

EMBEDDED SYSTEM DESIGN FOR HEALTH SUPERVISORY SYSTEMS

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ABSTRACT

Most of the systems used in medical healthcare are based on embedded electronics systems. These medical systems are primary made from OEM embedded electronics becoming mostly installed in health care systems nowadays. Utilization of these systems are more and more oriented also to home care applications are effective from the effectively of monitoring and economical point of view. The upcoming trends of distance monitoring embedded systems for supervisory applications require complexity of architecture and infrastructure for cost reduction and effectiveness. There are quit modern technologies for sensing, transferring a micro chip data processing technologies the can advance the better health supervision with first-aid treatment.

Keywords: Embedded System, Supervisory, Sensor.

1 INTRODUCTION

There are a lot of electronic products includes embedded systems nowadays. Not a few of them can be found in everyday use electronic instruments like MP3 players, cameras, multimedia, mobile phones, home electronics systems and toys, but this systems are at the same time in car's part, in medical devices and household appliances. There are mostly equipped by embedded system's the necessary intelligence. Likelihood of these using are so wide that the emergence of embedded systems their importance traversing the previous milestones of wrapped of cybernetics and information technology. Document Management Committee Embedded System Technology Platform, the strategic initiative defines Embedded Systems (ES) as a combination of hardware and software the intent is to drive an external process device or system. In the quiddity, the electronic module with the micro processor and other electronics programmed control device to whom installed in. Embedded systems are realized for functioning even without man machine intercession and were able to reply to occurrence in real time running. Not only those personal computers applying the interactions with the ambient mouse, keyboard, I/O and graphical user interface, but the sensors, activator and specialized communication channel amongst the wire and wireless

communications.

Because nowadays society becoming older and older and number of elderly and single seniors, as such the medical or hospital centres will probably need very soon. There will be important health supervisory policy displaced to ambient systems equipped with security and reliability wireless communication between embedded systems and supervisory headquarters.

The health services are divided to several types, like for unwholesome patients - sporadic stress on management of chronically states, implantable medical devices, and distance standalone embedded rehabilitation systems, get ahead of the gradely man, first-aid treatment and exquisite care.

Thanks to new medical progress in diagnostics and therapy like fine diagnoses set up, preventive medical examination, robot assistive treatment and drug efficiency the commitment time in the hospital ara shorter and shorter. In other way there more and more people to take care in these medical centers. Rest of the time instead spending in hospitals they spent in their home environments. This scheme from the psychological point of view include better for convalesce ting and also the reasonable cost and op ability of patients to be fitness settled to home care. Most of that people lives as singles and there are the target group for supervisory health systems for remote form checking and watch perilous to health situations in one time.

In recent days the boom of telemedicine systems starts. Many of them have different monitoring strategy and watching mechanism. In a modern

health supervisory systems have to be important the unidentified intelligent health care embedded system which can afford anamnesis about health check status for patients and medical centers in one time.

All of that involved person can easy check their health condition and vitality status in any time they want and share to doctor certainly.

The interface between the diagnosis and man are sensors measuring the objective biological signals in the flat environment and also on body placement. This type of measurement is rather different than on hospital biochemist laboratory. The measurement signal can easy inform us about actual and long time biosignal trends in time. The reconvalescent time in home care can produce twenty four hours mapping of hart rate variability, circadian rhythms and so on. Combination of information from on body and stationed sensors power up the signal entropy about the health status. Provisionment the biosignals to our unique modular embedded medical sensors parameters detection, relevant parameters will be extracted out by using proficient signal processing mechanism.



Figure 1: Body Area Network Protocol Choices for Transceiver <http://www.athena-gatech.org/research/BIOMEDICAL/index.html>

The proficient signal processing mechanism treated by experimental expert system with learning knowledge base for diagnosis of the health status. Preliminary diagnosis outputs dress to inconvenience by accident occurred is displayed as a tentative advice to the patients. The man has actual reaction about their health status and can make the plan visitation into doctor only if their problem gets inescapable.

