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## Topic of the Speech:

How Far Can Wearable Devices Read Our Mental and Physical States? — Representation Method of Autonomic Nerve Activity Index Based on Heartbeat Information Obtained from Wearable Devices


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**Satoshi Maeda** is a researcher at Toyobo Co., Ltd. Research Center and volunteers at several international standardization bodies (IEC, ISO, IPC, SEMI) on wearable electronics, flexible electronics and e-smart textiles.

After graduating from Suzuka National College of Technology, Department of Electrical Engineering, he transferred to Tokyo University of Agriculture and Technology and obtained a master's degree in electrical engineering.

In 1983, he joined Toyobo Co., Ltd. Since then, he has been engaged in the development of flexible printed circuit materials and processes, the development of magnetic recording media (FD and MOD), the development of inking and toner materials for color printers, the development of high heat-resistant polyimide film XENOMAX®.

Thus, he has consistently developed his career as an electrical engineer surrounded by chemical and textile engineers in the field of flexible electronics. His current main research area is Wearable E-smart textiles

He has been participating in international standardization activities at IEC and IPC since 2012, and has been co-convenor of the newly established IEC/TC124/WG2 since 2017, and co-chair of the SEMI FHE TC Chapter from 2021. serving. He has also received the IEC1906 Award in 2018 and 2021, and the IPC Special Recognition Award in 2020.

**ABSTRACT SUBMISSION**
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# How Far Can Wearable Devices Read Our Mental and Physical States?

## ——Representation Method of Autonomic Nerve Activity Index Based on Heartbeat Information Obtained from Wearable Devices

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**ABSTRACT (NO MORE THAN 500 WORDS:)**

**Purpose of This Research**

The purpose of this research is to provide a means of processing and representation data obtained from wearable devices (mainly clothing-type ECG device) in an easy-to-understand format for general consumers who do not have specialized knowledge in the medical field.

**Experiment and Result**

It has been known since the 1980s that FFT analysis of heart rate variability can be used to calculate the sympathetic nerve activity index (SNI: excitement index) and parasympathetic nerve activity index (PNI: relaxation index) of autonomic nerve activity. By obtaining and representing SNI and PNI according to the procedure shown below, it is possible to determine whether the subject's autonomic nerve state is ordinary or not.

(1) First, the subject's RRI over time is measured using a clothing-type wearable electrocardiogram measuring device.
(2) SNI and PNI are obtained from the FFT analysis of the obtained RRI time variation. (The calculation interval is every 10 seconds or every 60 seconds, and the FFT time window is 180 seconds.)
FFT : Fast Fourier Transform
(3) The obtained results are plotted on a 2D plane with the common logarithm of PNI on the vertical axis and the SNI on the horizontal axis. (This diagram is called ANAIM$_{TM}$: Autonomic Nerve Activity Index Mapping.)
(4) Find the regression line for the plots, and the standard deviation σ of the distance from the regression line to each plot, and draw a ±3σ straight line on the plane. The range enclosed by these two straight lines is the subject's autonomic nerve ordinary activity range.
(5) Next, SNI and PNI when the subject is under some special task or situation is obtained in the same way, and plotted on the previous ANAIM$_{TM}$. By reading whether the plot is within the ordinary range or deviated from it (that is, there was some extraordinary), it is possible to determine whether the subjects autonomic nerve state was ordinary or not .

Furthermore, the ANAIM$_{TM}$ plot during various tasks and experiences of various subjects, revealed that when subjects were nervous, during highly concentrated tasks, when they were exhausted,

when heatstroke was suspected, and when they were competing violently, when they have good sleeping, plots in each case were shown to be in a characteristic area. In these cases, even plots from the same heart rate respectively obtained in different cases were often in completely different areas.

**Conclusion**

ANAIM$_{TM}$ can express a subject's mental and physical condition using only ECG information. This technology allows remote and near-real-time (with several minutes delay by a FFT time window ) mental and physical monitoring of a subject. This method will have various applications such as stress checks, preventive diagnosis of diseases, evaluation of sleep quality, management of athletes during games, management of dangerous workers, and polygraph.