Subjective Sensing of Real World Activity on Group Study

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Abstract

Collaborative learning is efficient teaching/learning method, and it is widely introduced and practiced in various situations. However, it has a difficulty to perform formative assessment and real time evaluation without students' feedbacks. Therefore, demand for technologies to support formative assessment in collaborative learning is increasing. To tackle this problem, we have started the research project for automatic sensing and visualization of real world activities in collaborative learning. In this paper, we will report details about preliminary group work experiments and its results with visualization tool.

1. Introduction

Collaborative learning is one of the efficient methods to encourage students to explore and solve problems together with members who have different abilities and thoughts, and it can promote various skills such as oral communication, leadership, etc. Therefore, it is now widely introduced and practiced in many educational institutions. Assignment progress and exams are usually used for quantitative evaluations. However, in the case of collaborative learning, formative assessment becomes more important to evaluate learning process of each student. Since formative assessment during collaborative learning is very difficult, qualitative feedbacks by students are commonly utilized. Therefore, it is expected to be developed technologies that can perform formative assessment without student's feedback during learning

Although Computer Supported Collaborative Learning (CSCL) is widely studied [1,2], most of them used computer oriented virtual environment as a tool for quantitative evaluations. In the case of virtual environment, it is very difficult to measure natural communications and collaborations between students. Therefore, it is necessary to extend CSCL into real world group study where it is possible to observe natural behavior of students.

One of the important and expected evaluations in real world collaborative learning is to check whether a student is able to share his/her opinions or ideas together with other students [3]. When we saw well-communicated group in collaborative learning, members of such group appropriately payed attention to the speaker for sharing knowledge, and their activities seemed to be well synchronized and cooperated. Therefore, (1) attention level against the speaker, and (2) activity synchronization level, can be considered as important elements for formative assessment during collaborative learning. If we use (1), it may be possible to recognize the transition of leadership in the group since we can know who had been payed attention by whom on the group work timeline. If we combine (1) and (2), cooperativeness and activeness in each group are expected to be quantitatively measured.

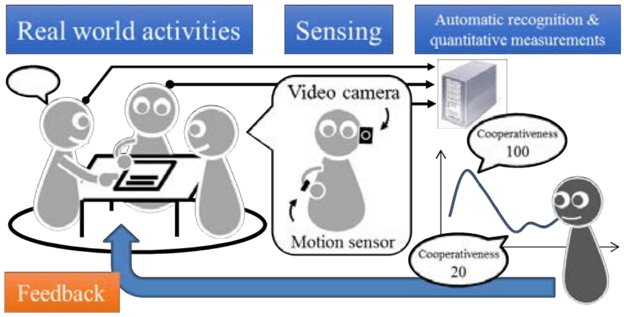

Figure 1. Concept of subjective sensing of real world activities on group study.

To develop technologies for measuring above (1) and (2), we have started the research project for automatic sensing and visualization of real world activities in collaborative learning (Fig.1). This paper report results of the small subjective experiment conducted as a preliminary study in this project. In the experiment, the task is a group work building a town diorama using LEGO blocks. For the purpose of measuring subjects' attentions and activities, first person view camera and wearable activity sensor are attached to each subject. To analyze group activities, all cameras and sensors were fully synchronized with manual adjustments.

Section 2 describes details of group work experiments and specifications of first person view camera and wearable activity sensor. Section 3 describes experimental results with visualization tool. Finally, the paper is concluded in section 4.

2. Methods

2.1. Target activity

As a target group activity, we configured a cooperative development work of making a town diorama. Followings are the reasons why we choose this type of group activity.

(1) Dense communication for making consensus and role arrangement among members are quite important aspects that expected to be trained via group activity. Cooperative making of a product can be considered as a good situation for naturally inducing subjects' communications for those purposes.
(2) Design workshop in which members propose some solutions to solve problems requires certain time (sometimes with large field) for investigation, discussion, and constructing results. More compact group activity was preferable for first analysis.

In our experiment, four university students and two staffs (six in total) joined as group activity members. They were divided into two groups, each of which consists of three members. An additional university staff performed as a facilitator conducting the activity. Each group used the same type LEGO blocks set to build a particular scene of a town. Before building a town georama, they discussed and determined a scene they will create and the way for members' cooperation.

The conducted group activity was roughly divided by the following 4 phases.

(1) Explanation given by the facilitator : 10 min.
(2) Discussion to determine a scene they build and the way to cooperate : 10 min.
(3) Working time : 40 min.
(4) Exhibition time : 10 min.

In the phase (1), the subjects had self-introduction time although most of them know each other. The explanation included the purpose of the experiment, but we asked the subjects to behave as usual. During the working phase (3), the facilitator sometimes asked about the idea for building or the progress to extract verbal communication. In the phase (4), the subjects explained what scene they built with what idea and gave some questions for each other. Figure 2 shows an example of the activity scene in the group work.

