Blood Velocity and Pusle Wave Velocity by using ECG-PPG-Radial Artery Pulse Wave Equipped with Magnetic Hall Device

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Through U(Ubiquitous)-health care era of the new medical paradigm has arrived, a confined diagnosis and treatment of existing medical services is expected now be expanded into the realm of real-life. Overseas global IT companies as Intel, IBM, etc predicted an advent of U-health care era are preparing the expansion of business to the east business line already. Thereby, the technical development to domestic companies is needed. U-health care is not only important as a new growth industry for next generation, but it can be the primary means of reduction for medical expenses in the nation's that economy keep increasing the medical expenses for the elderly by elderly society. Thus, development research of a wearable medical device which is able to analyze the U-health care's bio-signal of blood velocity is required.

In this study, we used clip-type pulsimeter which is fixed a permanent magnet on radial protrusion of wrist indicating pulse wave that hall device is sensing the change of magnetic field by work of radial artery. In other words, the hardware system detecting the voltage signal was applied through equipping the hall device right upper side after sticking a permanent magnet in the center of radial artery which is "Chawn". We developed the system that measures PRG and PPG simultaneously connecting with clip-type pulsimeter and PPG measuring equipment and researched capabilities and measurement of blood velocity through analyzing measured PRG and PPG simultaneously. The measured result of blood velocity that gained by simultaneous measurement system of PPG and clip-type pulsimeter was indicated 0.8 m/s and it became to be the grounds of being a bio-signal which can do monitoring. PRG-PPG hereby can be applied from simultaneous display monitor apparatus for patient to principal clinical parameter. This finding showed us using possibility of U-Health care Bio-monitoring system indicating continuous blood pressure and pulse measurement data by measuring the blood velocity using unpressured type conveniently with a PPG connection and furthermore analysis algorithm of pulse wave.

Fig. 1(a) is the explanation of functional several parts of and Fig. 1(b) schematic of the basic structure of a typical clip-type pulsimeter. Here is one form of the radial artery pulsimeter''s pulse-sensing and skin-contacting parts by using Hall device and permanent magnets, respectively. The pressure chamber between the skin-contacting and pulse-sensing parts is full of air. The status of working stages; Fig. 1(c) pulse measurement and Fig.1 (d) data process and results display.

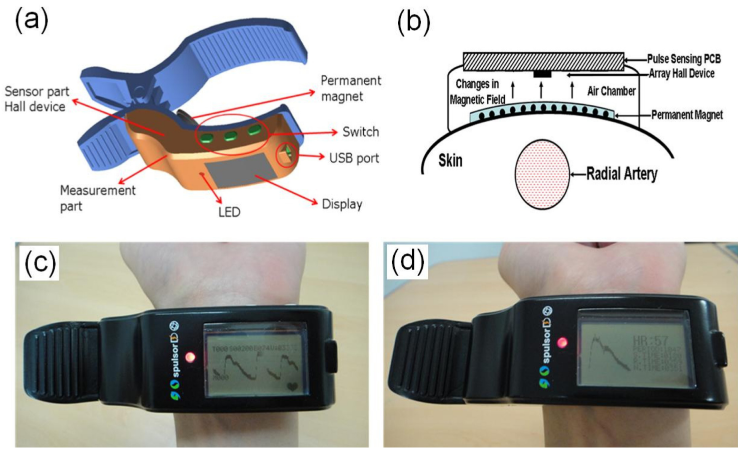


Fig. 1.

