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A CHALLENGE TO MINIMALLY INVASIVE SURGERY FOR EPILEPSY

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ABSTRACT: Up to 5% of people in the world may have at least one seizure in their lives and about 1% is suffered from seizures hindering their daily life. Although the seizures can be suppresses by adequate medication for about 80% of them, the residual 20% are not affected by the drug. The effective treatment for these patients of drug-resistive epilepsy is a surgical treatment to remove the "epileptogenc focus".

The current localization accuracy of the epileptogenc focus is not good and thus the extirpation of focus with significant margin causes the removal of normal brain and leads to the severe aftereffects such as restricted vision, motor dysfunction, disorder of memory, and so on. To cope with this problem, we should develop the

technology of (1) detecting the epileptogenic focus, and (2) necrotizing the epileptogenic focus excluding normal brain.

In order to identify the location of the epileptogenic focus which may be a point, definite area or disseminated form, the activated area of epilepsy should be detected by the non-invasive method, for instance, an optical topography (a kind of Near-Infrared Spectroscopy : NIRS). The location of the focus may be obtained by the transient waveform of the optical topography which is similar to the solution of an inverse problem. The candidate of the tool for solving the problem would be the SOR network developed by the author.

After identifying the location of the epileptogenic focus, almost all of the focus area should be necrotized by the way in which the narrow area can be affected with checking. The necrotizing equipment for the narrow area should be fine for not delivering damages on the healthy area of the brain. In our research two candidates of necrotizing equipments will be developed as shown in the following.

Rapid freezing and thawing of the biological tissue causes necrosis of cells and neurons in the narrow area because of destruction of subcellular organelle by the difference of salt concentrations. This is well-known as cryoablation in hepatoma, lung malignancy, carcinoma prostata, and so on, where the tip of the freezing probe is about several cm and not suitable for minimally invasiveness and narrow area freezing. Thus the coaxial double tube structure is employed for fine tip of the probe, where the outer diameter of the probe is less than 1 mm.

Another candidate to necrotize the focus of narrow area is a laser light focused on the target tissue. It exhibits the flexible treatment by changing the intensity, wavelength, time period of exposure, and thus a variety of usage will be expected.

The minimally invasive surgery for drug-resistant epilepsy is to be developed within four years by the support of JSPS (Japan Society for the Promotion of Science) in which the restricted area of the brain (epileptogenic focus) is necrotized excluding the healthy part of the brain. By employing this technology and equipment brain surgeons will be able to save the lives of patients of serious epilepsy.

About the Honoree: Takeshi Yamakawa, Professor Emeritus of Kyushu Institute of Technology. Takeshi Yamakawa is now a special-appointment professor of Department of Brain Science and Engineering, Graduate School of Life Science and Systems Engineering, Kyushu Institute of Technology, Wakamatsu, Japan and also the chairman of Fuzzy Logic Systems Institute (FLSI). He received the B. Eng. degree in electronics engineering in 1969 from Kyushu Institute Technology, Tobata and the M. Eng. degree in electronics engineering in 1971 from Tohoku University, both in Japan. He received the Ph.D. degree for his studies on electrochemical devices in 1974 from Tohoku University, Japan. From 1974 to 1977, he engaged in the development of new electrochemical devices as a Research Assistant at Tohoku University. From 1977 to 1981 he served as a Research Assistant in electrical engineering and computer science at Kumamoto University, Japan. From 1981 to 1989 he was an Associate Professor at Kumamoto University. During this time, he developed intrinsic fuzzy logic integrated circuits in pMOS (1983) and CMOS (1985), a fuzzy logic controller hardware (1986), a fuzzy logic computer hardware (1986), a fuzzy memory device (1986), and fuzzy micro processors (rule chip and defuzzifier chip) (1988).

He joined the Faculty of Computer Science and Systems Engineering, Kyushu Institute of Technology, Iizuka, Japan and received a full professorship in April 1989. He established a foundation, Fuzzy Logic Systems Institute (FLSI), in Japan in 1990 to promote the international collaboration on fuzzy logic, neural networks and soft computing, and to promote the spread of the research results. Prof. Yamakawa developed the fuzzy neuron chip in BiCMOS technology which facilitates hand-written character recognition within 1 microsecond by one fuzzy neuron chip (1991). He also developed the chaos chip in CMOS technology (1992).

In 2000 he moved to the new campus, Wakamatsu, of the Kyushu Institute of Technology to be a professor of the Department of Brain Science and Engineering.
In March of 2009 he retired from the Kyushu Institute of Technology and in April of 2009 he was engaged to the same university to promote the project for Specially Promoted Research.
His main research interest lies on hardware implementation of fuzzy systems, fuzzy neural networks, and chaotic systems. He holds 11 patents in U.S.A., 4 patents in Europe, 1 patent in Australia and 1 patent in Taiwan, and he has also applied for more than 90 patents in Japan. Prof. Yamakawa is a fellow of IEEE, International Fuzzy Systems Association (IFSA) and Japan Society of Fuzzy Theory and Systems (SOFT). He received IEEE 2008 Fuzzy Systems Pioneer Award. He is acting as a member of editorial board and a regional editor of 10 international professional journals. He contributed more than 80 international conferences as a member or the chairman of organizing/programming committee. He was used to organize the International Conference on Fuzzy Logic, Neural Nets and Soft Computing (so called IIZUKA Conference) every two years in Iizuka, Japan. He was the director of the 21st Century Center of Excellence entitled “World of Brain Computing Interwoven out of Animals and Robots” from 2003 to 2008. And now he is acting as the director of the project for Specially Promoted Research (Project No.20001008) entitled “Identification of Epileptogenic Focus by Employing Soft Computing and Establishment of Minimally Invasive and Definitive Surgery” from June 2008 to March 2012.

Prof. Yamakawa plays Karate (Japanese traditional martial arts) and possesses a black belt (5th Dan). And he likes swimming, a monocycle and horse riding as well. His interest also lies on Shakuhachi and Shamisen, which are Japanese traditional musical instruments.

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