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Graduate School of Science and Engineering, Aoyama Gakuin University

Title: Zumipen: Development of Handwriting Reconstruction Device using IMU and Strain Gauge

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Abstract

Various types of devices have been developed until today. However, it may take an heavy burden to the users because they need to learn how to use each device or application. Therefore, an input device that enable anybody to simply access to digital space is needed.

We have focused on handwriting movement as a new-type interface. Handwriting is familiar to anybody for a long time. A research by UNESCO in 2014, reported that 80% of the people have basic literacy skills. Using pen-type interface, the learning costs can be decreased. Also it has good portability, instancy, and intuitiveness.

We propose “Zumipen”, a stand-alone digital pen. Zumipen digitalizes handwriting trajectories using an IMU (Inertial Measurement Unit) and strain gauges. The advantage of Zumipen is that it does not need any outer module. The heading direction of writing has been estimated by FFNN (Feed Forward Neural Network) and accuracy evaluated. As a result, the accuracy of multi-strokes handwriting could not be improved. However, single-stroke figures such as circle, square, triangle, and star showed good reconstruction accuracy. The pen velocity and position integrated from acceleration signal are considered as the major error factor. Signal filtering should be improved and compensating methods investigated.

As an application of Zumipen, we have built a message transfer system using digital pen. The system consists of a digital pen and a smartphone. It allows to perform digital operations such as sending an e-mail, posting to an SNS, and saving a memo. The greatest feature is to enable to conduct those digital operations by only handwriting with the pen. We evaluated the accuracy and response of message-command recognition algorithm. It resulted that the accuracy was 93.8% after parameters tuning, and the required time was about 100ms for 90% of the strokes. Therefore, we demonstrated the usability of the system.