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ESTIMATION OF WATER INTAKE BY MEASURING VIBRATIONS CAUSED BY LARYNX MOVEMENT AND SWALLOWING SOUNDS

Abstract:

People suffering from dementia often forget to drink water due to deterioration of their cognitive functions. Usually water intake of these people is managed by care workers. However, the water intake cannot be monitored while the care workers are absent. Therefore, if we could estimate water intake of the patients while the care workers are absent, we could better manage the water intake of said patients. Therefore, in this paper, we propose a method for estimating water intake by measuring vibrations caused by larynx movement and swallowing sounds.

When we ingest water, the larynx rises up with a vibration of 1 Hz to 20 Hz in the pharyngeal stage, and water flows into the stomach with a swallowing sound of frequency 400 Hz to 750 Hz in esophageal stage. Here, we assume that water intake is associated with the vibration and the swallowing sound. To measure the vibration and the swallowing sound, we developed two sensing devices based on an electret condenser microphone. The first device is an earphone-type device that measures the swallowing sound. The other sensing device is a neck-collar type device and measures the vibrations caused due to larynx movement. Output signals from the earphone-type device and the neck-collar type device are filtered by band-pass filters with passbands of 1 Hz to 20 Hz, and 400 Hz to 750 Hz, respectively. To estimate the water intake, we apply the dynamic time warping (DTW) algorithm that can take time dynamics into account for template matching method. The template data, which have n types of labels representing the water intake, is prepared in advance. Water intake is estimated by comparing the unknown data with the template data and selecting the label which gives minimum DTW distance.

We conducted an experiment with two healthy subjects in their twenties. Each subject wears the proposed sensing devices. The sampling frequency is 25 kHz and measurement time is 3.2 s. In this experiment, n is set to three different values: 5 ml, 10 ml, and 15 ml. These are used as labels for

the template data. Three trials were conducted for each round of water intake; therefore, the total number of observations is 18. The leave-one-data-out cross validation is applied, and accuracy is calculated to be 0.78. This result indicates that the proposed method can be helpful for the improvement of food management.

Keywords:

dynamic time warping distance; electret condenser microphone; swallowing sound; water intake