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Human Fall Detection and Monitoring System

Development, Experimentation and Analysis

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Abstract— **The financial exertion and physical requirements required to provide the current level of health care to the rapidly growing elderly citizen population will create tremendous strain on the current health care systems, thus various ideas have been proposed to provide the appropriate level of care in a more efficient manner by taking advantage of current technologies. To facilitate the safety, security, and continual supervision of a constant care environment while still allowing the user to retain their ability to live at home, the ITALH, Information Technology for Assisted Living at Home, project has been initiated. This paper describes a fall-detection and real time monitoring system that will be implemented into a larger sensor network called SensorNet, which is being developed to safely and accurately monitor the user while still allowing complete privacy and security. Falling is one of the most significant causes of injury for elderly citizens, and one of the reasons why many otherwise healthy individuals are forced to leave the comfort and privacy of their own home to live in an assisted-care environment. By utilizing acceleration values corresponding to the user's body motion, much effort has been put towards developing a robust algorithm to accurately detect a fall by the user.**

I. INTRODUCTION

This human fall detection & patient monitoring (HFDPM) is a field where patient is monitored remotely through communication technologies (e.g. gsm, web, gps as location detector) by the medical staff. It is important to observe status of the patient in real-time which above mentioned technologies unfortunately are not seemed to fulfill. In this regard, HFDPM can play an important role where agents automatically perform patient monitoring and do remedial action in emergency condition (e.g. alert to hospital staff, precautionary measures etc.). HFDPM provides number of benefits: reduce loss of life, automated working with less human interaction, facilitate citizens and chronically ill patients. It can also be used just to make sure the location is safe for high profile kids. The agent on patient location monitors continuously health status of the patient, working on a computer or a cellular device. The citizen's agent provides proactive care and notifies the citizen before happening emergency condition. Upon obtaining updated information (like high temperature and pulse rate sensation), citizen agent sends report to doctor/responsible person's agent and patient records. Currently, Multi Agent System-based HFDPM systems are in growing phase and require maturity in different areas (e.g. alternative to continuous GPRS connection, battery life of nomadic devices and data management in the network, etc.). Realizing this need, we have proposed a MAS-based HFDPM framework in this paper. We have given solution of significant problems that is a step towards maturity in this domain.

II. RELATED WORK

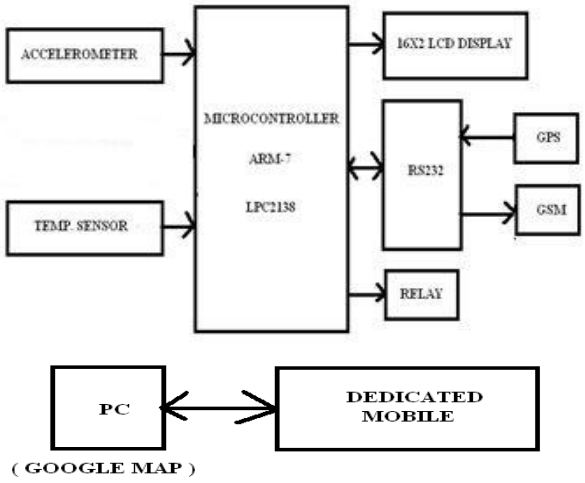
Multi-agent scenario has been shown to be precise in assigned tasks in sensitive environment. A detailed survey on the Multi-agent HFDPM highlights characteristics such as reusability, flexibility, reliability, robustness, adaptability and maintainability. The Multi-agent based system for collaborative scenario presented in the telemedicine field is applied for patient appointment, where external specialist functions are implemented for doctor appointment. To monitor patients at home through the Internet is proposed where acquired remote data are stored in the database of Web server. An agent is activated on receiving updated data from patient side. E-health mobile based MAS solve two problems. First, the patient bound to a room where a device is attached to bed. Second, the devices do not analyze results but provide recommendations. The mobile phone is the devise used to communicate. Another tele-health monitoring prototype system executes on the Personal Digital Assistant (PDA) that sense patient health status and sends this information to the remote server. Further, mobile-based system locates patient existence through Global Positioning System (GPS) to support mobility. A rule-based expert HFDPM system receives data from wired/wireless sensing device at patient location.

For better visualization there are some different approaches with which we can utilize software platforms. To enhance interface layout and consistency on mobile device, application of interface patterns is necessary. Design Pattern is encapsulated solution to recurrent problem, increasing consistency in software development. Mostly, it is used in architecture development, combining multiple standards.

