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Case Report

Remote Control and Smart Phone Display -- Human Body Loading by ECG Instrumentation

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Electrical instrumentation is now a real-time phenomenon and an active part of smart phone trends. Modern electronic devices and controllers can be seen everywhere. Personal information detectors provide timely and effective medical care. In previous times, personnel electronic devices, such as the smart phone, i-watch, and e-clothes were difficult to link. Nowadays, it's a good time to prevent a health tragedy in certain people. This study tries to focus on discussing the remote control and smart phone display topic, through ECG instrumentation from e-clothes to prevent the human body from taking excessive exercise. Besides, the research also built a database in a remote server, where it stored historical ECG records. Through the model, a real sport (running) case study and system validation was proposed. Humans have a possibility to optimize their sporting style. The e-clothes can send GPS signals to a remote server. The system would then track the routes taken and monitor human body loading. Future research suggests that mass human trials or more mathematical hybrid model designs should take place.

Key words: *ECG instrumentation, microwave power display, human body energy, optimal sport style, control engineering*

Introduction

Electrical instrumentation goes real-time and is an active part of smart phone trends. Modern electronic devices and controllers can be seen everywhere. Personal information detectors provide timely and effective medical care. In previous times, personnel electronic devices, such as the smart phone, i-watch, and e-clothes were difficult to link. Nowadays, it's a good time to prevent a health tragedy in certain people. This study tries to focus on discussing the remote control and smart phone display topic, through ECG instrumentation from e-clothes to prevent the human body from taking excessive exercise. Besides, the research also built a database in a remote server, where it stored historical ECG records. It would give strategic planning and advice to humans from their smart phone display to monitor real-time human heart loading.

Our study based on emergency department guideline, the normal adult heart rate is 60 to 100 beats/min, normal breathing 12 to 20 times/min; breathing if more than 30 times/min or less than 10 beats/min should give alert. However, in running exercise, upper bound of heart rate was setting at 150 beats/min.

The paper is organized as follows. In the next section, it would review previous related literatures. In section 3, the problem formulations were established. In section 4, information flow charts were described. Section 5 presented results and discussion. Finally, the paper is concluded in section 6.

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Literature Review

In the last 6 years, electrical instrumentation using mobile phones is a new trend, which is just beginning as a hot research topic. Wen et al. published a real-time ECG telemetered monitoring system design with a mobile phone platform.[1]

Kai et al. constructed a system of portable ECG monitoring based on a Bluetooth mobile phone.[2] Mitra et al. proposed a robust technique for delineation and features extraction of an ECG signal from mobile-phone photography.[3] Bose et al. stated that a smart phone enabled ECG recording can scale for the U.S. heart failure ambulatory population[4]

Although numerous literatures were related to ECG recording, there is only a limited amount of studies available on e-clothes of ECG instrumentation and medical computing in a remote controller, including mobile device applications.

Problem Formulation

This research adapts to finding the minimal health hazard factor, nt_i , as the model.[5] A dynamic selection model, in previous research, helps this study construct a more precise problem formulation.[5] In this study, the different stage of sport time ECG wave to historical ECG data records is compared. Let ECG_0 denote non-sport time ECG wave in a certain period time at stage 0. Let ECG_i denote sport time ECG wave in a certain period time at stage i. Let $Diff_i$ denote $ECG_i - ECG_0$ at stage i. Let Dan_i denote dangerous value of physiological signal acquisition instrument at stage i. Let denote a binary decision variable. The model is shown as follows.

