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An e-caring chair for physiological signal measurement and recording

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ABSTRACT

There is an increasing awareness among the populace of the need for regular health check-up to detect diseases in their early stages and thereby administer treatments in a timely fashion. However, commercially available physiological signal monitoring devices, which may offer clues on the onset of diseases, are time-consuming, far from user friendly and limited in their applications. We design an e-caring chair that combines six modular physiological signal measurement instruments into a single unit, enabling users to simultaneously measure the blood pressure, body temperature, heart rate, height, weight and body fat percentage, and display the results and simple diagnoses in real time. The e-caring chair further allows for easy integration of additional physiological signal measuring devices, speedy measurements and long term monitoring of any trends that may emerge, making it easier for users to be alerted to physiological changes in the body without the need to enlist assistance from medical personnel. In this paper, we describe how this e-caring chair can be placed in several different environments for different purposes.

1. Introduction

Heightened awareness of a myriad of health care issues means that people nowadays are increasingly scheduling regular health check-up to ensure their physical well-being. Prevention is better than cure, and having regular health check-up will allow patients to identify potential symptoms before full-scale onset of diseases and thus nip them in the bud. However, the vast majority of people will only seek assistance at a hospital and schedule a detailed full body check-up only under severe discomforts or when the symptoms of the diseases are already manifest. While advanced medical technologies can easily pinpoint the exact symptoms of various diseases, they are often utilized at too late a juncture for the patients, forcing the latter to either expend tremendous amount of medical resources on (often futile) treatments or suffer long-term physical pains.

When physical ailments arise, they are usually accompanied by changes in the physiological signals dispatched by the body. This implies that when a disease begins setting in for a previously healthy individual, he or she can implement a self-treatment regime or seek medical assistance to prevent the disease from deteriorating into something more threatening. We can classify changes in the physiological signals into two categories, namely point exception and trend exception. Fig. 1 illustrates the concept of point exception; in this case, the body temperature of an individual exceeded 37 °C on Day 5. In the case for Fig. 2, the body weight of the subject increased by almost 5 kg in 4 weeks. Point and trend exception of physiological signals are equally important in the prevention of major diseases, although they are often neglected by the patients themselves.

According to statistics from the Taiwan Bureau of National Health Insurance [1], 10.6 billion New Taiwan Dollars a year was spent on outpatient hypertension treatments, primarily on medications to control the blood pressure, more than often with unsatisfactory results. One key reason is that there are usually no obvious symptoms for high blood pressure, high cholesterol levels, or high blood sugar levels. As such, patients often fail to follow through with continual monitoring, regular medications and regular follow-up visits. If patients can adhere more strictly to blood pressure control regimes, the incidence of stroke can be reduced by 30–40% and that of heart failure by 50%. Therefore, doctors are generally in consensus that patients should continue to monitor the physiological signals from their bodies. It should be noted that the average family typically owns two to three devices for continual monitoring of the physiological signals. Most of these devices have a number of glaring drawbacks. For example, the devices are usually manufactured by different companies, and can only monitor one or two physiological signals. Further, the data collected are usually stored separately in each individual device, rendering com-

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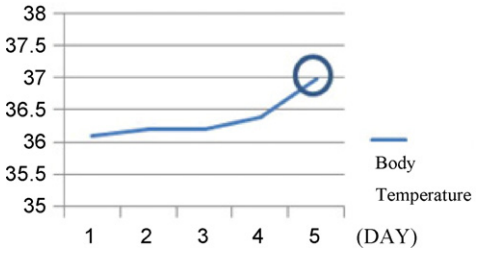

Fig. 1. The body temperature exceeded 36.5 °C on Day 5.

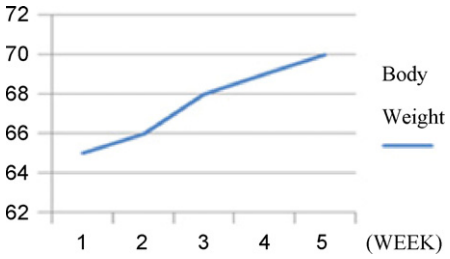

Fig. 2. The body weight increased by about 5 kg.

prehensive overview and long term observation difficult. Last but not least, it is prohibitively expensive and thus impractical for a patient to buy several different types of monitoring devices. In the rare scenario where the patient has a dedicated device for measuring each of the relevant physiological signals, he would still be unable to monitor the long term trend if he fails to record each and every measurement unfailingly every single day over an extended period.