Patterns for cross-platform development of web applications are proposed. Pattern approach for information visualization is presented to enhance the interface design. HFDPM works as follows: the agent at patient's location receives updated health condition from monitoring devices; with this information, it treats and analyzes these data and sends recommendations if any to patient, and reports it to doctor agent. Doctor agent makes a proper visualization on PC screen so as to trace the location on google map with the help of which medical help can be sent to the exact point. During this cycle, recommendation and report are sent to corresponding entities like body temperature and pulse rate measurement sensor. Tangible benefits are provided to patients at home: they can be treated and monitored online directly.

Agents are executed by the following way - Nomadic devices provide easy connectivity without non-mobility constraints. Patient at home or road can be treated by the medical staff by sending them alert. Using mobile technology, doctors may be alerted about patient condition and his or her body parameters.

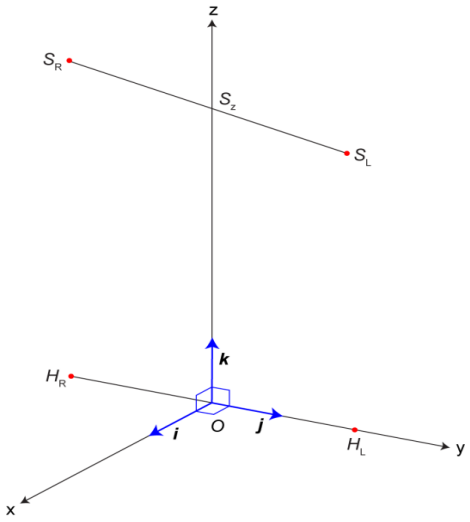
A. Block Diagram



III. System Parameters

1. ACCELEROMETER**:**

An accelerometer is an electromechanical device that will measure acceleration forces. These forces may be static, like the constant force of gravity pulling at your feet, or they could be dynamic - caused by moving or vibrating the accelerometer. By measuring the amount of static acceleration due to gravity, you can find out the angle at which the device is tilted at with respect to the earth. By sensing the amount of dynamic acceleration, you can analyze the way the device is moving. Accelerometers use the piezoelectric effect - they contain microscopic crystal structures that get stressed by accelerative forces, which causes a voltage to be generated. Another way to do it is by sensing changes in capacitance. If you have two microstructures next to each other, they have a certain capacitance between them. If an accelerative force moves one of the structures, then the capacitance will change. Adding some circuitry to convert from capacitance to voltage, and you will get an accelerometer. The three axis accelerometer are basically used to identify the movements across the three axis i.e. x-axis, y-axis, z-axis. Accelerometer is an electronic device which is interfaced using I2C protocol and provides the reading after every 1msec. According to the requirement of the application, the microcontroller will take the reading from the accelerometer within a fixed interval of time and do the necessary operation according to the requirement of the application.



An accelerometer is a device that measures proper acceleration, also called the four-acceleration. This proper acceleration is associated with the weight of a test mass. For example, an accelerometer on a rocket far from any gravitational influences (assume gravitation is zero) that is accelerating through space due to the force from its engine, will measure the rate of change of the velocity of the rocket relative to any inertial frame of reference, because such changes require application of a (rocket) force that can be felt (as weight), for any mass. However, the proper acceleration measured by an accelerometer is not necessarily the coordinate acceleration (rate of change of velocity), when gravity becomes involved.

Gravitation may make these types of acceleration differ. For an example where these types of acceleration differ, an accelerometer will measure a value of g in the upward direction when remaining stationary on the ground, because masses on earth have weight m*g. Such weight is transmitted from the push of the ground, and is not directly caused by gravity, but rather by the mechanical force from the ground, in the same way as the push of the engine in the rocket example. However, there is no change in velocity in this example, as the push from the ground counteracts the acceleration of gravity, which is not felt. By contrast, an accelerometer in gravitational free fall toward the center of the Earth will measure a value of zero acceleration because, even though its velocity is increasing, it is at rest in a frame of reference in which objects are weightless. Like the human

body, therefore, an accelerometer is not sensitive to the "acceleration of gravity" per sec, and will read zero whenever gravitation provides the only acceleration that acts on the device (or the only "force" on the device). Accelerometers read "zero" on all inertial paths, including free-falls, orbits, and gravitationally directed motion.

2. GSM MODEM:

GSM (Global System for Mobile communication) is a digital mobile telephony system. With the help of GSM module interfaced, we can send short text messages to the required authorities as per the application. GSM module is provided by sim uses the mobile service provider and send sms to the respective authorities as per programmed. This technology enables a wireless system with no specified range limits. GSM uses a variation of time division multiple access (TDMA) and is the most widely used of the three digital wireless telephony technologies (TDMA, GSM, and CDMA). GSM digitizes and compresses data, then sends it down a channel with two other streams of user data, each in its own time slot. It operates at either the 900 MHz or 1800 MHz frequency band.

