Hybrid Vital Sensor of Health Monitoring System for the Elderly

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Abstract. There are many sensors to monitor vital signs in u-Healthcare system. These vital sensors including ECG, PPG, blood pressure sensor spend heavy processing resource and costs. We propose and developing a new type of hybrid vital sensor. We combine accelerometer and PPG module and control two basic sensors with classified situations. So, we can monitor vital signs more compactly, inexpensively and conveniently using our hybrid sensor. We measured the activity using 3-axis accelerometer and measured the heart rate and oxygen saturation using pulse oxymeter. The major problem of pulse oxymeter is motion artifact. But we suggested a new method using the combination of these two sensors. In case of active motion, we used and analyzed the accelerometer signal and withdraw the pulse oxymeter signal. In case of no activity, we adopt pulse oxymeter signal which has no motion artifacts. The important thing is to categorize activity patterns such as normal or abnormal activity. We categorized activities to 4 patterns which are normal activity, no activity(resting), sleeping and abnormal state. When the device detects abnormal condition, it sends a short message to server and then connected to the u-Healthcare center or emergency center.

Keywords: Hybrid, Vital, Sensor, Health, Monitoring.

1 Introduction

Rapid transition to aging society becomes very important problem day by day. Especially for the single elderly, it is critical problem that whose vital situation. According to the data from Statistics Korea, the aging index will increase rapidly from 9.5%(2006) to 14.3%(2018) and 20.8%(2026). With this trend, the number of single elderly is increases too. Knowing the emergency status of these single elderly is a critical problem in the emergency monitoring system. But the more exact status we want the more expensive and complex sensors will be necessary for this system.

In this research, we proposed a new hybrid method to extract vital sign using the accelerometer and the PPG sensor. Generally, PPG sensor needs more processing resource and power than the accelerometer. If we can classify a person's status to

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normal or abnormal, we can make more powerful investment in case of abnormal status. As a result, we may reduce processing resource, power and finally physical size of the sensor. The more compact size and reduced processing power will be helpful of wearing it.

2 Methods

2.1 System Block

Fig. 1 shows the illustration of our hybrid vital sensor. Touch sensor and temperature sensor decide the wearing status. Our sensor module will be worn on the wrist. The basic hybrid components are the PPG module and the accelerometer module. The processor classifies a person's status with the data from accelerometer and control the PPG module. We adopt 3-axis accelerometer which has maximum 8g gravity range and 50Hz acquisition rate. PPG sensor module has dual optical sensor which are arranged separately for more robust working. The basic idea is, categorize the human state using accelerometer and then switch on & off PPG sensor according to the categorized state. Then we can reduce the overall power consumption and increase the accuracy. Other sensors such as temperature and touch sensor are used to identifying wearing the module or not, and are used to the wearer's response.

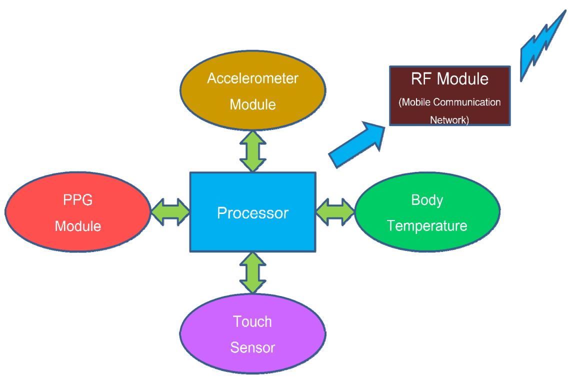

Fig. 1. System block of the hybrid vital sensor

We categorized the human state using the accelerometer. According to these states, our hybrid sensor works in appropriate operation mode. In normal activity, there exist motion artifacts, so pulse oxymeter is useless so we put the PPG in sleep state and activate the accelerometer. In resting state we can get the heart rate using pulse oxymeter. In sleep state further information that is O2 saturation can be obtained. In abnormal state, all sensors will be activated to monitor and judge the accurate status. These operation modes are illustrated in Fig. 2.

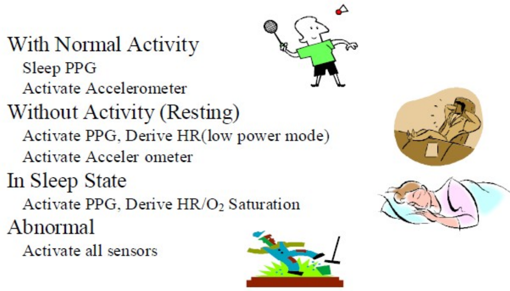

Fig. 2. Operation modes of hybrid vital sensor

2.2 Algorithm

Fig. 3 is an algorithm of hybrid vital sensor. When the algorithm starts, system power on and initialize each sensors. Then, first the activity data is acquired from accelerometer and classifies activities to appropriate patterns. Periodical activities such as working, running and other regular activities are classified to “Normal Activity”. When activity is classified to “Abnormal” the PPG module is powered on for more classification. The PPG module derives heart rate using simple algorithm which uses less power than deriving oxygen saturation. Derived heart rate is analyzed with activity to determine a person’s accurate status. If it is classified simple resting status, the algorithm continues heart rate monitoring. In the case of abnormal heart rate, the PPG module measures the oxygen saturation to determine emergency status.