EGG_0 : non-sport time ECG wave in a certain period time at stage 0

EGG_i : sport time ECG wave in a certain period time at stage i

$Diff_i$: $EGG_i - EGG_0$ at stage i

Dan_i : dangerous value of physiological signal acquisition instrument at stage i (It can be obtained from historical data records.)

nt_i : indicator of health hazard factor from sensor i

$$nt_i = \begin{Bmatrix} 1, \; if\; Diff_i > Dan_i \\ 0, \; otherwise \end{Bmatrix}$$

The MBINP (Mixed binary integer non-linear programming) model to minimize the times of indicator of a health hazard factor is as follows (Eq. 1-2):

$$\textbf{Min} \quad \sum_{i \in N} \tag{1}$$

s.t.

$$nt_{\mathrm{i}} \in \{0, 1\} \; \forall \; i \tag{2}$$

The Eq. (1) is to find a minimal times indicator of a health hazard factor.

The Eq. (2) declares artificial binary decision variable constraints. This model can be extended to become a new type of hybrid model of ECG wave, breathing wave, and 3D-motion study. We did not directly jump into that model due to research purposes and there were few literature discussing an optimal sports style, not to mention a new hybrid model.

Information Flow

A real-time ECG instrumentation and human body excessive exercise control is shown as Fig. 1. As sensors detect human ECG information, the signals will transfer into the remote server; then automatically compare this data to historical records. It evaluates the times of indicator of a health hazard factor. It also decides if the human body has undergone excessive exercise; if yes, let the smart phone alarm;otherwise, go to the next step. It would decide if the human needs any help; if yes, list strategic planning and advice; otherwise, go to the next step. Finally, it still continously monitors human body energy.

Case Report and Discussion

The cloud server was a desk computer with Intel Core i7-2670Qm 2.2 GHz CPU and 4 GB RAM for the computations. There were two versions of smart phone, one is an Apple Iphone 5, and the other is android based. The ECG instrumentation was bought from the Zephyr Company. The heartbeat parameter set at 40 to 150 times per minute. Based on research, if the heartbeat was not in this range, the instrument perhaps alert sportsman.[6,7] A 20 years-old young man ran around the university. The system detected the heart rate, respiration rate, ECG wave, and 3D move-