2 DEIGN OF EMBEDDED HEALTH SUPERVISORY SYSTEMS

Deign of mobile embedded health supervisory systems should be mobile and communicate with surrounding sensors by wire or wireless way. Characteristics of the supervisory systems are mobility with light weight, long life battery profile, first aid emergency pushbutton and user interface for self check information. The sensors and health embedded systems also should be under undisturbed in prevailing life style with the cheap

operation. This system has to give high authenticity, security and diagnosis validity with respect of the hardware and software parts.

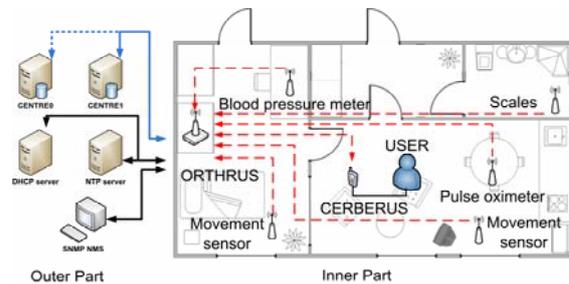


Figure 2: Health Supervisory Embedded System Design

There is necessary also native interaction and ambient intelligence in medical between healthcare processes and the home-care supervisory systems and the deep embedding of wireless sensor and actuator technologies into the neighborhood. These are the most responsible feature of embedded systems application in look of systems provides technological infrastructure for ambient intelligence realization.

2.1 Data Reading

The most important part of health systems are high quality and statements biological data. The data are measured by sensors from on body and patient's surrounding. The data are disturbed by artifact from human body as biological artifacts and technical artifacts biasing the measurement from circumambience. The on body sensors are mostly wirelessly connected and powered to mobile embedded system. The wide range of biosignal types are measured like ECG, PPG, ACC for position and energy expenditure measurement, temperature, and so. on.



Figure 3: Commercial one sensing t-shirt by Vital Jacket <http://elitechoice.org/tag/heart/>

There are also sensors for wirelessly communication with embedded systems where the wire connection is not convenient or inability as vibration sensors on pletysmography on ear.

Common use glue electrodes for electrical heart activity on stuck on skin are time limited due contact gel dewatering, skin shifting ac. Nowadays trend is use the innovative type of measuring by conducting polymer based electrodes covered on any type of flexible t-shirt. Polymer based electrodes are deployed for any number of leads ECG or other type of biosignal measurement and the wirelessly are connected outright on the t-shirt pin terminal. The preference of that solution is long term stability of electrical signal conduction and scanning even perspiration does the it suitable for skin-electrode right connection. Fig.2.

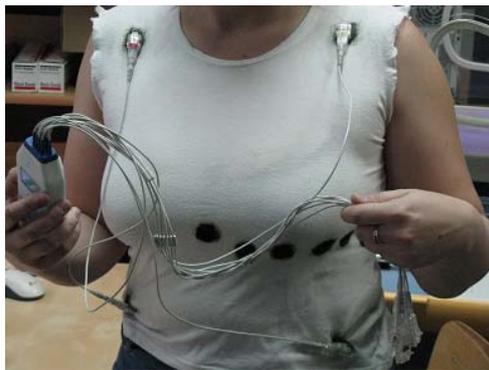


Figure 4: Alternative Conducting Polymer T-Shirt with Wire Connection into Personal Embedded System

The embedded health supervisory systems are able to measure falls and positions of human body. A lot of number of elderly people has problem with stability and subsequent falling which is vicariously risky. The next problem based on physics and late age osteoporosis are in context very hazardous not for living, but if the are living alone the exhaustion, starvation and pain stress and immobility. Together it causes fatal situation with less possibility of distress call.

The competence to men's standing and movement monitoring may help either to identify man at risk of falls or to planning time monitoring of user movement on the flat and their anomaly in circadian rhythms. Collective information about the fall and other biosignals gives necessary information to establish right reason of fall and set up the right diagnose and consecutive response.