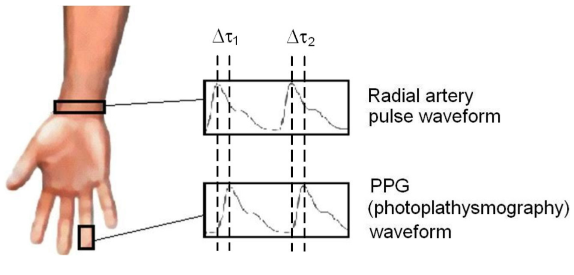


Fig. 2

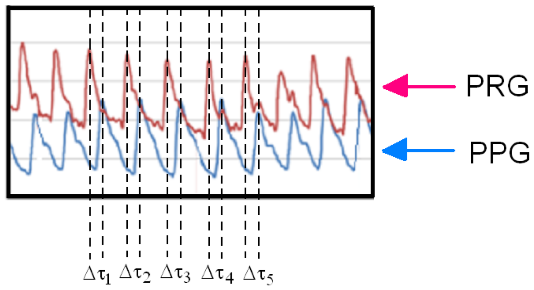


Fig. 3

Fig. 2 is a schematic of three dimensional motion of radial artery. Relationship of arterial pulse''s motion, ECG (electro cardiograph) and blood flow of radial artery according to the cardiac cycle. Fig. 3 is two differently PRG (pulse of radial artery graph) and PPG signals obtained by the simultaneous measurements from clip-type pulsimeter and PPG meter mounted with left hand wrist and finger. Here $\Delta\tau_i$ is time interval measured from ith phase difference of two pulse waveforms. The analysis of blood velocities in ascending order of Fig. 3(a) systolic bood pressure, Fig. 3(b) diastolic blood pressure, Fig. 3(c) heart rate, and Fig. 3(d) pulse rate measured from clinical 40 participants. The average value of blood velocity is about 0.8 m/s.

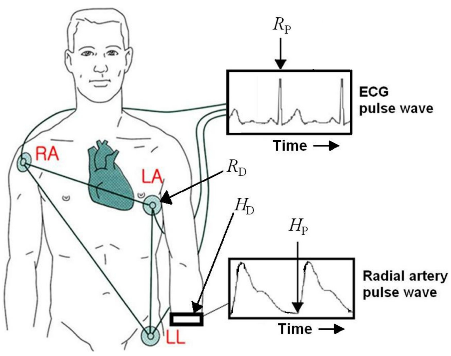


Fig. 4

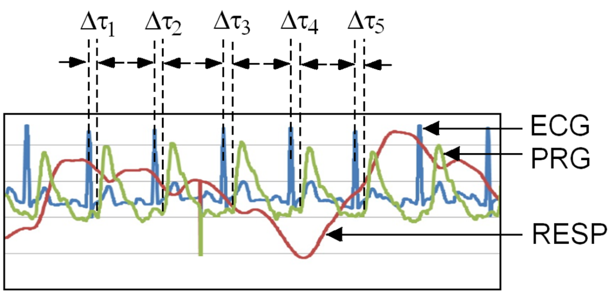
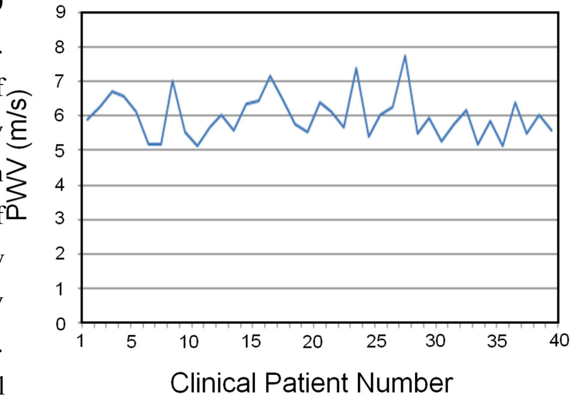


Fig. 5

Fig. 4 is configuration of ECG and radial artery pulsimeter for the measurement of PWV. Here *RP*, *RD*, *HP*, and *HD* are maximum peak of ECG pulse wave, distance of heart position, starting point of radial artery pulse wave, and distance of radial wrist position, respectively. Fig. 5 is ECG, PRG, RESP signals obtained by the simultaneous measurements from ECG meter and clip-type pulsimeter mounted with I, II, III and axis for the standard (anode) limb lead and a left hand wrist, respectively. Here $\Delta\tau_i$ is time interval measured from ith phase difference of two pulse waveforms.

Fig. 6 is the analysis of PWV from clinical 40 participants. The average value of PWV is about 6 m/s. Therefore, in the this research, two simultaneous peaks of radial artery pulse wave and ECG pulse wave measured by using clip-type pulsimeter and ECG were investigated in order to analyze pulse wave velocity. The measured value of a pulse wave velocity is about 5~7 m/s, it is proved one new method to measure an exact value of pulse wave velocity more than the typical biomedical signal monitoring system. This result implies that data measured by the oriental medical diagnosis apparatus as pulsimeter is clinically used in future. Fig. 6.



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