2.2. How to record activities

One of the important issues on analyzing real world behavior in group activity is to develop a practical sensing system accepted by general group activity configurations including purpose, location, and style. In this viewpoint, a complexed sensing system taking much construction time and effort is not feasible. A simple and compact construction is required. In our work, we attach small wearable sensors including first person view cameras to the subjects for easy preparation. Followings are specifications of actual sensors used in the experiments.

2.2.1. Wearable first person view video camera (Fig. 3). Small but high performance action cameras were attached on the heads of all group members. This method can be used not only in an indoor activity and also in an outdoor one with easy preparation. With this sensing, visual record of the target activity is captured from the subjective and internal viewpoints. Therefore, it is possible to analyze transition of subject's attention during group work. In addition, communications between subjects can be analyzed through voice recordings. The FOV, image resolution and frame rate of the camera are

Figure 2. Example of a scene of the conducted activity.

Figure 3. Wearable first person view camera.

Figure 4. IMU sensor.

approximately 90 degrees, 1920x1080 pixels and 30 fps, respectively.

2.2.2. IMU sensor (Fig. 4). The group members also attached wrist type watch sensors implementing inertial measurement units (IMU). These sensors can record activeness of each person that is difficult to estimate from visual information. The IMU sensors records up to ±20G acceleration and ±5deg./s angular velocity along X, Y, and Z axes, respectively.

2.2.3. Fixed video camera. In addition to the above sensors, video cameras were fixed in the environment and they recorded perspective view of the activity. Because even if with multiple internal views, an overview of activities is difficult to be estimated. But we use recorded videos for confirmation (acquiring ground truth through manual browsing) and will not use as input data of automatic analysis.

3. Experiments

3.1. Dataset specification

Each person wore a wearable video camera to his head/chest and a wristwatch type IMU sensor on his right arm. Two fixed video cameras were arranged in the room in order to capture the whole scene as described in 2.2.3.

We recorded three kinds of data, i.e., 1) image sequence of wearable first person view video camera, 2) motion sequence of IMU sensor, and 3) image sequence of fixed video camera. The video cameras captured the scene at 30 fps, meanwhile the IMU sensors measured acceleration and angular velocity at 50Hz.

3.1. Visualization

We developed a visualization tool as shown in Fig. 5. The visualizer provides three sub-windows to show a video sequence and two waveforms. In each sub-window, we can select a corresponding file, e.g. video and recorded files of the same person. The waveforms are automatically synchronized by referring to the timestamp of the data.

We extended the above visualizer to compare the activities in the same group. In Fig. 6, the extended visualizer has three components (one component corresponds to one person). The data sequences are synchronized among the components. Figure 6 shows examples of visualization during the cooperative development work. The screen shots of group 1 and group 2 are arranged in upper part and bottom part of Fig. 6 respectively. We selected two typical scenes from each group. When the facilitator gave an explanation about the task of cooperative work with a whiteboard, all member of both group paid attention to the facilitator. In this

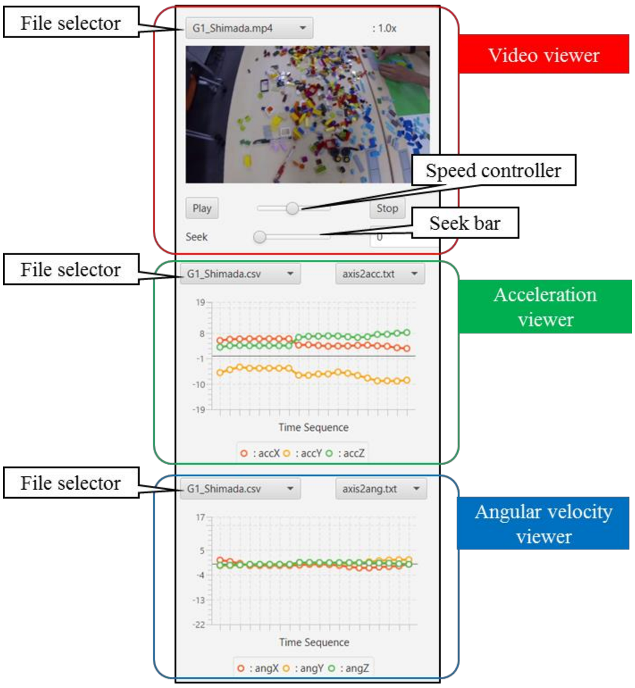

Figure 5. A component of visualizers for camera and IMU sensors.

period, acceleration and angular velocity values were almost flat, in other words, there were no hand motions. In contrast, IMU sensor values were frequently changed when the members build up LEGO blocks. In our future work, we have to extend our system for automatic analysis of group work activity by introducing ideas of lifelog analysis (e.g. [4]).

4. Conclusions

In this paper, we reported about preliminary experiments on subjective sensing of real world activity on group study. In the case of collaborative learning, although formative assessment becomes important, it is currently very difficult to perform its evaluation in real time without students' feedbacks. To tackle this problem, our research project aims for automatic sensing and visualization of real world activities during collaborative learning. As a first trial, we developed a system consisting of first person view camera and wearable IMU sensor for measuring group activity, and visualization tool for captured activity data. Potential of this tool could be confirmed through subjective group work experiments for building a town using LEGO blocks.

