Bluetooth-enabled Electrocardiogram Monitoring GBA System

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**Introduction**

Electrocardiogram (ECG) is important for detecting heart activities of patients. However, its equipment is expensive and bulky. This introduces great inconvenience to both of doctors and patients.

In order to reduce the cost and provide a user-friendly monitoring device, we have built a Bluetooth enabled Electrocardiogram (ECG) Game boy Advance (GBA) Monitoring System by using the GBA, a low cost console, to detect the ECG signals with the implementation of Bluetooth technology for the wireless communication between GBA and the base station.

**Aim & Objectives**

Our aim was to develop a multi-user detecting system to monitor handheld ECG devices which connect ECG circuit, GBA and Bluetooth together.

In terms of the hardware, we had to build a two-layered PCB, which could reduce the size of the ECG circuit. A special control switch had to be developed so that GBA could make use of one port to connect to two circuits (ECG module and Bluetooth module) at the same time.

In terms of software, We had to implemented the Bluetooth protocol stack up to L2cap, which provided connection oriented data services to upper layer protocol in GBA. Moreover, a user-friendly GUI in both GBA and base station for user to initialize the Bluetooth stack, and to choose application mode and user data for monitoring purpose had to be developed.
ECG-GBA-Bluetooth device

- Right Leg Electrode
- Right Arm Electrode
- Left Leg Electrode
- Left Arm Electrode

89c52 Micro-controller

- Stage I pre-amplifier
- Stage II amplifier
- Analog/Digital Converter

- Band pass filter
- Notch filter

GBA serial adaptor

- GBA Application Program

GBA Application Program

- Mode 1: ECG detection and storage of data
- Mode 2: User Data Transfer of stored data
- Mode 3: ECG real time transmission

Listening and ECG application Program in Linux

- Signal processing
- Display of ECG waveform and heart beat calculation

Mode 1: ECG real time transmission

Mode 2: Saved record display (User Database)

Mode 3: ECG real time transmission

Switch open for data from 89c52 to GBA

Switch closed for initialization of Bluetooth

Listening ECG data from Bluetooth

ECG data from GBA

ECG data to Bluetooth

ECG signal + Noise

Noise filtering out of ECG signal (50Hz)

ECG signal captured every 10ms

Digitalized ECG signal

ECG data from GBA

ECG data to GBA

Signal processing

Interaction between real time modes
Results

ECG & heart beat detection in GBA

Transmission of stored ECG data from GBA to base station

ECG data received from GBA

User database in base station

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