lifestyle, but also allow detection of any health risk and facilitate the implementation of preventive measures at an earlier stage. The objectives of this paper are to provide an overview of unobtrusive sensing and wearable systems with particular focus on emerging technologies, and also to identify the major challenges related to this area of research. medical data using a first medical data collection appliance coupled to a network, the first appliance transmitting data conforming to an interoperable format, wherein the medical data is transmitted using a first wireless protocol translating the medical data to a format compatible with a second appliance and sending the translated medical data to the second appliance using one of the first protocol and a second wireless protocol; and Storing data for each individual in accordance with the interoperable format.

2. EXISTING SYSTEM

A person performs daily activities at regular interval of time. This implies that the person is mentally and physically fit and leading a regular 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. 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 growing amount of research is reported in recent times on development of a system to monitor the activities of an elderly person living alone so that help can be provided before any unforeseen situation happened.

Proposed System

An intelligent home monitoring system based on GSM wireless 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. 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 the camera or vision based sensors. The intelligent software, along with the electronic system, can monitor the usage of different household appliances and recognize the activities to determine the well-being of the elderly.

3. ARCHITECTURE AND WORKING THEORY

The overall structure of the system consists of two important modules: i) Wireless Sensor Network (WSN) with GSM modules and ii) Intelligent home monitoring software system to collect sensor data and perform data analysis. Exploration of the sensor data involves measuring the wellness and detecting behavioral changes of an elderly. Fig.1 depicts the block diagram of the wellness measurement system. Block diagram of Computer Based Wellness Measurement system A. Design of the Sensing Units: The WSN setup used for monitoring smart home consists of fabricated electrical sensing units. These are installed at an elderly home to monitor their daily activity behavior in terms of object usages and execute effectively process. The electrical sensing units connected to various household appliances

In this proposed system we implement a health monitoring platform such as temperature heart beat fall occurrence and in addition to this gives an alarm message to caring persons or hospitals by using GSM technology. In addition to this an automatic environment controlling like temperature dependent fan controlling and intercity based room light controlling and the additional features to this system There is a clear trend that the devices are getting smaller, lighter, and less obtrusive and more comfortable to wear. Although physiological measurement devices have been widely used in clinical settings for many years, some unique features of unobtrusive and wearable devices due to the recent advances in sensing, networking and data fusion have transformed the way that they were used in. First, with their wireless connectivity together with the widely available infrastructure, the devices can provide real-time information and facilitate timely remote intervention to acute events such as stroke, epilepsy and heart attack, particularly in rural or otherwise underserved areas where expert treatment may be unavailable. In addition, for healthy population, unobtrusive and wearable monitoring can provide detailed information regarding their health and fitness, e.g., via mobile phone or flexible displays, such that they can closely track their
wellbeing, which will not only promote active and healthy lifestyle, but also allow detection of any health risk and facilitate the implementation of preventive measures at an earlier stage. The objectives of this paper are to provide an overview of unobtrusive sensing and wearable systems with particular focus on emerging technologies, and also to identify the major challenges related to this area of research. medical data using a first medical data collection appliance coupled to a network, the first appliance transmitting data conforming to an interoperable format, wherein the medical data is transmitted using a first wireless protocol; translating the medical data to a format compatible with a second appliance and sending the translated medical data to the second appliance using one of the first protocol and a second wireless protocol; and Storing data for each individual in accordance with the interoperable format.

4. HARDWARE MODULES USED

ARM-LPC2929:
The LPC2929 combine an ARM968E-S CPU core with two integrated TCM blocks operating at frequencies of up to 125 MHz, Full-speed USB 2.0 OTG and device controller, CAN and LIN, 56 kB SRAM, up to 768 kB flash memory, external memory interface, three 10-bit ADCs, and multiple serial and parallel interfaces in a single chip targeted at consumer, industrial and communication markets. To optimize system power consumption, the LPC2926/2927/2929 has a very flexible Clock Generation Unit (CGU) that provides dynamic clock gating and scaling.