2. Related works

Since the end of the 20th century, many studies have begun to emphasize the importance of daily physiological monitoring. For example, the Ideo Company developed a mirror in the bathroom that can measure the heart rate and blood pressure of the user and subsequently forward the results to doctors for further diagnosis [2]. A research team from Kawarada pioneered a way to perform the ECG test through the use of weak electrical currents in the water within a bathtub [3]. Tatsuo and his research team applied the same concept from Kawarada, and installed sensors on the toilet seat for gathering ECG data [4–6].

Many renowned companies in Japan have devoted significant financial investments to research and development of measurement devices for daily physiological signals. One notable example is Panasonics, which unveiled the eHII House [7] to showcase the functional structure of a next generation house [8–12]. It includes a toilet that can collect data such as the body weight, body fat percentage, body temperature, blood pressure, etc. for display on a LCD screen nearby and for transfer into an information center developed by Panasonic via the Internet. Professional nutritionists will then provide users with the proper assessments and appropriate recommendations with regard to diet and rest.

TOTO, another sanitary equipment company, has collaborated with the Smart Building Simulation Laboratory in Taiwan [13] to develop an Intelligent Health Toilet that can collect data on the sugar concentration in the urine and display the real-time results on a screen to the user. The system also allows for the transfer of data to the medical center for monitoring the physical well-being of the patient. TOTO has also announced another toilet named "Well You II", which can measure body weight, body fat percentage, blood pressure, heart rate, sugar and protein concentrations in the urine, etc.

In this paper, we attempt to integrate several physiological signal measurement devices into a chair, after which additional devices can be incorporated into the chair as the needs of the user evolve; this chair can also analyze and monitor the physiology for long term observation.

3. Our proposed chair

One key consideration during the design is to facilitate the daily measurement of the user's physiological signals in as convenient and expedient a manner as possible. Most of the physiological signal measurement devices nowadays are designed to operate in a sitting pose, with the exception of the body height and body weight. Therefore combining all the measuring devices into a chair is a reasonable approach.

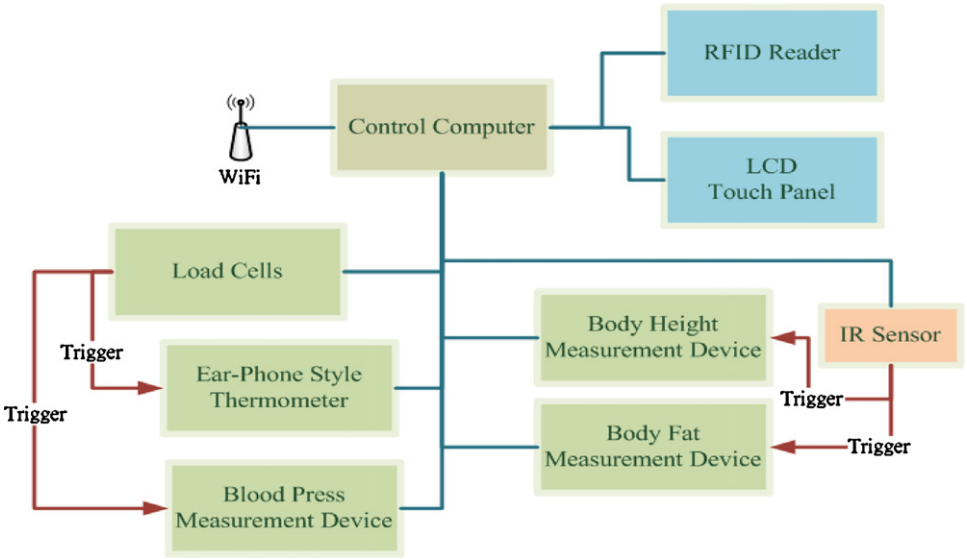

Fig. 3. The hardware architecture of our proposed physiological signal measurement chair.