

Transferring ECG Signal Using GSM Technology

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Abstract— Nowadays, there are many growing attempts and achievements to elevate efforts in biomedical field. Best achievements are those to save human life in the first concern. It is in fact that people are in a growing need of emergency care before being moved to hospitals or health centers. Therefore, patients may suffer from the delay of being aided because of there far place from health centers. Having the patients' ECG available with the emergency physician helps the emergency doctor in the ambulance to correctly deal with the patient based on the preliminary diagnoses. This requires the patient's electrocardiogram (ECG) to be transmitted in a compact or portable way to be diagnosed remotely.

This paper aims at providing an overview of ECG transformation and proposing a specific application to accelerate the treatment with the patient by correct transformation of the ECG using the mobile technology to a target or assigned physician over at the emergency department. Researchers have started the methodology with getting a hold of scientific background of biomedical related issues. Then, the paper empirically proposed an application that used mainly the ECG module, PIC microcontroller, and two GSM's modules to transfer ECG from patient's location to the assigned physician remotely. As part of the achievements, researchers successfully tested the application that resulted in satisfied outcomes as expected.

Keywords- Biomedicine, ECG transformation, GSM application, e-health, telemedecine.

I. INTRODUCTION

Telemedicine can be defined as the delivery of health care and sharing of medical knowledge over distance using telecommunication means. The aim of telemedicine is to provide expert-based health care to understaffed remote sites through modern telecommunication (wireless communications) and information technologies. Telemedicine nowadays is being enhanced and growing very fast. The power of telemedicine is the effective use of current technology to better services and fast treatments while having patients in emergency case before moving to hospital such as treatments during the travel of the ambulance.

This paper focuses in the first place on achieving a better and fast treatment while moving the patient to hospital by the ambulance. The main concentration and contribution is having the ECG signal of the patient transferred to the physician's PC

over at the hospital in order to be diagnosed and hence a better and fast appropriate instructions.

The main objective of this paper and the proposed application is to present a better health service for the patient especially for the critical cases. On the other hand, this provides a responsible physician with the ECG before having the patient admitted to the health center.

Researchers used in the methodology a scientific search of related work, then built a complete application based on ECG module (KL-75001), PIC microcontroller (PIC 18F4550), two GSM modems, and the programmed application over the physicians PC on the remote side. The system then, has been tested after being installed in the PPU computer labs. The tested system provided a correct outcomes. Mainly it received the ECG by GSM network and received the transferred ECG signal by the peer physician exactly without noticeable severe errors.

Other than the hardware components needed to be used to form the wireless ECG system, several platforms and tools were essentially used, such as programming the PIC (using MPLAB C18) to make analog-digital conversion (ADC) [5]. The PIC is interfaced with GSM modem at the patient side. The master application over the physician side is programmed using C#.net. Note that the study inevitably required some other tools used to fulfill the research objectives and obtain the accurate intended outcomes.

II. RELATED WORK

The number of reported deaths in Palestine in 2010 (10,733), the heart and blood vessels are the main cause of death for the Palestinians reported in 2010, where the rate was (25.4%) of the total reported deaths [1]. The availability of prompt and expert medical care can meaningfully improve health care services at understaffed rural or remote areas. During emergency cases such as coronary artery diseases and cardiac arrests, survival of patients is related to the "call to needle" time, where thrombolytic might require in less than 60 minutes and has to be done during transportation to a main hospital.

Rodriguez et. al [2] in their proposed wireless ECG Bluetooth based prototype, have implemented and presented a low cost, portable system with wireless transmission for real time ECG acquisition, archiving and visualization both in a mobile phone and a PC. They achieved their results by

transforming their ECG signals by Bluetooth module between the PC and mobile device.

Borromeo et. al [3] presented a new wearable wireless system for Electrocardiogram (ECG) acquisition and processing, using wireless transmission on demand (either the complete ECG or only one alarm message, just in case a pathological heart rate detected). Size and power consumption are optimized in order to provide mobility and better service. In this study, they have designed a modular hardware system and an autonomous platform based on a Field-Programmable Gate Array (FPGA) for developing and debugging. The modular

useful tool for electrocardiograph calibration and monitor, to incorporate as well in educational tasks and in clinical environments for early detection of faulty behavior.

III. HARDWARE SYSTEM

Hardware part is divided into two parts: the first part is placed near the patient either in ambulance or in patient's house. It consists of the ECG module (KL-75001), PIC microcontroller and GSM module. The second is placed nearby in the hospital (doctor side). This part consists of a peer GSM module connected serially with the PC as shown in figure 1.