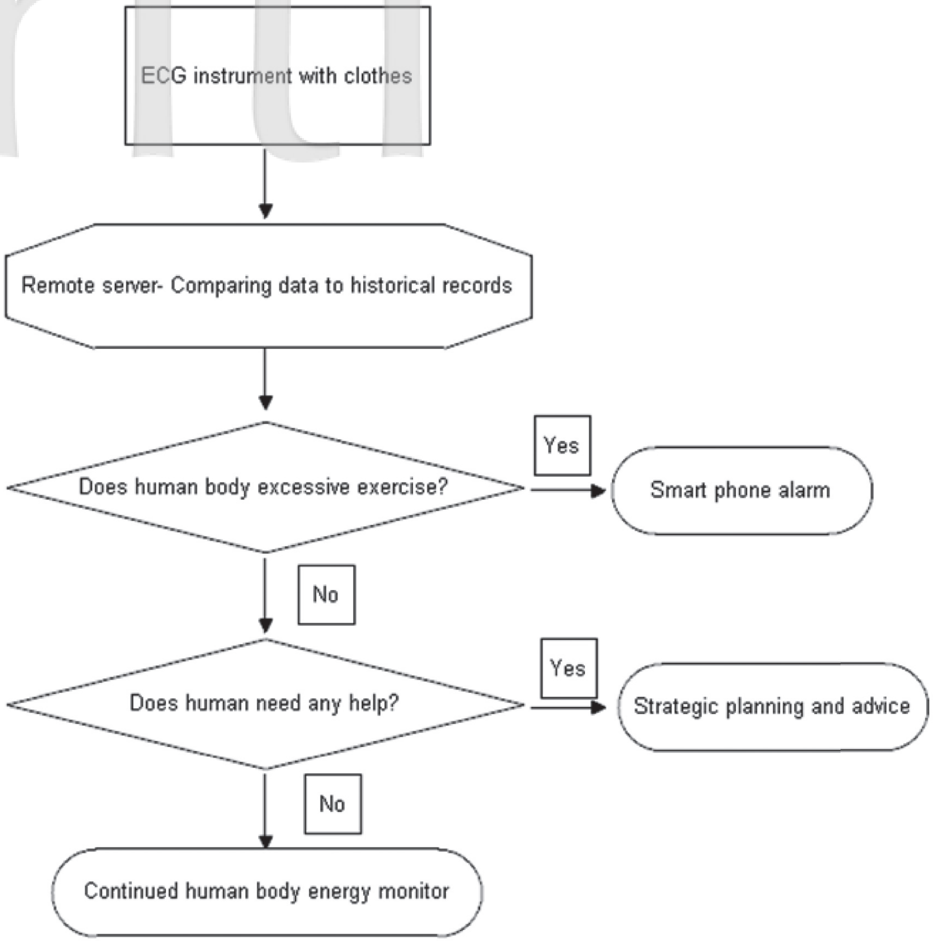

Fig. 1. Real-time ECG instrumentation and human body excessive exercise control.

ment of the human body, and body temperature was shown as Fig. 2. The e-clothes would send GPS signals to the remote server. The human can be precisely positioned. In Fig. 3, there was a map and running route and responding ECG wave. If excessive exercise is detected, the signals will send a warning to the e-clothes and smart phone. The research also built a database in a remote server, where it stored historical ECG records. It would give advice to remind the human to take a rest when the heart rate was too fast. When the respiration rate was too high, the smart phone would suggest that the human body should slow down the exercise due to preventing hyperventilation.

Conclusion

In previous research, although an ECG wave can be monitored in real-time, industries focused on the e-clothes and giving advice to remind humans when their sport was not found or mentioned. This research focuses on a remote control and smart phone display, especially in e-clothes, ECG wave, human body energy consumption and smart phone display. Through the model, a real sport (running) case study and system validation is proposed. Humans have a possibility to optimize their sporting style. The e-clothes send GPS signals to the remote server. The system would track the routes and monitor heart rate, respiration rate, ECG wave, and 3D movement of the human body, and body temperature, while preventing a tragedy happening.

Future research suggests that mass human trials or a more mathematical hybrid model design should be contemplated.

