

Development of an Embedded System with MATLAB Based GUI for Real Time Health Monitoring

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Abstract:

Technology is being used everywhere in our daily life to fulfill our requirements. We are employing different sensors for different applications which have increased its speed with the technology boosters. We can not only increase the speed of life but also increase security with good ideas to make use of this technology. Now a day's technology is running with time, it completely occupied the life style of human beings. It is being used everywhere in our daily life to fulfil our requirements. We can not only increase the comfort of life but also increase the health monitoring techniques by making use of advanced technology. In this project we are making use of technology to sense serious health problems so that efficient medical services can be provided to the patient in appropriate time. One of the ideal ways of using technology is to employ it to sense serious health problems so that efficient medical services can be provided to the patient in correct time.

Importance of telemedicine to provide efficient health service to patients has given birth to the project Patient health telemetry system using GPS and GSM services and also using MATLAB GUI. The system also capable of tracking the location of cardiac patients and also monitoring of heart rate alerts in case of emergency through SMS to predefined numbers. In this paper we proposed a completely automotive localization technique using both GPS and GSM-SMS communication modules for enabling the quick solutions by sending the health parameters to concerned authorities. An efficient patient health monitoring system using temperature sensor, heartbeat sensor, ECG monitoring using ECG plates and alerts the user through SMS messages and also plots the ECG wave form on to the PC using MATLAB GUI.

Key words:

GPS, GSM modem, ECG, Heartbeat, temperature sensors, MATLAB GUI,

I. INTRODUCTION:

Electrocardiography (ECG or EKG from Greek: kardia, meaning heart) is the process of recording the electrical activity of the heart over a period of time using electrodes placed on a patient's body. These electrodes detect the tiny electrical changes on the skin that arise from the heart muscle depolarizing during each heartbeat. In a conventional 12 lead ECG, ten electrodes are placed on the patient's limbs and on the surface of the chest. The overall magnitude of the heart's electrical potential is then measured from twelve different angles ("leads") and is recorded over a period of time (usually 10 seconds). In this way, the overall magnitude and direction of the heart's electrical depolarization is captured at each moment throughout the cardiac cycle. The graph of voltage versus time produced by this noninvasive medical procedure is referred to as an electrocardiogram (abbreviated ECG or EKG).

During each heartbeat, a healthy heart will have an orderly progression of depolarization that starts with pacemaker cells in the sinoatrial node, spreads out through the atrium, passes through the atrioventricular node and then spreads throughout the ventricles. This orderly pattern of depolarization gives rise to the characteristic ECG tracing. To the trained clinician, an ECG conveys a large amount of information about the structure of the heart and the function of its electrical conduction system. Among other things, an ECG can be used to measure the rate and rhythm of heartbeats, the size and position of the heart chambers, the presence of any damage to the heart's muscle cells or conduction system, the effects of cardiac drugs, and the function of implanted pacemakers.

The ECG Sensor measures electrical potentials produced by the heart (Electro? cardiogram). These small voltages are measured at the Skin of the wrists and elbow through electrodes. The ECG sensor can also be Used to Measures the electrical potentials generated by muscles cells

when these cells contract and relax (Electromyogram). For safety reasons the sensor uses an optical mcoupler to avoid any direct electrical contact between the person whose ECG is measured and the measurement interface or computer.

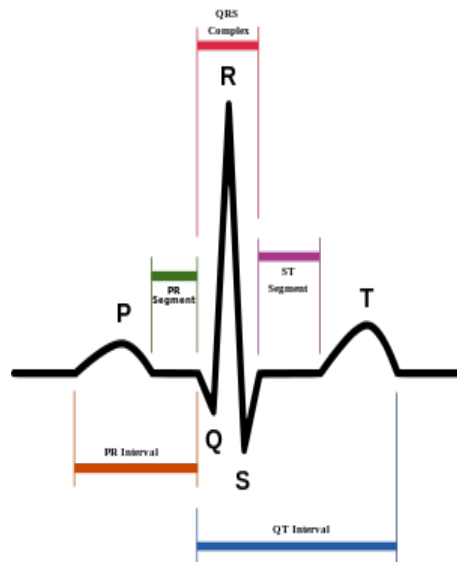


Figure-1: Image of ECG graph

Basic signal features of time and amplitude which are measured and form the basis for automated ECG analysis

- A digital representation of each recorded ECG channel is obtained, by means of an analog-digital conversion device and a special data acquisition software or a digital signal processing(DSP) chip.