Future works will include automatic recognition of transition of subject's attentions from first person view camera, analysis of detailed communications, evaluation of cooperativeness using IMU sensor.

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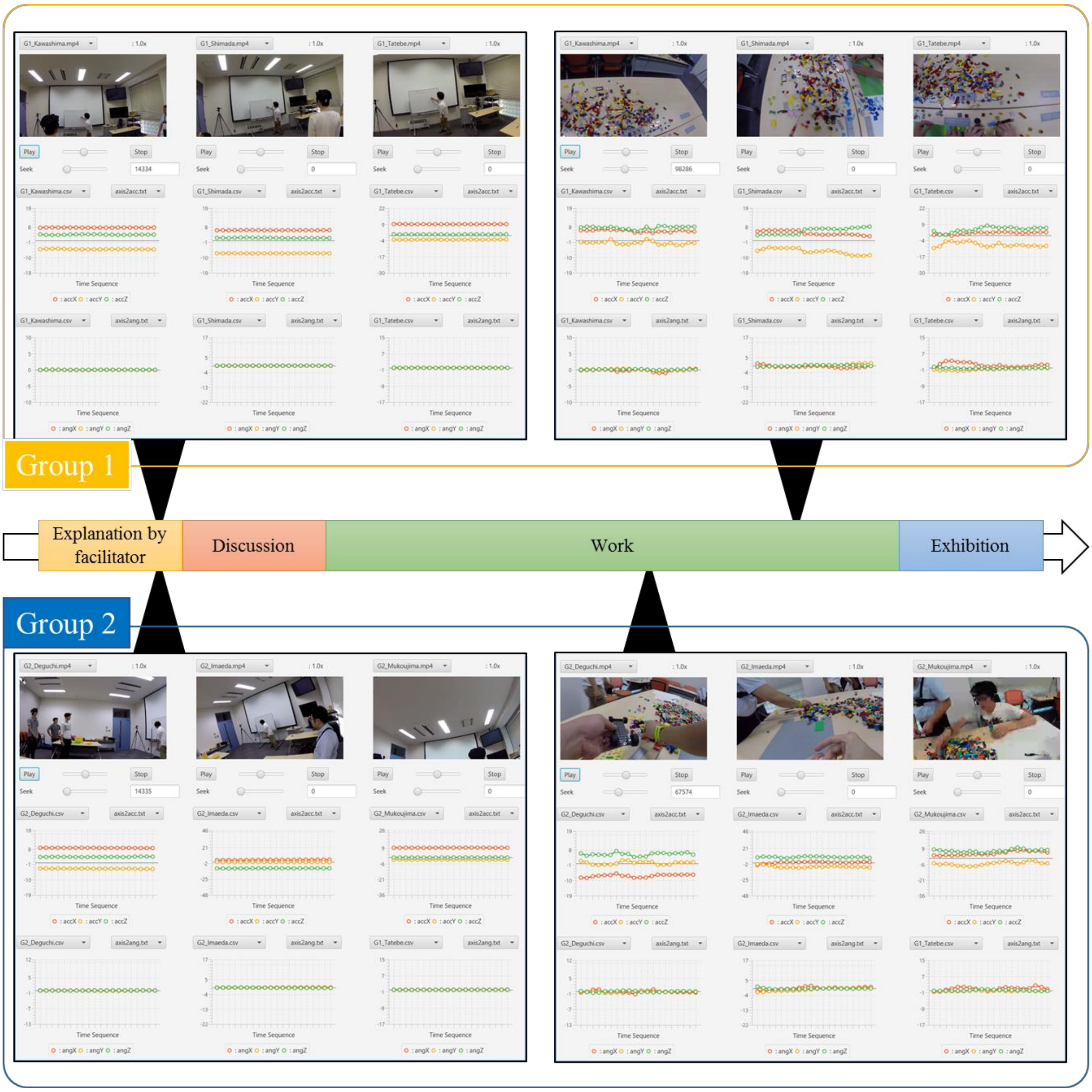

Figure 6. Visualization of group activity a cooperative development work.

References

[1] M. Baker andK. Lund, "Promoting reflective interactions in a CSCL environment," Journal of Computer Assisted Learning, Vol. 13, No. 3, pp.175-193, 1997.

[2] D. D. Suthers, "Technology affordances for intersubjective meaning making: A research agenda for CSCL," International Journal of Computer-Supported Collaborative Learning, Vol. 1, No. 3, pp.315-337, 2006.

[3] C. I. Damşa, P. A. Kirschner, J. E. B. Andriessen, G. Erkens, and P. H. M. Sins, "Shared Epistemic Agency: An Empirical Study of an Emergent Construct," Journal of the Learning Sciences, Vol. 19, No. 2, pp. 143-186, 2010.

[4] H. Ogata, Y. Matsuka, E. M. Moushir, and Y. Yano, "LORAMS:Capturing, Sharing and Reusing Experience by Linking Physical Objects and Videos," Proceedings of the Workshop on Pervasive Learning, pp.34-42, 2007.