Abstract of Doctoral Thesis

Title: Study on Signal Source Estimation for Bioelectrical Signals inside Human Body using Switching Voltage Divider Electrode

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This thesis presents a novel signal source estimation method for bioelectrical signals inside human body using a switching voltage divider electrode. This method can obtain the voltage information as well as the position information for a signal source inside human body. The final goal of this study is to develop a signal source estimation system with a small number of body surface electrodes using the two type of information obtained, and the basic theory for this estimation method is discussed in this thesis.

First, a theory for measuring the body surface potential using a voltage divider is proposed. The human body and signal source are assumed as an electrical circuit that consists of many electrical resistances and a voltage source. Using Thevenin's theorem, the human body can be conceptualized as an equivalent electrical circuit consisting of an internal resistance and an equivalent voltage source. This internal resistance can be obtained using a voltage divider circuit consisting of it and the voltage dividing resistance connected across two electrodes. Second, a theory for calculating the position information of the signal source is shown. In detail the attenuation ratio calculated from measured potential with and without voltage dividing resistance reflects the location of signal source; i.e., whether the signal source is far from or near the electrode. Subsequently, the body surface potential originating from the signal source is leaded as the solution of Laplace equation, and a signal source estimation theory that combines the internal resistance and aforementioned solution is given. Finally, the signal source inside human heart is estimated using electrocardiogram. The signal source of R waves is estimated, and the estimated position would be in heart ventricle. The results accordance with knowledge of cardiac electrophysiology, and therefore the possibility that the R wave signal source could be estimated is shown.