- The resulting digital signal is processed by a series of specialized algorithms, which start by conditioning it, e.g., removal of noise, base level variation, etc.

- Feature extraction: mathematical analysis is now performed on the clean signal of all channels, to identify and measure a number of features which are important for interpretation and diagnosis, this will constitute the input to AI-based programs, such as the peak amplitude, area under the curve, displacement in relation to baseline, etc., of the P, Q, R, S and T waves,[1] the time delay between these peaks and valleys, heart rate frequency (instantaneous and average), and many others. Some sort of secondary processing such as Fourier analysis and wavelet analysis may also be performed in order to provide input to pattern recognition-based programs.

- Logical processing and pattern recognition, using rule-based expert systems, probabilistic Bayesian analysis or fuzzy logics algorithms, cluster analysis, artificial neural networks, genetic algorithms and others techniques are used to derive conclusions, interpretation and diagnosis.

- A reporting program is activated and produces a proper display of original and calculated data, as well as the results of automated interpretation.

- In some applications, such as automatic defibrillators, an action of some sort may be triggered by results of the analysis, such as the occurrence of an atrial fibrillation or a cardiac arrest, the sounding of alarms in a medical monitor in intensive-care unit applications, and so on.

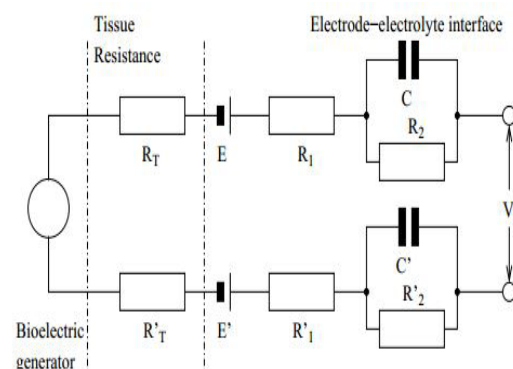


Figure-2: Circuit of capturing charges from the body using ECG

ECG signal processing consists of three stages extraction, amplification and filtering. Extraction done by instrumentation amplifier and amplification done by an op-amp and an IC AD8232IC which solely gives the combination of the three stage.

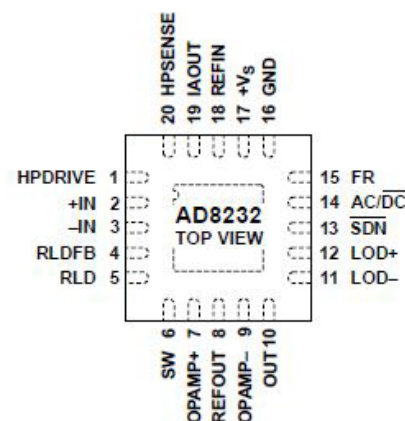


Figure3: Top view of AD8232

II. RELATED SOFTWARE WORK:

MATLAB (matrix laboratory) is a computing numerical environment and fourth generation programming language. Developed by Math works, MATLAB allows matrix manipulations, plotting of functions and data, implementation of algorithms, creation of user interfaces, and interfacing with programs written in other languages, including C, C++, Java, and FORTRAN. MATLAB stands for matrix laboratory. MATLAB (matrix laboratory) is a numerical computing environment and fourth-generation programming language. Developed by Math Works, MATLAB allows matrix manipulations, plotting of functions and data, implementation of algorithms, creation of user interfaces, and interfacing with programs written in other languages, including C, C++, Java, and Fortran. MATLAB can be used in a wide range of applications, including signal and image processing, communications, control design, test and measurement, financial modeling and analysis, and computational biology. For a million engineers and scientists in industry and academia, MATLAB is the language of technical computing.