The ARM968E-S is a general purpose 32-bit RISC processor, which offers high performance and very low power consumption. The ARM architecture is based on Reduced Instruction Set Computer (RISC) principles, and the instruction set and related decode mechanism are much simpler than those of micro programmed Complex Instruction Set Computers (CISC). This simplicity results in a high instruction throughput and impressive real-time interrupt response from a small and cost-effective controller core. Amongst the most compelling features of the ARM968E-S are:
• Separate directly connected instruction and data Tightly Coupled Memory (TCM) interfaces
• Write buffers for the AHB and TCM buses

Pipeline techniques are employed so that all parts of the processing and memory systems can operate continuously. The ARM968E-S is based on the ARMv5TE five-stage pipeline architecture. Typically, in a three-stage pipeline architecture, while one instruction is being executed its successor is being decoded and a third instruction is being fetched from memory. In the five-stage pipeline additional stages are added for memory access and write-back cycles. The ARM968E-S processor also employs a unique architectural strategy known as THUMB, which makes it ideally suited to high-volume applications with memory restrictions or to applications where code density is an issue. The key idea behind THUMB is that of a super-reduced instruction set. Essentially, the ARM968E-S processor has two instruction sets:
• Standard 32-bit ARMv5TE set
• 16-bit THUMB set

MEMS:
MEM Solver is a powerful yet simple design and analysis tool for researchers, engineers and students working in the field of Micro Electro Mechanical Systems or MEMS. MEMS is a highly specialized inter-disciplinary field of engineering which engages in the development of micro mechanical sensors, actuators and other micro devices. Unlike some numerical analysis and finite element analysis software which require extensive programming skills and knowledge of the system to create a successful model, MEM Solver has readymade models and its associated mathematics wrapped up into one ME Solver is used in some of the most technically advanced nations and universities and also in some of the least known nations in the MEMS technology map. ME Solver attempts to deliver MEMS knowledge and technology at affordable rates.

MEMS Technology
Micro-Electro-Mechanical Systems (MEMS) is the integration of mechanical elements, sensors, actuators, and electronics on a common silicon substrate through micro fabrication technology. MEMS is an enabling technology allowing the development of smart products, augmenting the computational ability of microelectronics with the perception and control capabilities of micro sensors.

The increasing demand for MEMS (micro-electromechanical systems) technology is coming from diverse industries such as automotive, space and consumer electronics. MEMS promises to revolutionize nearly every product category by bringing together silicon-based microelectronics with micromachining technology, making possible the realization of complete systems-on-a-chip, first developed for the integrated circuit industry, for this emerging market.

Features of MEMS:
3-axis single-chip accelerometer
Built-in IC integrating temperature Sensor and self-diagnosis function
High sensitivity: up to 1,000 mV/G
External connection for low pass filters
**HEART BEAT SENSOR:**
The Heart Beat Sensor provides a simple way to study the heart's function. This sensor monitors the flow of blood through ear lobe. As the heart forces blood through the blood vessels in the ear lobe, the amount of blood in the ear changes with time. The sensor shines a light lobe (small incandescent lamp) through the ear and measures the light that is transmitted. The clip sensor shines a light lobe, the amount of blood in the ear changes with time. The signal is amplified, inverted and filtered, in the box. By graphing this signal, the heart rate can be determined, and some details of the pumping action of the heart can be seen on the graph. Blood flowing through the earlobe rises at the start of the heartbeat. This is caused by the contraction of the ventricles forcing blood into the arteries. Soon after the first peak a second, smaller peak is observed. This is caused by the shutting of the heart valve, at the end of the active phase, which raises the pressure in the arteries and the earlobe.