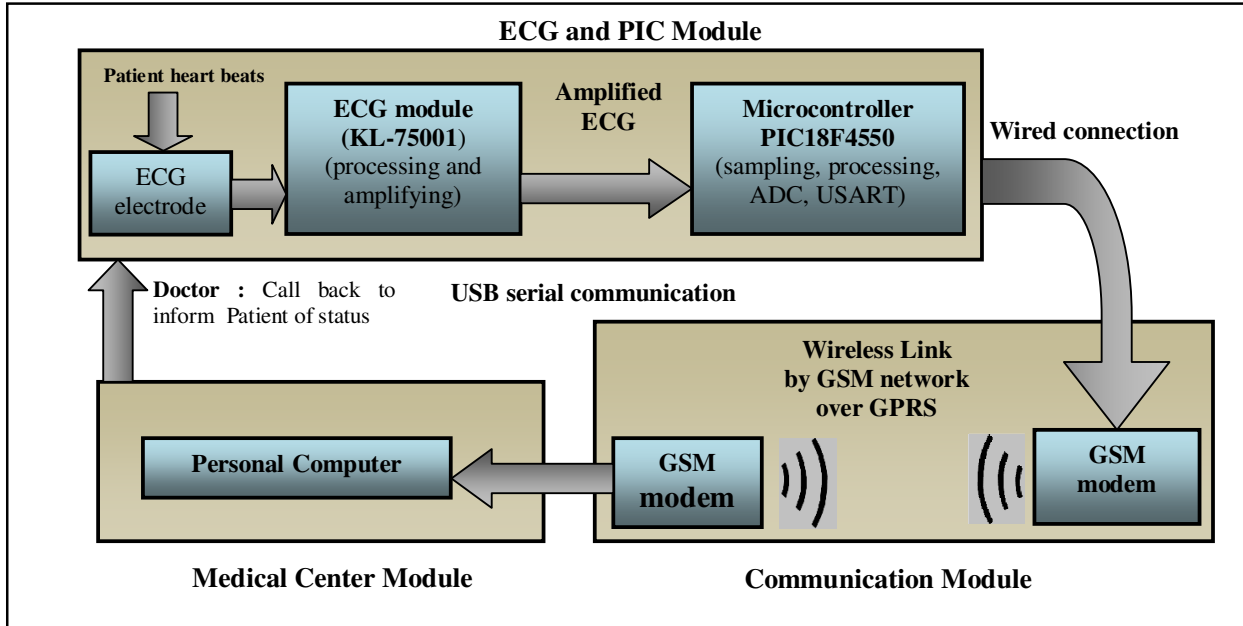


Figure 1: Hardware Block Diagram

approach allows to redesign the system in an easy way. Its adaptation to a new biomedical signal would only need small update.

The hardware system is composed of three layers that can be plugged/unplugged: communication layer, processing layer and sensor layer. In addition, they presented a general purpose end-user application developed for mobile phones or Personal Digital Assistant devices (PDAs).

Another tangible contribution to Tele-Health via GSM mobility is the proposal for the development of a module that provides mobility to the doctor and the patient, by detecting the abnormalities in the bio signal of the patient in advance and sending an alert SMS to the doctor through Global System for Mobile (GSM) [4]. Thereby taking suitable precautionary measures and reducing the critical risky-level of the patient.

Martinezl et. al [5] presented a simulator for surface recorded ECG signals. The device, based on a microcontroller and commanded by a personal computer, produces an analog signal resembling actual ECGs, not only in time of course and voltage levels, but also in source impedance. The simulator is a

ECG module is responsible for reading heart rate from patient's body and sending it to PIC microcontroller. PIC microcontroller converts the heart rate from analog form to digital binary code. GSM module sends the binary code from the first part to the second part where the peer GSM module take care of the received signals.

IV. SOFTWARE SYSTEM

PIC microcontroller PIC18F4550 is used as analog to digital converter (ADC) as well as initialization of universal synchronous asynchronous receiver transmitter (USART) for a serial connection to GSM modem. The microcontroller also controls the sample frequency which is set to 200Hz, where the frequency equals to $(2 \times \text{ECG signal frequency})$ as shown in figure 2. We have used sample rate as 200 sample/sec having number of samples of 2400 with an 8 bit resolution, as provided by the microcontroller.