Blood pressure and glucose, weight and temperature trends, motion in apartment, blood oxygenation characteristics can be manipulated similarly to the ECG signal as long as the sensors are well-implemented. One of the really important characteristic is modular implementation of each supervisory embedded sensor according to user's requirement.

2.2 Infrastructure of Data Transfer

Next important part of ambient supervisory system is fine data communication from sensors to processing system. Data communication can be done by wireless communication in most of medical applications raising practicability and comfort in long-run user monitoring. There are some short-range wireless transmission standards on the market that allow appropriate data transfer rates suitable for continuous transmission of necessary values of user vital state inquest.

Previous works on the available wireless communication standards focuses on the most common technologies with available specifications which are namely Bluetooth (IEEE 802.15.1.), WIFI (IEEE 802.11), WPAN (IEEE 802.15.4 / ZigBee), WiMax (IEEE 802.15.4). Fig. 3., 4.

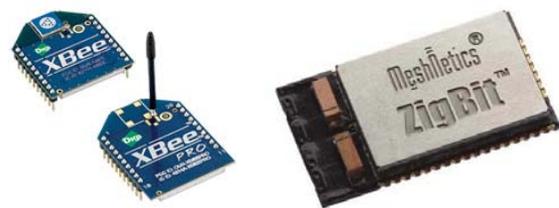


Figure 5: Xbee is a ZigBee transceiver developed by (www.digi.com) <http://zigbeeproducts.com/> (left), IEEE802.15.4/ZigBee Module with Chip Antenna <http://www.automatedbuildings.com/news/sep07/articles/meshnetics/070821030505leonov.htm> (right)

Decision on what wireless data transmission system to use is driven by data capacity and transmission range from sensors to sensors and Embedded system. Nowadays the ZigBee technology due bandwidth, communication range, energy consumption, and reliability benefits gives reasonable utilization in home care applications.

There were realized the communication test for validating the usability in home-care applications. We used the OEM-modules for vital parameter monitoring from Microchip, and Maxstream inc. We were also tested the WiMax technology for data middle distance range transmission with the weak results actually.

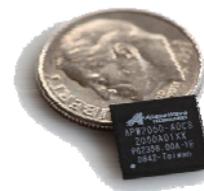


Figure 5: ApacheWave APW2050 Low-cost Mobile WiMAX Baseband SoC System-on-a-Chip (www.apacewave.com)

2.3 Mobile Embedded System

The heart of electronics system and also coordinator in communication is embedded system managing biometric data from numerous stationary and on body (Fig. 6). Next the investigation information about the inquisition parameters are transferred into outer part of flat. The outer part represents the LAN or long distance wireless communication within health services, first aid or family relatives. (Fig.7)

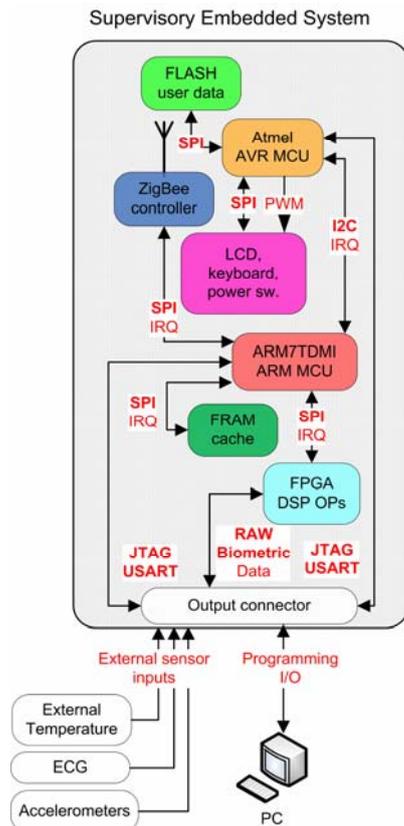


Figure 6: Block Diagram of Portable Embedded System

The biosignals related to the decision-making process are able to be transformed remotely. When the users go out, the mobile embedded system is possible to take with. Coming back the mobile embedded system should be plugged in docking station as LAN gate and also battery-charging. Cell practical installation of the system were tested success in our biotelemetry flat.

