A Study for Exploration of Relationships between Behaviors and Mental States of Learners For an Automatic Estimation System

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Abstract: It is an important task to implement an e-learning system that can automatically detect changes of learners’ mental states by observing their behaviors in learning activities. In this study, we conducted an experiment to explore relationships between mental states and behaviors of a learner on our experimental tools designed along with an assumption of a learning environment with an e-learning system. We focused on mouse and face movement as the behaviors. The results of the experiment revealed some features about the behaviors and the mental states.

Keywords: e-learning system, automatic estimation, mental states, mouse tracking, face movements

Introduction

Current e-learning systems are classified into two types: synchronous and asynchronous systems. In the former systems, learners can learn anytime and anywhere without being under any time and spatial constraints. However, teachers cannot observe the learners’ behaviors on the system to estimate their understanding. The latter systems allow teachers to observe learners, but such systems impose time constraint on the teachers and learners because they have to work simultaneously. Therefore, it is an important task to implement an asynchronous system that can automatically detect changes of the learners’ mental states by observing their behaviors. Here, we call such a system an estimation system.

Several studies have addressed the implementation of an asynchronous e-learning system that estimates the learners’ mental states, such as reaching an impasse in problem solving or impressions of problem difficulties perceived by learners. Ueno’s estimation system has succeeded in detecting unusual states of learners by measuring response time required to solve each problem (Ueno, 2007). However, it cannot specify sources that cause unusual responses in problem solving processes because it is based on response time. An estimation system by Nakamura and his colleagues can detect sources of unusual behaviors based on learners’ responses (Nakamura, Akamatsu, Kuwabara, & Tamaki, 2002). To detect the sources, it needs learning contents that embed particular materials, such as buttons to present hints. A system by Nakamura, Kakusyo and Mino (2007) judges
whether or not learners find problems difficult based on behavioral data: eye and face movements acquired through a stereo-camera, and interval time among input operations on the system. Because the specific device stereo-camera is required, it may be difficult to actually adapt the system to practical e-learning environments.

In order to adapt an estimation system into ordinary e-learning environments, it should require no specific devices. In our previous study (Horiguchi, Kojima, & Matsui, 2008), we have proposed an estimation system that detects unusual behaviors during problem solving based on velocity of mouse movements. Although the system can specify sources of unusual behaviors in problems to some extent, we consider it needs further study to refine its model of the behavioral detection. According to the concept “no specific devices” described above, we conducted an experiment that examined relationships between behaviors and mental states of a learner in order to expand the detection model for implementation of a system that possesses a more accurate estimation.