SERIAL COMMUNICATION USING MATLAB:

Serial communication is the most common low-level protocol for communicating between two or more devices. Normally, one device is a computer, while the other device can be a modem, a printer, another computer, microcontroller or a scientific instrument such as an oscilloscope or a function generator. As the name suggests, the serial port sends and receives bytes of information in a serial fashion — one bit at a time. These bytes are transmitted using either a binary (numerical) format or a text format. The serial port interface for connecting two devices is specified by the TIA/EIA-232C standard published by the Telecommunications Industry Association. The original serial port interface standard was given by RS-232, which stands for Recommended Standard number 232. The term RS-232 is still in popular use, and is used in this guide when referring to a serial communication port that follows the TIA/EIA-232 standard. RS-232 defines these serial port characteristics:

- The maximum bit transfer rate and cable length
- The names, electrical characteristics, and functions of signals
- The mechanical connections and pin assignments

Primary communication is accomplished using three pins: the Transmit Data pin, the Receive Data pin, and the Ground pin. Other pins are available for data flow control, but are not required. Other standards such as RS-485 define additional functionality such as higher bit transfer rates, longer cable lengths, and connections to as many as 256 devices.

The MATLAB serial port interface provides direct access to peripheral devices such as modems, printers, and scientific instruments that you connect to your computer's serial port. This interface is established through a serial port object. The serial port object supports functions and properties that allow you to

- Configure serial port communications
- Use serial port control pins
- Write and read data
- Use events and callbacks
- Record information to disk

Instrument Control Toolbox™ software provides additional serial port functionality. In addition to command-line access, this toolbox has a graphical tool called the Test & Measurement Tool, which allows you to communicate with, configure, and transfer data with your serial device without writing code. The Test & Measurement Tool generates MATLAB code for your serial device that you can later reuse to communicate with your device or to develop GUI-based applications.

The toolbox includes additional serial I/O utility functions that facilitate object creation and configuration, instrument communication, and so on. With the toolbox you can communicate with GPIB- or VISA-compatible instruments. Using MATLAB we can select COMPORT, BAUDRATE, START BIT, STOP BIT, PARITY BIT and DATA BIT for serial communication.

- Create a serial port object:

Obj=serial('port','propertyname',propertyvalue)

Example: s = serial('COM1','BaudRate',9600);

To specify properties during object creation

s = serial

('COM2','BaudRate',9600,'DataBits',8);

Obj = serial('port') creates a serial port object associated with the serial port specified by port. If port does not exist, or if it is in use, you will not be able to connect the serial port object to the device.

Creation of GUI in MATLAB:

A GUI provides the user a simplified experience of running a program. In the Proposed system we used the following steps for ECG graph plotting in MATLAB GUI.

1. MATLAB provides two ways to create a GUI

- Through GUIDE
- Through scratch
- Both allow us to associates functions with components of the GUI.

2. Steps in creating GUI:

- At command prompt type “guide”.
- After laying out GUI in the layout editor define data in Opening Function.
- Edit/Align your components by

- » Tools Menu
- » Align
- » View menu
- » Property Inspector

3. Write the Callbacks

This is the most difficult aspect when creating GUI's

4. Adding serial values to the GUI for plotting:

- Set the relevant serial port used for plotting by using the command
`s = serial ("Serial Port")`
- Access the port by using the command
`fopen(s);`
- Read the values from the port by using the command
`fscanf(s,'%f');`
- Plot by using the command
`plot();`

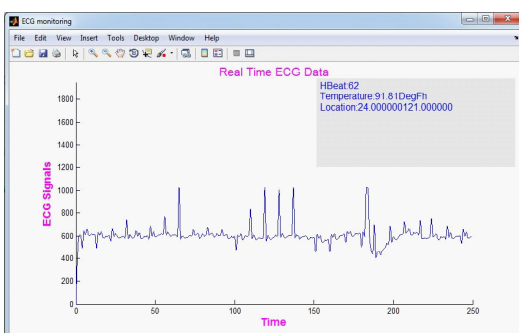


Figure-4: ECG signal plotting in MATLAB

The proposed system uses MATLAB software for ECG signal plotting using GUI. Using serial communication port MATLAB is used for plotting graph of ECG signals along with the heart beat and temperature monitoring data with location display in the dialogue box.