**Temperature sensor:**

The LM35 pin diagram is shown in the figure. As a temperature sensor, the circuit will read the temperature of the surrounding environment and relay temperature to us back in degrees celsius. The LM35 is a low voltage IC which uses approximately +5VDC of power. This is ideal because the arduino's power pin gives out 5V of power. The IC has just 3 pins, 2 for the power supply and one for the analog output. The output pin provides an analog voltage output that is linearly proportional to the celsius (centigrade) temperature. Pin 2 gives an output of 1 millivolt per 0.1°C (10mV per degree). So to get the degree value in celsius, all that must be done is to take the voltage output and divide it by 10- this give out the value degrees in celsius.

**GPS MODULE:**
The Global Positioning System (GPS) comprises three segments:

- The space segment (all functional satellites)
- The control segment (all ground stations involved in the monitoring of the system master control station, Monitor stations, and ground control stations)
- The user segment (all civil and military GPS users).

GPS was developed by the U.S. Department of Defense (DOD) and can be used both by civilians and military Personnel. The civil signal SPS (Standard Positioning Service) can be used freely by the general public, whilst the Military signal PPS (Precise Positioning Service) can only be used by authorized government agencies. The first Satellite was placed in orbit on 22nd February 1978, and there are currently 28 operational satellites orbiting the Earth at a height of 20,180 km on 6 different orbital planes. Their orbits are inclined at 55° to the equator, ensuring that at least 4 satellites are in radio communication with any point on the planet.

During the development of the GPS system, particular emphasis was placed on the following three aspects:

a) It had to provide users with the capability of determining position, speed and time, whether in motion at rest.

b) It had to have a continuous, global, 3-dimensional positioning capability with a high degree of accuracy, irrespective of the weather.

c) It had to offer potential for civilian use.

**GSM MODEM:**
A GSM modem is a wireless modem that works with a GSM wireless network. A wireless modem behaves like a dial-up modem. The main difference between them is that a dial-up modem sends and receives data through a fixed telephone line while a wireless modem sends and receives data through radio waves.

A GSM modem can be an external device or a PC Card / PCMCIA Card. Typically, an external GSM modem is connected to a computer through a serial cable or a USB cable. A GSM modem in the form of a PC Card / PCMCIA Card is designed for use with a laptop computer. It should be inserted into one of the PC Card / PCMCIA Card slots of a laptop computer. Like a GSM mobile phone, a GSM modem requires a SIM card from a wireless carrier in order to operate. GSM SMS messaging can handle large number of transaction in a very short time. You can receive large number SMS messages on your server like e-mails without internet connectivity. E-mails normally get delayed a lot but SMS messages are almost instantaneous for instant transactions. Consider situation like shop owners doing credit card transaction with GSM technology instead of conventional landlines. time you find local transaction servers busy as these servers use multiple telephone lines to take care of multiple transactions, whereas one GSM connection is enough to handle hundreds of transaction. Mobility, Quick installation: GSM technology allows mobility, GSM terminals, modems can be just picked and installed at other location unlike telephone lines. Also you can be mobile with GSM terminals and can also communicate with server using your mobile phone. You can just purchase the GSM hardware like modems, terminals and mobile handsets, insert SIM cards, configure software and your are ready for GSM communication.
5. CONCLUSION AND RESULT

We presented an interactive embedded measurement of daily activities through usage of household appliances sensor data. Predicting the behavior of an elderly person was based on past sensor activity durations. Combination of sensing system with time series data processing enabled us to measure how well an elderly person is able to perform their daily activities in real-time. So far, the forecasting process was able to rightly measure the wellness indices related to non-electrical appliances. Hence, some of the basic elderly daily activities such as sleeping, toileting, dining and relaxing are rightly assessed care takers and hospitals by the wellness measurement system. Most of the electrical appliances usage durations are predefined; validation for activities such as preparing food is limited. However, additional data processing method such as sensor sequence activity pattern analysis was able to rightly measure the occurrences of activities such as preparing breakfast, lunch, dinner and snacks. The next step will be to devise a robust forecasting method including outliers in the wellness of old and ill people measurement and alerting system.

REFERENCES


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