博 士 論 文 の 内 容 の 要 旨

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論文題目	Study on blood pressure measurement using optical fiber sensor （光ファイバセンサを用いた血圧計測に関する研究）

（博士論文の内容の要旨）

Everyone hopes to stay fit and healthy. However, the hope is hindered by various diseases as proved by the gap between the life expectancy and the healthy life expectancy. There is approximately 10-year gap between the life expectancy and the healthy life expectancy and the gap between two expectancies is estimated to increase in future. Moreover, the advance of age, the shortage of doctor and the shortage of medical expense have resulted in increased demand for home health care and preventive medical care to avoid or find disease symptoms. Therefore, the wearable multi vital sign monitoring system is highly demanded.

Focusing on the hypertensive, over 1 billion people worldwide are estimated to have hypertension. Hypertension is called “silent killer” and as its name suggests, it may have no warning signs or symptoms. Not only have that, but hypertension increases the risk of various complications and leads to deadly diseases such as cerebral infraction and heart attack. For these reasons, regular blood pressure measurement is essential to prevent such dead full diseases. However, the blood pressure strongly depends on the physical and mental health conditions and some hypertension such as nocturnal hypertension is difficult to find by the conventional blood pressure measurement. Accordingly, the continuous blood pressure measurement is desirable. Nevertheless, the conventional blood pressure measurement device is not suitable for the continuous measurement since the device is too big to carry and give the user a sense of restraint.

To solve the problems which the conventional device has, many researchers have reported new blood pressure measurement device. However, these methods also risk of hurting users, instability of the measurement or are not suitable for the wearable measurement.

I have suggested a wearable, non-invasive and continuous multi vital sign measurement system using a fiber-type strain sensor, fiber Bragg grating (FBG) sensor, to solve the problems as mentioned above. The pulse wave signal is measured by just attaching the FBG sensor on the surface of the skin. The estimation methods of pulse rate, respiration rate, stress, blood pressure and glucose level using the pulse wave signal measured by the FBG sensor had been reported.

The purpose of this dissertation was to make the blood pressure value estimation method using an FBG sensor signal and enhance its versatility and widen the applicability of the FBG sensor system as a multi vital sign measurement device.

In Chapter 1, the research background was described.

In Chapter 2, I focused on the similarity between the pulse wave signal obtained by the FBG sensor and the second derivative of the plethysmogram (SDPTG) signal. Classified the pulse wave signals measured by the FBG sensor and investigated the tendency of the relationship between the pulse wave shape and age or the blood pressure level. Comparing the tendencies of FBG signal and SDPTG signal, it was revealed that the two signals had the same tendency. In other words, the verification of the FBG sensor system for the vascular age and arteriosclerosis estimation was shown.

In Chapter 3, the verification whether the FBG sensor system can trace sudden blood pressure change was performed supposing the real-life situations. The abrupt blood pressure change was simulated by the cold pressor test while measuring the pulse wave signal by the FBG sensor. A variation in the blood pressure values owing to individual difference in rise of sympathetic nerve activity was observed. The signal processing effectively emphasized the shape change of pulse wave signals. The shape change of the pulse waves reflected from the peripheral blood vessels became notable according to the blood pressure change. It was clarified that the blood pressure value estimation method for gradual intra-day blood pressure was also able to apply for the sudden blood pressure change estimation.

In Chapter 4 and 5, new blood pressure value estimation methods were presented aiming to improve the estimation accuracy and to make our system generally applicable. In Chapter 4, estimation results with Partial Least Square Regression (PLSR) and with Artificial Neural Network (ANN) were compared. The individual difference of the pulse wave shape which affects the estimation accuracy. By the optimization of the combined load and the bias of the network by repetitive learning, ANN was able to reduce the effect of the individual difference of pulse wave shape which causes of lowering the estimation accuracy. Consequently, ANN was more suitable than PLSR for the blood pressure value estimation. In Chapter 5, the calibration curves were constructed with non-classified data set and classified data set and the estimation results were compared. Comparing the estimation results using non-classified data set and classified data set, it is found that the classification of the pulse wave signal reduces the effect of shape difference of the pulse wave which degrading the estimation accuracy.

In Chapter 6, the conclusions, the future task, and the prospect of this dissertation were described.