II. PROPOSED METHODOLOGY:

In this paper we are presented a system that can provide an efficient health service to patients along with patient telemetry system using GPS, GSM services. The monitoring system is interconnected with the patient and continuously monitors the health parameters like ECG, heartbeat, temperature of the body etc and alerts in case of emergency to the predefined numbers through SMS messages along with location using GPS receiver. This tracking system is composed of a GPS receiver, ARM-7 LPC2148 Microcontroller and a GSM Modem for SMS services in case of emergency times. GPS Receiver gets the location information from satellites in the form of latitude and longitude. The ARM-7 LPC2148 Microcontroller processes this information and this processed information is sent to the authorities like take care or doctors using GSM modem.

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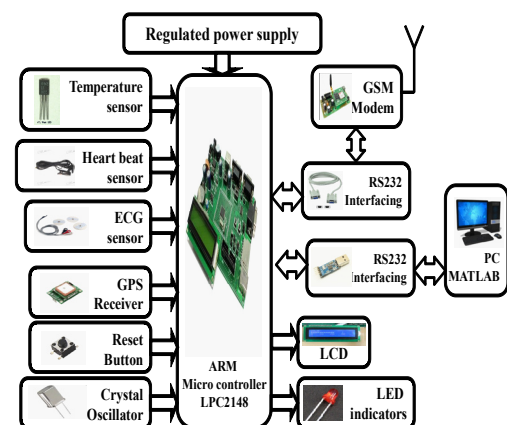


Figure- 5. Block diagram of proposed model

The presented application is a low cost solution for an efficient patient health monitoring and alerting system along with location using GPS. The controlling device of the whole system is an ARM-7 LPC2148 microcontroller. GSM modem, temperature, heartbeat, ECG plates and sensors are interfaced to the ARM-7 LPC2148 microcontroller. The health status can be sensed using different sensors using the ARM-7 LPC2148 microcontroller.

The system can efficiently send alert messages in emergency times, i.e. when a person is alone in home or traveling and his heartbeat or body temperature rises or lowers then alerting messages will be sent to the mobile phone, the message consists of location of that person also. Also, we can get the heart rate of the person by simply sending a pre-defined format SMS. The GPS receiver gets the data from the satellites. The system plots the graph of ECG monitoring and also displays the heart rate and temperature along with location on to the PC using MATLAB GUI. The proposed solution can be used in other types of application, like in security and tracking regions etc where the information needed is requested rarely and at irregular period of time (when requested).

