MUSHA Toshimitsu 1992-MT-E-Tokyo-Tech-EEIC-Engrg.

Investigation on 1/f fluctuations and the development of Brain activity Mapping

1. Biography

(Toshimitsu Musha)

1931-06 Birth, 1954-03 Graduated Dept of physics, University of Tokyo, Joined NTT Research Institute, 1963-03 Doctor of Science (Univ.of Tokyo); Research on the negative resistance in hollow cathode discharge. 1964 joined Researcher at MIT. 1965 Researcher at the Royal Institute of Technology in Sweden, moved to RCA Tokyo Institute. 1966 he joined Tokyo Institute of Technology as Associate Professor, then promoted to Professor of the Interdisciplinary Graduate School.

1992-03 Professor Emeritus, Tokyo Institute of Technology, 2021 Jan 30th passed away (aged 89)

2. Summary

As an Associate Professor and Professor at Tokyo Institute of Technology in 1966, Toshimitsu Musha was engaged in education in electromagnetics and quantum electronic engineering, and investigated in elucidating 1 / f fluctuation phenomena. He also developed techniques for estimating brain activity using electroencephalograph. After retiring from Tokyo Institute of Technology in 1992, he established Brain Functions Laboratory Co., Ltd. in 1994 after working as a professor at Tokyo University of Science. At the company, he engaged in the development of systems for Emotion Analysis and early dementia detection technology (NAT), using Electroencephalograph . He also opened the Fluctuation Research Institute and, as CEO, developed products applying 1 / f fluctuations.

3. Research Summary

3.1 Elucidation of 1 / f fluctuation phenomena

The current flowing through the semiconductor is accompanied by so-called "1 / f fluctuation" in which the power spectrum is proportional to the reciprocal of the frequency f, which may case deterioration of the S / N of the high-sensitivity amplifier in the low frequency range. This 1 / fluctuation [1] is a phenomenon that is often observed not only in semiconductor noise but also in the natural world. Especially in the fluctuation in the living body, there are many phenomena that have such a spectral tendency, for example, in Giant African snail, it was found that the interval of potential spikes observed in the ganglia has a 1 / f characteristic over a wide frequency range, and this tendency is also seen in human heart rate variability as well as α component of brain waves. The idea that 1 / f fluctuation is a comfortable stimulus for living organisms has become a popular concept accepted by society in general, and applied for various industrial products such as electric fan wind fluctuations, furniture designing patterns, and electrical stimulator for pain relief. He laid the foundation for incorporating it into industrial products and medical devices.

3.2 Imaging of neural activity in the brain by EEG and application to early dementia detection

The brain potential (electroencephalogram: EEG) observed from the scalp reflects the neural activities in the brain, and the power spectral distribution over the scalp are important for diagnosing whether the function in the brain is performing normally. By estimating the fluctuation of the equivalent current dipole in the brain from the potential distribution observed from the scalp, he devised a method (DIMENSION) foe early diagnosis of Alzheimer's disease. In addition, the result of frequency analysis of EEG observed from the scalp is expressed as a power spectral distribution on the scalp, and the NAT method (Neuronal Activity Topography) quantitatively evaluates whether the subject's EEG pattern is close to the normal group or the dementia group. The NAT method developed by Brain Functions laboratory Co., Ltd., where Prof. Musha served as the representative director, The NAT method provided a diagnostic support technology for early dementia [2].

4. Social Activities

Prof. Musha Organized the International Symposium on 1/f fluctuations (1977 Tokyo). In 1990, he started the Brain Research Group in Tokyo Tech and organized Brain Research Open Symposium every year for communications among wide range of research fields related to the brain function and neuronal information processing. He also explained physical phenomena through lectures and wrote books for the reader in a concise language as:

・"World of fluctuations 1 / f wonders of fluctuations in the natural world" Kodansha Bluebacks 1980 (in Japanese)

"Fluctuation Idea 1 / f Fluctuation Mystery" ;Japan Broadcast Publishing Association 1994 NHK Library 1998

・"Why people feel comfortable and uncomfortable Sound, Images, Touch-feeling etc; Approaching the wonder of comfort "; Kawade YumeShinsho 1999

・"Electronic Fluctuations Whispering the Universe 1 / f Fluctuation Lecture" with Isao Tomita ; Asahi Press Lecture books 1985

・"Fluctuation Medicine 1 / f Fluctuation Health Law" co-edited; Shujunsha 1985

・"Fluctuation / Chaos / Fractal Toshimitsu Musha, Koji Sawada "Dialogue Collection" ;Nihon Hyoronsha 1991

・"Science of Fluctuation", vol.1-vol.10,; Morikita Publishing 1991-99

・"Image diagnosis of dementia-Learning by seeing" with Hiroshi Matsuda, edited by Takashi Asada; Nagai Bookstore 2010.

5. References

[1]T. Musha: "Theoretical background of 1/f fluctuations of energy partition among harmonic oscillators in equilibrium," Int. J. Physical Sciences Vol.7(43), pp.5717-5722, 2012.

[2] T.Musha, et al.,: EEG Markers for Characterizing Anomalous Activities of Cerebral Neurons in NAT Method, IEEE Trans Biomed Eng, vol.60, no.8, pp.2332-2338 (2013)

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