3 SOFTWARE ROLE

Every system is as good as the software implemented in. Also in the embedded systems the possibility of embedded software makes it powerful. From the beginning the sensing by sensors is driven by software for frequency of reading, filtering, and data packet construction. Next step is data

communication between transceiver and it amount transferred packet managing to store and reliable and security. Embedded systems process the data to and aggregate information for preliminary diagnosis set or assigns them to health expert as medical doctor or first-aid treatment.

The complexity of the software part is area of implementation if infrastructure of that system is big. Realization of that part of measuring is much more complicated than hardware realization. The cooperation between the hardware and software realization groups has to be narrow.

4 SUPERVISORY HEALTH SYSTEM

4.1 Information Explication

In the home care application data measurement is problem of objective information delivery. Many beneficial information about the health condition gives ECG signal from twelve leads measurement. Its generally caused 82 % of all health problems. That is the ECG analysis is important part of our signal interpretation.

There were used modern mathematical methods and experimental expert system also decision trees for evaluation signals measured by embedded system. The detailed signal processing of this signal will be described in other paper due to huge number of information.

Home monitoring is assuming more and more importance to perform patient diagnosis and therapy and reduces hospitalization costs. Telemedicine technologies allow unifying different clinical objectives: prevention, diagnosis, therapy, admission and home assistance. [7]

This out-of-hospital system makes closer patient-physician relationship because of patient active participation to patient own treatment process. In this way it is possible not only to check patient's health condition but also to study care efficacy as to eventually modify pharmacological treatments. [7]

4.2 Distance Anamnesis Assessment

The goal of all supervisory systems especially health supervisory systems is convey critical situation and first-aid treatment safeguard.

Incorporation of software and hardware parts affair the software agents on each levels to process the adaptable remote diagnostic system.

The critical and a life threatening situations are advice by text message service into supervisory center, first aid and other like family relations or neighbor. Simultaneously there should be chance to transfer measured data from user by LAN, WiFi, 3G communication into the supervisor center.

The supervisory centre with physician is able to check the risk factor of each user remotely. From

this point of view the representative data set from the user gives clinical information's about the real plunge risk to set up the sensing parameters in case of a spurious warning. After obtaining at supervisory centre a demand from the medical sight There is possibility to update information in decision software in mobile embedded system at user by different way like GSM.

There is also possibility for distance monitoring and up-dating the embedded system by internet web based interface like Figure 7. Thanks to that the broad range of users and physician can enter the real conditions of each monitored user and also by this way the personal verification with the trend data are displayed.

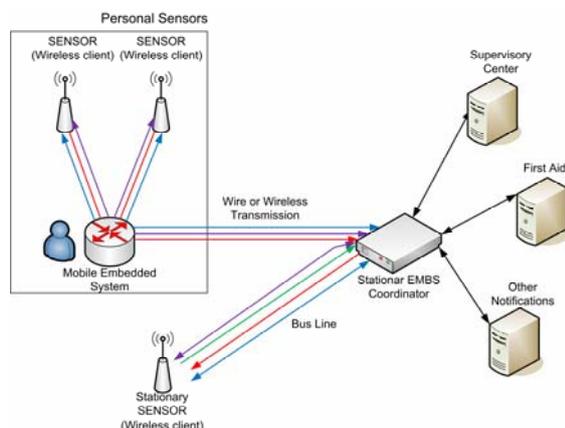


Figure 7: General Configuration of Remote Diagnose

Avery user can have a specific set in the seat up for the embedded system diagnosis software for their specific diesis. It concern number of sensors, and list of tests making without user interaction. The diagnosis is saved at central terminal server. The central terminal server contains the software agents that start various diagnostic tests on the personal embedded system.