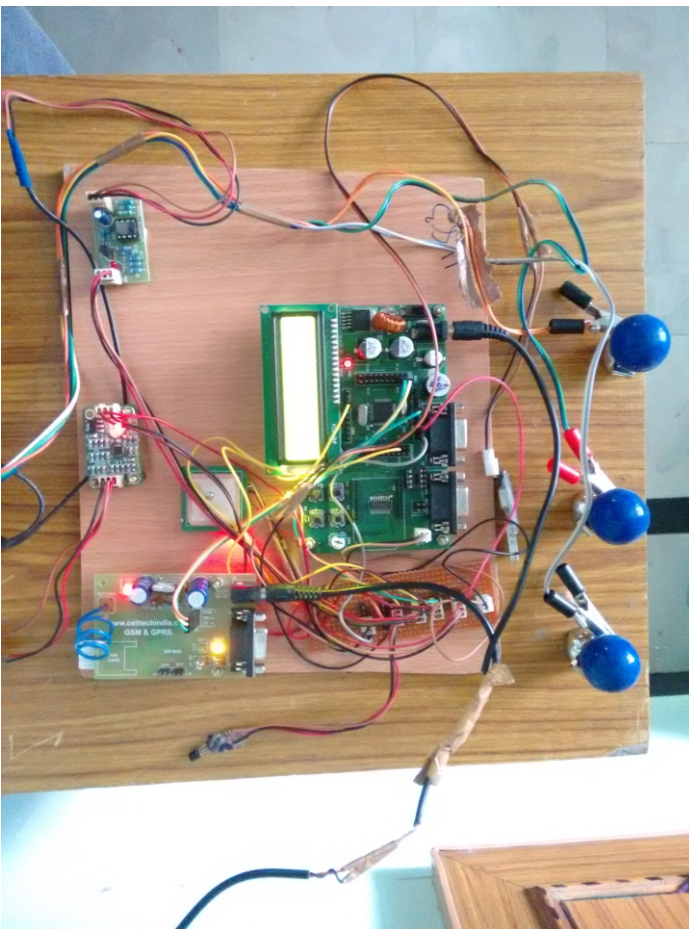


Figure- 6. Figure of all peripherals interfacing with the ARM 7 Microcontroller

Features of the proposed model:

- a) ECG signal acquisition and interfacing with micro controller.
- b) Temperature sensor and interfacing with micro controller.

- c) Heartbeat sensor and interfacing with micro controller.
- d) GSM module interfacing with micro controller.
- e) GPS module interfacing with micro controller.
- f) Construction of GUI using MATLAB.
- g) Interfacing microcontroller with MATLAB based PC.

III. HARDWARE DESIGN OF PORTABLE DEVICE:

The portable Electronic Health monitoring and alerting with secure mobile device consists of GPS receiver module, GSM modem, sensors like heart beat, temperature, ECG plates interfaced to an ARM-7 (LPC2148) microcontroller. The microcontroller (ARM-7 LPC2148) collects the data of location using GPS module and sends as input to the microcontroller (LPC2148). The wireless GSM transceiver transmits the location based information in the form of SMS messages either to the owners or authorities in case of emergencies to the predefined numbers.

a. ARM-7 LPC2148 Microcontroller:

In the Proposed health monitoring system we used the ARM-7 microcontroller is RISC microprocessor architecture from Advanced RISC Machines Ltd. The ARM7 architecture is made up of a core CPU plus a range of system peripherals which can be added to a CPU core to give a complete system on a chip. It offers several architectural extensions which address specific market needs, encompassing fast multiply and innovative embedded ICE support.

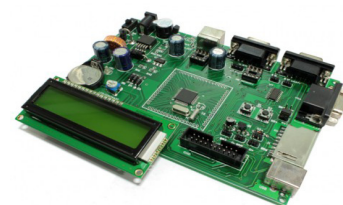


Fig.7 ARM-7LPC2148 Microcontroller

b. GSM modem:

The GSM modem provides the communication mechanism between the user and the microcontroller system by means of SMS messages.

It is capable of receiving a set of command instructions in the form of Short message service and performs the necessary actions. We will be using a dedicated modem at the receiver module i.e. and send the commands using SMS service as per the required actions.



Fig 8. GSM modem

c. GPS Receiver

In the idea behind an efficient health service provider we used location based alerts in emergency times using GPS receiver. GPS stands for global positioning system, which provides unequalled accuracy and flexibility of positioning for navigation. The GPS provides continuous three-dimensional positioning 24 hrs a day throughout the world. GPS provides accurate location and time information for an unlimited number of people in all weather, day and night, anywhere in the world. The Global Positioning System (GPS) is a satellite-based navigation system made up of a network of 24 satellites placed into orbit

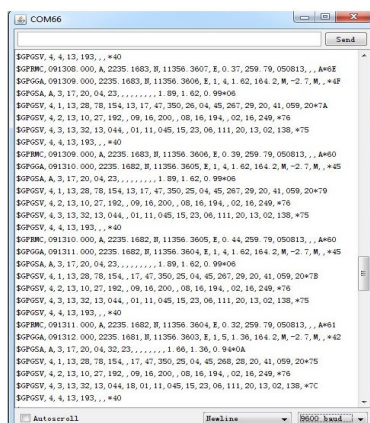


Fig 9. String data from GPS receiver

d. Heart beat sensor:

The functioning of this device is based on the truth that the blood circulates for every one heart beat which can be sensed by using a circuit formed by the combination of an LDR and LED.