3. RS 232:

RS 232 is a serial communication cable used in the system. Here, the RS 232 provides the serial communication between the microcontroller and the outside world such as display, PC or Mobile etc. So it is a media used to communicate between microcontroller and the PC. In our system the RS232 serves the function to transfer the edited notice (or data) from PC (VB software) to the microcontroller, for the further operation of the system.

RS 232 IC, is a driver IC to convert the µC TTL logic (0-5) to the RS 232 logic (+-9v).Many device today work on RS 232 logic such as PC, GSM modem, GPS etc. so in order to communicate with such devices its required to have the logic levels to the 232 logic (+/-9v).

4. GPS Smart Receivers:

Some of the key functionalities provided by the GPS receivers are Location detection at real time, Geographic surveying, Personal/portable navigation, Sports and recreation.

List of the extensions provided by 16 channel GPS receiver is provided in the next section.

NMEA Message Prefix	Format	Direction
$PNMRX100	Set serial port parameters.	In
$PNMRX101	Navigation initialization	In
$PNMRX103	NMEA message rate control	In
$PNMRX104	LLA navigation initialization	In
$PNMRX106	Set Datum.	In
$PNMRX107	NemeriX messages rate control	In
$PNMRX108	NMEA message sequence control	In
$PNMRX110	Fix Settings	In
$PNMRX111	Software Reset	In
$PNMRX112	Operating Mode Control	In
$PNMRX113	Fix and Extraction control	In
$PNMRX300	Almanac data transfer	In / Out
$PNMRX301	Ephemeris data transfer.	Out
$PNMRX302	Ionospheric correction	Out
$PNMRX303	UTC Time	Out
$PNMRX304	GPS Constellation Health Status	Out
$PNMRX600	SW Version report	Out
$PNMRX601	ISP mode	In
$PNMRX602	Flash content version report	Out
$PNMRX603	Settings Report – Out	

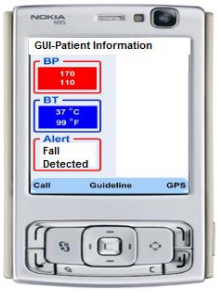
Features provided by these receivers are:-

1. 16-channels GPS search engine
2. Ultra low power design (38mA, typical)
3. Compact size
4. Built-in low noise, high gain active antenna
5. Super-cohesive magnetic for installation
6. High sensitivity (up to -152dBm typ)
7. Apply to host devices with USB or RS232

5. ADVANTAGES:

1. Less time delays
2. Quick response time.
3. Fully automate system
4. Robust system
5. Low power requirement

6. USER INTERFACE:



Such GUI can also be seen on PC screen which is been kept at Doctor's agent location. Actual visual graphics simplify the complications which are supposed to be eliminated. Basically such GUI's are cross platform built. Cross Platform means

they use two or more development platforms at the same time like JAVA, Ajax, J-Query, Jumla and likewise there are various stations where such applications are developed.

IV. FUTURE EXTENSIONS

This HFDPM system has wide scope in the field of Advanced Telecommunication Trends where Green ICT has tremendous importance as Moore's law states that chip size and chip area are decreasing day by day and electronic sensor equipment will get double every year. Current sensor studies are telling World that across every square feet area there will be at least one sensor present to overlook a particular task with the functionality of communicating with sensors present at next corners. Self-decision making, autonomous interaction are the features of sensors that are present in next era of communication.

HFDPM system will have body merging sensors that can be embedded within citizen's body to look after all his/her body parameters and they will automatically communicate with at responsible emergency response center in order to take corrective measures in order to support the needs of human beings.

We can embed GPS locating sensors in kid's body and set limits about the coverage so that when it crosses the boundary, automatic alert will be generated so as to provide the safety.

There are thousands of application following this context of research which can assure Human Empowerment in various fields like tele-health. This is a sincere attempt to put forth our point regarding HFDPM system.

V. CONCLUSIONS

Remote patient monitoring is active research area that device techniques to provide healthcare for old, disable and ill patients. We have explored, in this paper, mobile based tele-health service system approach that use Multiagent paradigm. Based on our findings we have proposed an optimized framework. The proposed system provides multiple services in HFDPM in one framework. We have solved significant problems in the existing MAS-based infrastructure. Finally, prototype system demonstrates its practical viability. The system work efficiently and securely in the MAS environment.

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