4.3 Predictive Events

The future of the supervisory maintenance system will cooperate with artificial movement systems and implantable devices of nanostructures to prevent the fall, cardiac incidents and glycemy shock. This prediction can be realized for several cases of diesis, but with great impact to ser health. Using fast multi parallel calculating code we can make fats decision from the measured signal to activate some of the actuators to minimize consequence.

Main focuses can be put on cardiac problems to predict sudden occurrence from the set of information saved on central terminal server and reviewed by embedded system. In these cases this system early and reliably recognizes dangerous patient survival change.

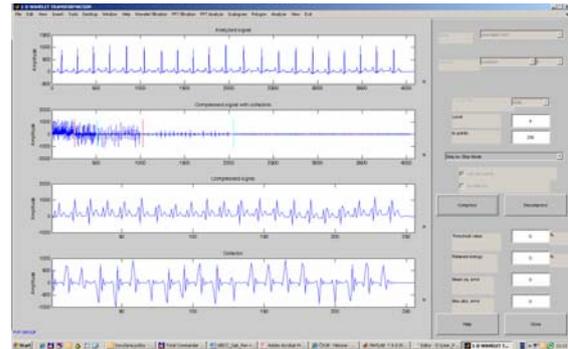


Figure 8: Advanced Signal Processing Methods used for Electrocardiogram Analyzing.

For example the sudden death syndrome is predicted from ECG signal (Figure 8 and 9), temperature, breath frequency and blood oxygen saturation. Also prediction of blood pressure and blood glucose (which require fewer parameters e.g. systolic and diastolic for blood pressure, glucose level for blood glucose), can prevent from hypertension shock and hyper or hypoglycaemic shock. [4]

Respecting the traditional procedures in signal processing were designed software for precordial leads reconstruction ECG recording [15].

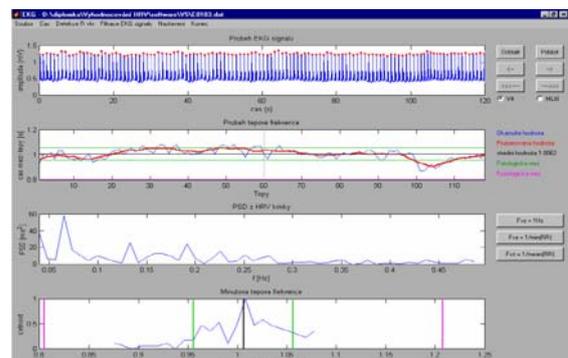


Figure 9: ECG Processing Chart from MATLAB where Signal is Filtered and Highlight Point, where was Detected R-peaks. In the Bottom Hearth Tachogram Display Heart Rate Variability in Time.

4.4 Systems Controlling by Biomedical Reaction

The controlling supervisory systems in health care makes it sense for example of changing pH when the hearth muscle are not sufficiently oxidized. This is preliminary information about the weakening heart function or ventilation on first or second grade problem.

Methods of soft computing can be applied to combine continuous measurement of indirect parameters to produce sensors that can provide continuous estimation of the key physiological parameters: Closed loop control of blood carbon dioxide and oxygen tension, Blood glucose

regulation in diabetics, Pain management of postoperative patients - patient controlled analgesia. [4]

In Home care application there impossible to measure direct parameter. There are only mesasured indirect parameter witch inform us in a hidden information included in measured data about becoming problem. Thereafter the therapy shock or feedback to user can break that situatin. As example the is sleeping apnea definitely dangerous at half-slim elderly people.

5 CONCLUSION

Actual home electronics are equipped with some embedded intelligent. Many of them are designed for temperature, environment and food-supply. The new age of ambient intelligent is more and more concentrated into health supervising services especially for singles a elderly people in home background. From the economical point of view and quality of medical care the home-made sequential therapy is perspective. This is a very important role taken by more and more complex supervisory embedded systems. Perspective of this kind of systems are in modern sensors and communication technologies and also roofed-in high quality implemented software. Those kind if medical supervision gives to this personal system role of health bodyguard.

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