Depending upon the rate of circulation of blood per second the heart beat rate per minute is calculated. This device consists of a micro controller which takes the input from the heart beat sensor, temperature sensor, pressure sensor and also calculates the heart rate of the patients.



Fig 10. Heart beat sensor Flip model

d. Temperature sensor:

The LM35 sensor series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. To detect the heat produced during fire occurrence, engine over heat of vehicles, we make use of it. The temperature sensors contain a sensing element enclosed in housings of plastic or metal. With the help of conditioning circuits, the sensor will reflect the change of temperature.

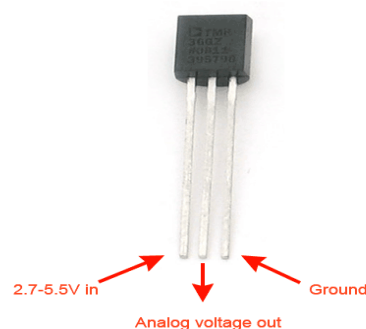


Figure- 11.LM35 Temperature sensor

e. ECG sensor Plates:

Electrocardiogram sensor is a graphic produced by an electrocardiograph, which records the electrical voltage in the heart in the form of a continuous strip graph. It is the prime tool in cardiac electrophysiology, and has a prime function in screening and diagnosis of cardiovascular diseases. This sensor measures the pulse rate of the patient



Fig-12: Block diagram of ECG sensor

f. LCD Display module:

One of the most common devices attached to a micro controller is an LCD display. A liquid crystal display is special thin flat panels that can let light go through it, or can block the light. Some of the most common LCD's connected to the many microcontrollers are 16x2 and 20x2 LCD displays. It means that 16 characters per line by 2 lines were displayed and 20 characters per line by 2 lines were displayed, respectively. Liquid crystal displays are usually abbreviated as LCD's. These displays are often used in battery-powered devices, such as digital watches, since they require very little amount of electricity consumption. **Results:**



Figure: values displayed in LCD

Fig.13. LCD module

IV CONCLUSION:

The existing system proposes a way to use the resources provided by the controller which has good availability and is able to monitor the vital parameters of health in a cost efficient manner. A good monitoring of ECG is provided if it accompany with a good DSP processor to process raw ECG waveform using MATLAB GUI tool. The system presents an Integrating feature of all the hardware components been used and developed in it. The Presence of each and every module has been reasoned out and placed very carefully. Hence the contributing to the best working unit for a tracking of vehicle security system has been designed perfectly.

Secondly, using highly advanced IC's like GPS module, GSM technology with the help of growing technology, the project has been successfully implemented with a unique idea. Thus the project has been successfully designed and tested. The presented idea can be extended by using other wireless technology like Wifi, Bluetooth can be used to increase the communication wireless distance onto the smart mobile phone for plotting ECG graph using Android OS. Also, GPRS module can be used to send the monitored heart beat values and alerting messages to predefined web link about emergency. By interfacing with MMC card the health parameters can be stored. The assistance of a web server to the present project will made the system more independent which will email the details of victim.

REFERENCES:

- [1] Joseph A. O'Sullivan, Robert Pless, "Advances in Security Technologies: Imaging, Anomaly Detection, and Target and Biometric Recognition", Microwave Symposium IEEE/MTT-S International Volume, Page(s):761 – 764, 2007.
- [2] Lihe, LvFlang "Design of Intelligent Mobile Vehicle Checking System Based on ARM7"
- [3] Robert T. Collins, Alan J. Lipton, et al. A System for Video Surveillance and Monitoring. Carnegie Mellon University, 2000.
- [4] C. Stauffer, W. E. L. Grimson. Learning Patterns of Activity Using Real- Time Tracking. IEEE Trans, PAMI, 2000, 22(8): 747- 757
- [5] American Heart Association, <http://www.american-heart.org>, 2007.
- [6] D. Lloyd-Jones, R. Adams, M. Carnethon, "Heart disease and stroke statistics—2009 update: a report from the American heart association statistics committee and stroke statistics subcommittee," Circulation 2009; 119: 41.
- [7] Y. M. Huang, M. Y. Hsieh, H. C. Chao, "Pervasive, Secure Access to a Hierarchical Sensor-Based Healthcare Monitoring Architecture in Wireless Heterogeneous Networks," IEEE Journal on Selected Areas in Communications, vol. 27, No. 4, May 2009.

