博 士 論 文 の 内 容 の 要 旨

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学位授与年月日	2020 年 3 月 20 日
論文題目	Human motion detection using an earphone type wearable device and its application to health care （イヤホン型ウェアラブルデバイスを用いた身体動作検出とヘルスケアへの応用）

（博士論文の内容の要旨）

In Japan, interest in personal health care has increased with the graying of society, and the term “healthy life expectancy” has gained prominence year by year. Dietary habits are known to be closely related to lifestyle-related diseases such as obesity, high blood pressure, hyperglycosemia, and hyperlipidemia. Poor chewing and fast eating are especially associated with obesity. Objective evaluation of dietary habits adopted by a nonprofessional person outside of hospital is less effective than the objective evaluation of exercise. Moreover, chewing relates not only to obesity, but also to exercise capacity. People with high chewing potential can self-support their health to a certain degree by maintaining their exercise capacity, and can maintain high nutritional status by eating foods with any degree of hardness. For these reasons, chewing can largely dictate the healthy life expectancy. Therefore, I aim to develop a measurement device that monitors chewing (occlusal force) during mealtimes by an earphone-type wearable device. The device is expected to provide objective evaluations by nonprofessional persons in general environments.

In this thesis, I propose two objective measurement techniques of dietary habits using the earphone-type wearable device. Both evaluation techniques assess the dietary habits at mealtimes to discourage fast eating, and measure the occlusal forces to promote good chewing capacity.

The first technique detects mealtimes among the everyday life activities of the wearer by a small optical sensor inserted into the ear hole of the user. The sensor is composed of a light-emitting diode and a phototransistor, and estimates the mealtimes from the time variations in the amount of received light as the ear canal deforms during chewing. This measurement technique can also measure the body motions associated with running. Using the data obtained from the ear-inserted optical sensor, the wearer can support a healthy eating, and exercise lifestyle. The proposed algorithm in the wearable ear sensor distinguishes mealtimes and running activities without error, despite the similar characteristics of the two signal types.

The second technique estimates the occlusal force without inserting a sensor into the mouth. The occlusal force during eating can be measured from the movement of the ear canal. Electrode pads, which impede the movement of the masticatory muscle and the jaw joint, are not required. Within the range of occlusal forces exerted by typical healthy adults, this method estimates the occlusal force with comparable accuracy to conventional methods that measure the myoelectricity of the masseter muscle.

The proposed portable mealtime monitoring device and non-intraoral occlusal force meter can contribute to the lifestyle improvement of humans, providing an objective numerical value of the dietary habits in individual homes. Such devices can monitor the exercise quantity and body weight of the user, promoting health self-maintenance by allowing users to review their own state.