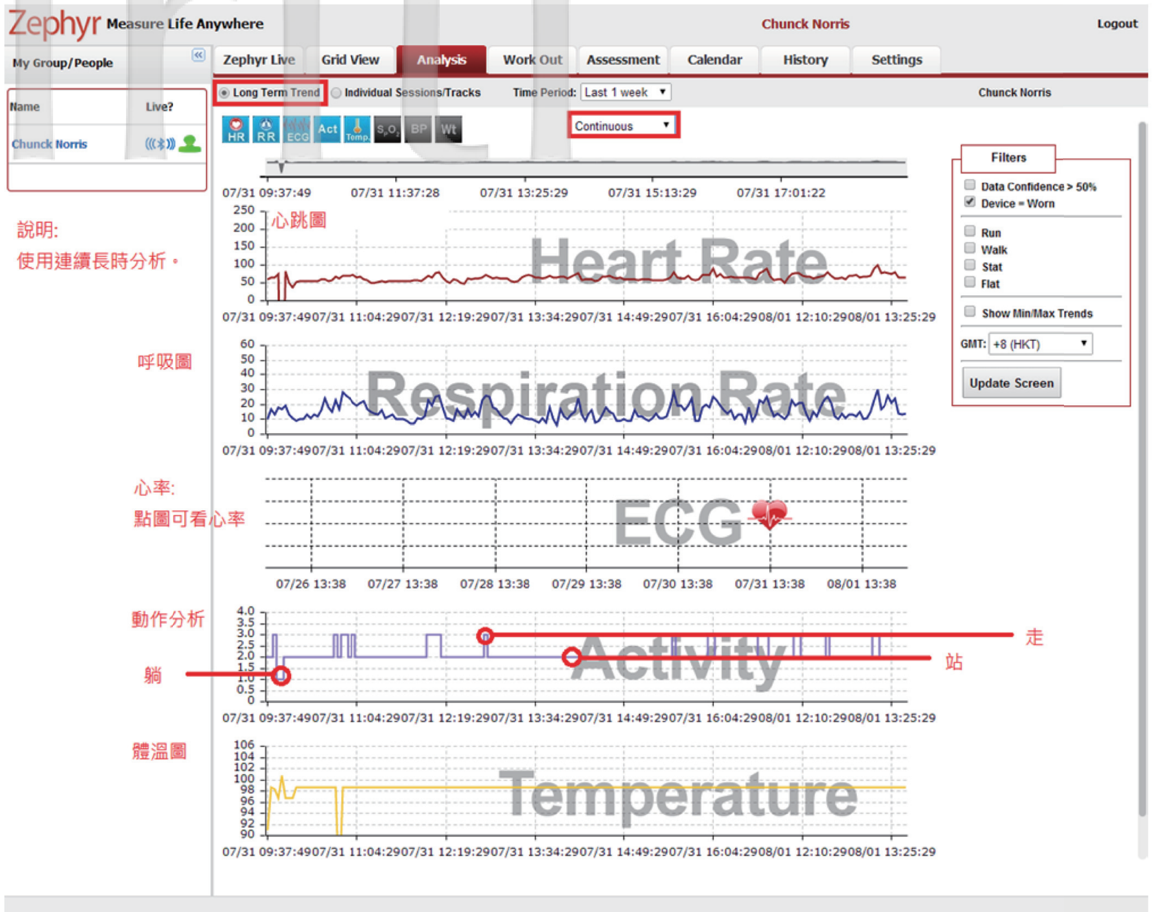

Fig. 2. Real-time monitoring of heart rate, respiration rate, ECG wave, and 3D movement of the human body, and body temperature.

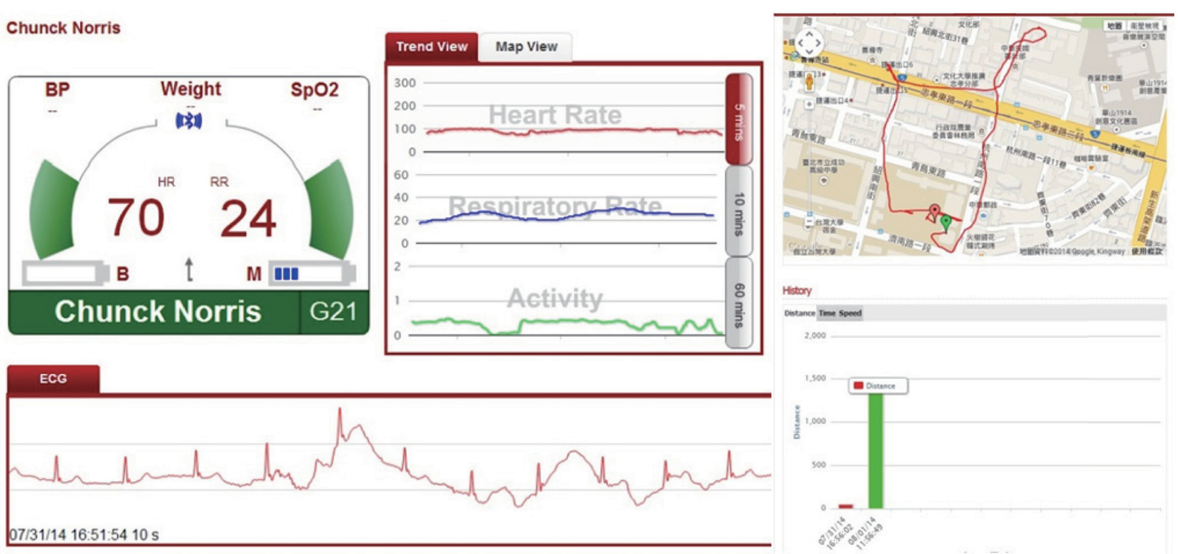

Fig. 3. The e-clothes sending GPS signals to the remote server.

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