In real world, situations are more complex and ambiguous. So, the classification algorithm is difficult. But as refine more accurately the algorithm, the result will be more realistic.

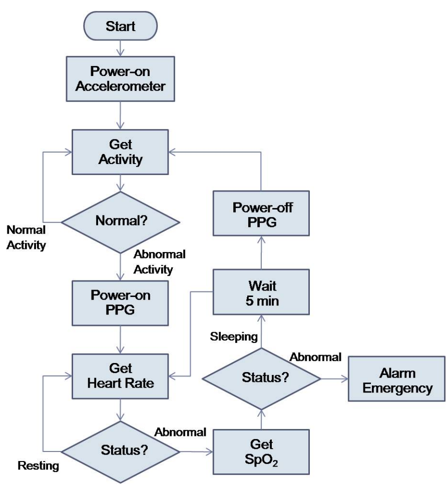

Fig. 3. Hybrid vital sensor algorithm

3 Results

Fig. 4 ~ Fig. 5 show classified results according to our algorithm. Data from sensors are transmitted to personal computer and are processed with Labview software to verify our algorithm. Transplant to micro-controller is being performed.

Once we classify the elderly activity to abnormal we can further investigates the accurate status with the reaction button or pulse oximeter which will be adopted our monitoring device.

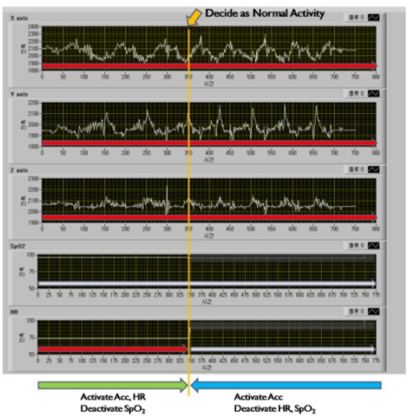

Fig. 4. Classified to normal Activity

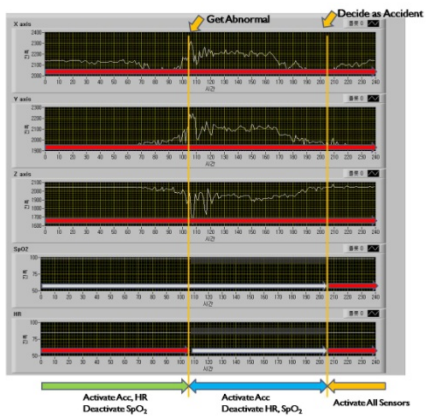

Fig. 5. Classified to Accident

If we can classify a person's status to normal or abnormal, we can make more powerful investment in case of abnormal status. As a result, we may reduce processing resource, power and finally physical size of the sensor. The more compact size and reduced processing power will be helpful of wearing it.

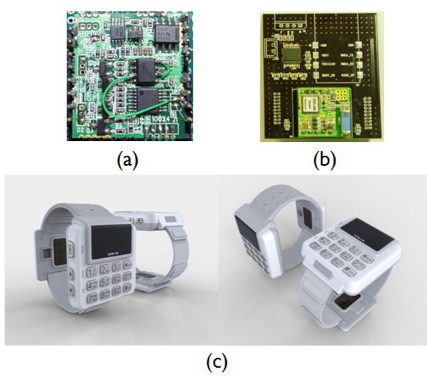

Fig. 6. A prototype hybrid vital sensor

(a) Hybrid sensor (b) Main module
(c) An assembled watch-type mobile device

Fig. 6 is our prototype. Our watch-type wearable device is composed of two main parts. Battery part and main module parts. We use the RF module which is commercially released by Seoul Mobile Telecom company. The data rate is six thousands four hundreds bps. Frequency band is separated to up and down.

4 Conclusion

The main idea of our hybrid vital sensor is control each sensor properly. What we want to say is, in each status, by controlling and activating each sensor properly we can raise the overall efficiency and accuracy. So we can compose the vital sensor more inexpensive, power saving and compact. As a result, this cost effective and easily wearable hybrid vital sensor will raise the use of u-Healthcare devices.

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