- [8] K. Dearne, "Project Flatline," Australian IT, September 2005, pp. 1- 4. [9] T. Martin, E. Jovanov, and D. Raskovic, "Issues in wearable computing for medical monitoring applications: A case study of a wearable ECG monitoring device," Int. Symp. Wearable Computers ISWC 2000, Atlanta, GA, Oct. 2000.
- [10] C. Otto, A. Milenkovic, C. Sanders, and E. Jovanov, "System architecture of a wireless body area network for ubiquitous healthmonitoring," J.Mobile Multimedia, vol. 1, no. 4, pp. 307–326, 2006.
- [11] A. Milenkovic, C. Otto, and E. Jovanov, "Wireless sensor network for personal health monitoring: Issues and an implementation," Computer Communications, vol. 29, no. 13/14, pp. 2521–2533, 2006.
- [12] M. F. A. Rasid and B. Woodward, "Bluetooth telemedicine processor for multi-channel biomedical signal transmission via mobile cellular networks," IEEE Trans. Inf. Technol. Biomed., vol. 9, no. 1, pp. 35– 43, Mar 2005.
- [13] V. Shnayder, B. Chen, K. Lorincz, T. R. F. Fulford-Jones, and M. Welsh, "Sensor networks for medical care," Div. Eng. Appl. Sci., Harvard Univ.,Cambridge, MA, Tech. Rep. TR-08-05, 2005.
- [14] R.-G. Lee, C.-C. Lai, S.-S. Chiang, H.-S. Liu, C.-C. Chen, and G.-Y. Hsieh, "Design and implementation of a mobile-care system over wireless sensor network for home healthcare applications," in Proc. 28th Annu. Int. Conf. IEEE-EMBS, New York, Aug. 30–Sep. 3, 2006.
- [15] S. Dagtas, Y. Natchetoi, and H. Wu, "An Integrated Wireless Sensing and Mobile Processing Architecture for Assisted Living and Healthcare Applications," Proc. 1st ACM international workshop on systems and networking support for healthcare and assisted living environments, pp. 70–72, 2007.
- [16] J. Rodriguez, A. Goni, and A. Illarramendi, "Real-Time Classification of ECGs on a PDA," IEEE Transactions on Information Technology in Biomedicine, vol. 9, pp. 23-34, 2005.
- [17] N. Daja, I. Relin, and B. Reljin, "Telemonitoring in cardiology-ECG transmission through mobile phones," J.Annals Academy Studenica, vol. 4, 2001, pp.63-66.
- [18] Cardio Control. <http://www.cardiocontrol.com/cardio.htm>.
- [19] R. C. Hawkins, "Evaluation of Roche Accu-Chek Go and MedisenseOptium blood glucose meters," Clin Chim Acta 353:127-131, 2005.
- [20] L. Dockstader, R. Benlamri, "MORF: A Mobile Health-Monitoring Platform," IT Professional, vol. 12, pp. 18–25, 2010.
- [21] W. Wu, J. Cao, Y. Zheng, and Y. Zheng, "WAITER: A wearable personal healthcare and emergency aid system," In PerCom '08: IEEE International Conference on Pervasive Computing and Communications, 2008.
- [22] A. Pantelopoulos, N. G. Bourbakis, "Prognosis - A Wearable Health- Monitoring System for People at Risk: Methodology and Modeling," IEEE Transactions on Information Technology in Biomedicine, vol. 14, no. 3, 2010.
- [23] V. Gay, P. Leijdekkers, and E. Barin, "A Mobile Rehabilitation Application for the Remote Monitoring of Cardiac Patients after a Heart Attack or a Coronary Bypass Surgery," PETRA'09, June 09–13, 2009, Greece.
- [24] Alive Technologies, <http://www.alivetec.com>
- [25] A&D Medical website <http://www.andmedical.com.au>