Development and application of the ECG acquisition based on BMD101

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\textbf{Abstract}—The article describes the development of a system of ECG measurement based on the chip BMD101 of NeuroSky. The whole system consists of the analysis and acquisition software run on the Android platform, BMD ECG acquisition and a pair of paste electrodes. We made several measurements and tests on different groups of people (divided by the ages, gender & jobs) and worked out some conclusion about the pattern of heart rate and those factors.

\textbf{Keywords}—BMD101, NeuroSky, ECG algorithm, Android

\section*{I. INTRODUCTION}

NOWADAYS, people’s life become more and more closely related to their smart phones. At the same time, with the fast development of economy, people’s health conditions are at risk of getting damaged potentially by their careless diet habit, long-hour of working and lack of exercises. Therefore, a software that can reveal the heart rate and the heart age of the tester would be a great help for those who care too little on their health condition and help them adjust their lifestyle timely. In addition, we designed the software based on Android in order to provide a convenient way for people to implement their health checking everyday.

\section*{II. INFORMATION ABOUT BMD101}

BMD101 [1] is NeuroSky’s 3rd generation bio-signal detection and processing SoC device. BMD101 is designed with an advanced analog front-end circuitry and a flexible, powerful digital signal processing structure. It targets bio-signal inputs ranging from uV to mV level and deployed with NeuroSky proprietary algorithms. The Low-Noise-Amplifier and ADC are the main components of the BMD101 analog front end. Because of the BMD101’s extremely low system noise and programmable gain, it can detect bio-signals and convert them into digital words using a 16-bit high resolution ADC.

\section*{III. FORMATION OF THE ECG ACQUISITION SYSTEM}

The whole system consists of an Android phone(with an analysis and acquisition software), BMD101, and three paste electrodes. The constitution is designed as followed:

BMD101 is designed to attach the phone by Bluetooth on one side and the pair of three paste electrodes by wires on the other. BMD receives analog signals from the paste electrodes by SEP and SEN and then transforms the analog signals into digit signals and send them to the phone by TX and RX.

\begin{figure}[h]
\centering
\includegraphics[width=0.5\textwidth]{system_composition.png}
\caption{System composition}
\end{figure}

\section*{IV. DESIGN & IMPLEMENTATION OF SOFTWARE SYSTEM}

\subsection*{A. Tools and environment of development}

Software Development Environment: Windows

Development tool: JDK, Eclipse, ADT, the API of NeuroSky.

JDK is the abbreviation of Java Development Kit, which is the core of Java. (Download: http://www.oracle.com/technetwork/java/javase/downloads/index.html)

Eclipse is an extensible development platform based on Java with open source. Eclipse is used as the IDE for the development of Java and Android.

Android SDK is the Android development kit tool. It provides the Android platform development kit and tools at all levels.

Android Development team dedicated to the Eclipse IDE to customize a plug-in: Android Development Tools (ADT). After the Eclipse installs ADT, we can start our development[2].

The ThinkGear SDK (Android) from NeuroSky[3] would assists us in developing the softwares based on the biosensor of ThinkGear Theories. The Android apps could acquire and use the bio-signal data, such as acquiring ECG and EEG information from the NeuroSky sensors (including the equipment based on BMD101)

\subsection*{B. Introduction of the function}

The primary function of the system are Connecting, Disconnecting, Data-collecting, Data-display, etc. The data collected are mainly the heart rate, along with Relaxation, Heart Age, etc. We use the ECG algorithm of NeuroSky. NeuroSky biometric algorithms are a collection of the most useful and widely applicable heart health algorithms for wearables, mobile devices and health and wellness service providers that are building consumer products. Our biometric algorithms are designed for the purposes of monitoring fitness and heart health and for applications that monitor the health of a recovering heart.

\subsection*{C. Software Interface}

The interface of the software consists three parts, the upper,
On the upper of the interface are three icons: connect, disconnect, clean, which are for controlling the software to receive signals and shut down.

Below the three icons are six numbers, each of which stands for a reference point:
1) The heart rate (int value) reports the current heart rate of the user, in units of beats per minute (BPM).
2) The Heart Age data value provides an indication of the relative age of a subject heart, based on their Heart Rate Variability (HRV) characteristics as compared to the general population. A low HRV is associated with an increased risk of mortality, and is represented by a Heart Age that is possibly higher than the user's biological age.
3) The Respiration data value reports a user's approximate respiration rate in breaths per minute.
4) The Relaxation data value gives an indication of whether a user's heart is showing indications of relaxation, or is instead showing indications of excitation, stress, or fatigue, based on the user's Heart Rate Variability (HRV) characteristics. It is reported on a scale from 1 to 100. High Relaxation values tend to indicate a state of relaxation, while low values tend to indicate excitation, stress, or fatigue.
5) Whenever an R-peak is detected along a user's PQRST ECG/EKG, then a RrInt data type is sent to your app's data event handler indicating the R-R interval, in milliseconds, since the last R-peak.

V. APPLICATIONS
Stick the pair of paste electrodes on the left chest, right chest and one of the legs (Notion: stick the electrode horizontally). Then turn on the ECG acquisition by BMD101 and run the software on the phone. After a few seconds, the information would appear one by one. To reach the best version of the results, we suggest the testers to run the test calmly sitting.

We tested the system on 450 people of all ages, jobs and gender. We recorded all their information collected. Eventually, we have 436 effective data set. Then, we worked out a curve that is formed by age and the heart rate as followed:

From the curve, we find that teenagers, who are undergoing the period of the Development with their body functioning become more and more mature and more and more exercises, have a increasing heart rate as they grow older. When people reach their mid-twentieth, the heart rate reaches its pinnacle. After 25, the heart rate of most people starts to fall. However, then people become older than 50, their heart rates start to rise again. This time, the increase of the heart rate is cause by the decrease in metabolism.

From all the work above, it is proved that the system is of certain utility.

REFERENCES

Mr. Tingyu Wang is currently a student in Wuxi Big Bridge Academy International Department and is working on a research paper about the study based on the BMD101 of NeuroSky. He had also attended the 2015 MindTomorrow Conference in Beijing. Mr. Tingyu Wang focuses on mathematics and electronic engineering. He had attended the 2014 Interdisciplinary Contest in Modeling.

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