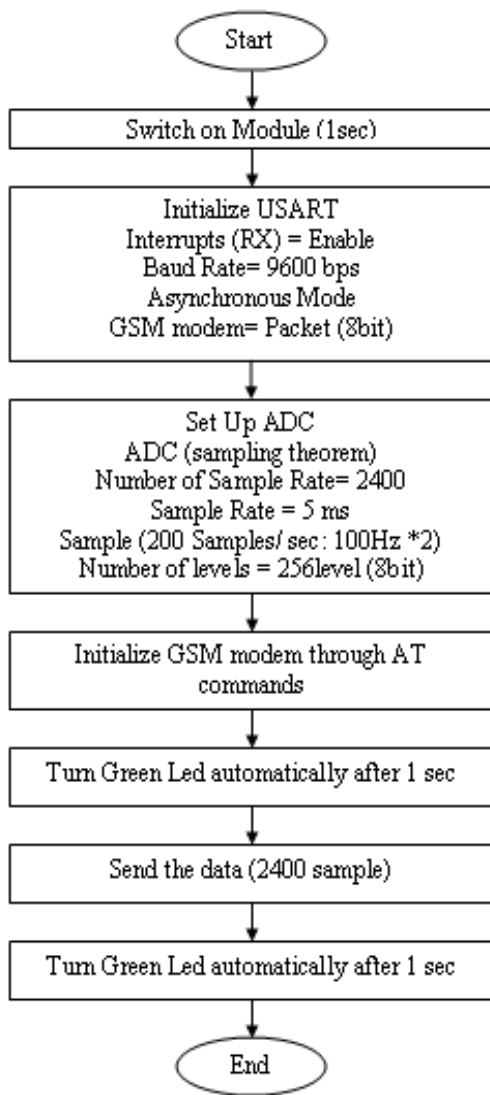


Figure 2: PIC Microcontroller Function Steps

Researchers built the main interface application using C#.Net. The general functionality of the system is to enable the doctor for monitoring and diagnosing the Patients, reconvert the digital packets to analog signal (DAC), and storing patients information in the SQL Database to be authentically retrieved upon request. The following algorithmic steps show the general functionalities of the system.

1. *Start*
2. *Apply authentication*
3. *Enables the system*
4. *Apply connection (COM, Baud rate, Parity, Stop bit)*

5. *Get the digital ECG*
6. *Digital to Analog conversion*
7. *Display an ECG signal*
8. *Store patients information and ECG*
9. *Stop*

After reading ECG signal from the patient by electrodes of ECG module, signal will be transmitted to the PIC microcontroller to make analog to digital converter (ADC) operation, then the digital packets will be transmitted to GSM module. GSM module receives the digital packets to send them to the other GSM module in the hospital, then transmits them to the doctor PC.

The application on PC is responsible for receiving the digital packets then reconverts them to analog signal. This heart rate signal is then displayed on the screen as shown in figure 3, and be stored into the patient database to be used by the responsible doctor.

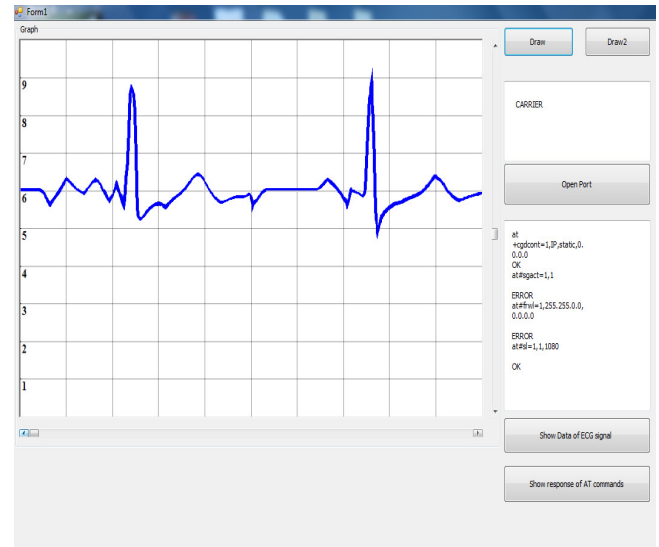


Figure 3: Received ECG signal

In the following figure 4 the sequence diagram shows the high level dialogue between the blocks of the system represented as instances of classes. The stimuli actor in this scenario is the patient. The heart beats are taken by the nurse or the doctor in the patient side. Then the system transforms the digitized signal wirelessly to the remote side to be reconverted back to the original ECG signal by the application and then treated and used as needed.

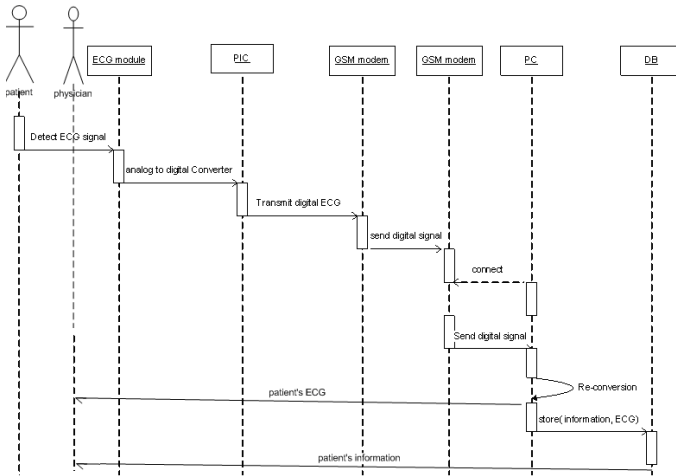


Figure 4: Sequence diagram of the system

V. CONCLUSION AND FURTHER WORK

In this paper we proposed and presented a way of transferring ECG signal wirelessly using GSM technology. The final application successfully received the digital signal from the GSM modem at the patient side, and then successfully reconverts the received signal on the peer PC at the hospital side.

The future work, as a continuation of this paper, is the ability of sending other information such as the blood pressure and patient's temperature along with the ECG. This application is recommended to be applied among the hospital sites and also, to monitor patients at home remotely.

ACKNOWLEDGMENTS

In this work, we gratefully acknowledge the role of Teaching Assistance Engineers in parts of this work which has been presented as a graduation project. We also acknowledge the contribution of Hasan Alsa'adah, Raed Salhab, and Ali Daraweesh who worked in the communication part of the graduation project.

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