Estimating Physical Interactions with Neighboring Student for Detecting Active Learners in the Computer Classroom

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Abstract: In the classroom, some students may isolate themselves, hesitant to seek help due to psychological barriers. These students need active addressing from Teaching Assistants (TAs). Especially in computer classroom due to the types of study. However, there are cases where some classes are arranged with only a few TAs for a large number of students, and it may cause that students who should be approached may be overlooked. In order to support isolated learners, this study estimates the physical interaction with neighboring student based on the learner video in a computer classroom. Analysis of learner video reveals the possibility of using a depth camera to separate movements and estimating interactions. This result can be applied to the TA support system which detects isolated learners.

Keywords: Student interaction, computer classroom, depth camera, learner video

1. Introduction

Teaching Assistants (TAs) are introduced to support classes in universities. One of the roles of TAs in the classroom is to provide support to students. However, TAs do not have much experience about education (Luo, Bellows, & Grady, 2000). They may overlook students who should be assisted. Some students are also hesitant to seek assistance due to psychological barriers (Price et al., 2017). A proactive approach from TAs is needed for these students.

A more proactive approach is taken by implementing the TA supporting system (Imamura et al., 2020). Support from TAs is not necessary when students can resolve issues among themselves. Detecting student isolation would allow for more appropriate support. Many supporting systems in programming classes use learning results and programming code. It is hard to measure student behavior which do not show up in the code. This study considers shooting from above the classroom. Additionally, a depth camera is used to capture the student behavior. As a measure of student isolation, this study estimates physical interactions with neighboring student.

2. Estimating interaction with neighboring students

This study focuses on classes using computer classroom. In the computer classroom, a display is equipped in each student's seat. In order to avoid being behind the display, this study take pictures from above the classroom without any obstacles. Figure 1 shows images that can actually be taken in the computer classroom.

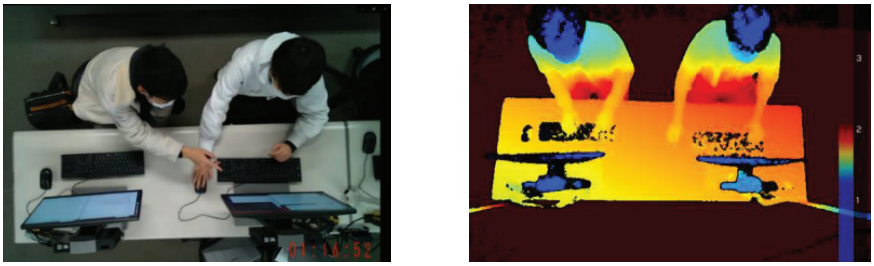

Figure 1. RGB image from above the classroom (left) and depth image (right)

By using a depth camera, the distance from the camera can be obtained as depth data. When shooting from above, changes of depth data show vertical movement. Using this, the system can separate movements that take place directly above the desk, such as keyboarding, from those that take place at eye level, such as pointing at a display or looking into a neighbor's display.

3. Analytics method

If changes of depth data can be captured, it may be possible to separate movements just above the desk, movements at shoulder height, and movements where the head changes position. In this study, estimating physical interactions is performed using the separation of these movements and the setting of the calculation area.

To capture the movement of students, the value of change in depth data is calculated between each frame per pixel. To separate movements, it is counted the number of pixels in three ranges of the obtained value of depth data changes. In order to capture the movement just above the desk, the movement of the height near the desk, and the movement of the changing head position, each range are defined and the value of change is counted as 30mm to less than 140 mm for "low," 140 mm to less than 400 mm for "middle," and 400 mm or more for "high". The increase in the number of pixels in each range confirms the occurrence of the movement.

As Figure 1 shows, the video data analyzed in this study shows two student side by side. Analyze one student by splitting the area into two parts, left and right. Physical interactions with neighboring student is estimated by some kind of change in the area between students. For example, point to the next display or move body closer to the next seat. These interactions are analyzed by calculating the space between displays.

4. Result

Learner videos ware collected in a programming class at a science and engineering university. Each class were 90 minutes long. Each student can use the computers equipped in the computer classroom. The video captures the actual student behavior. Intel RealSense L515 was used to collect depth video. Data from 15 students were collected in six times of classes in total. Then, analysis was performed on each video data. The analysis results are shown based on the fourth experimental session in which physical interactions with neighboring student were confirmed.

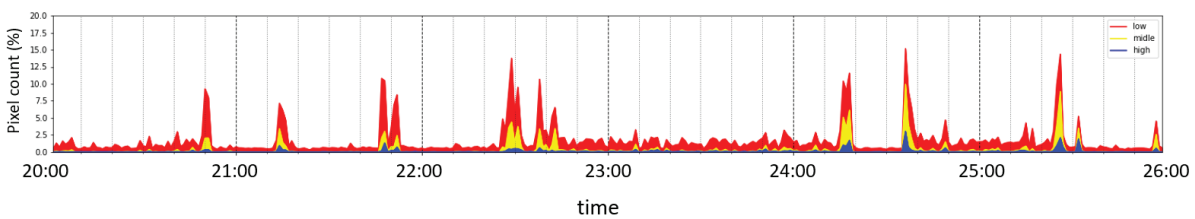

Figure 2. Calculation results

Figure 2 shows the results of the calculation for one learner. The vertical axis shows the percentage of pixels and the horizontal axis shows the time. In the graph, “low” is represented by red, “middle” by yellow, and “high” by blue.

There is a notable area around 20m50s or 22m30s in the graph. The ratio of “high” does not increase relative to the increase of the ratio of “low” in this range. In this moment, the student was reaching for the mouse. Another notable area is around 24m40s or 25m25s in the graph. As the ratio of “low” increases, the ratio of “middle” and “high” increases. In this moment, the student was moving all of body like a postural change. Moreover, the other notable areas are the ranges from around 22m45s to 24m15s and from around 24m35s to 25m20s. The ratio of low is continuously changing in that range. In this time, the student was keyboarding while his face and body turned in the direction of the display.

The calculation results for the other experimental sessions confirmed the same results. At times when the ratio of “high” changed significantly, movements such as postural changes or changing the position of the chair were confirmed. During time when the ratio of “low” was present in a continuously changing, movements such as keyboarding and checking textbooks on the desk were confirmed.

About calculation results in the space between displays, there were four areas where the “high” ratio intermittent changed. Two of these scenes had one student pointing at the other's display like figure1 (left). As for the other two parts, they were the scene of taking a seat at the beginning of the class and the scene of getting out of their seats at the end of the class. When interactions were not confirmed, the ratio of “high” has not changed. These range changed only the ratio of “middle” or "low".

5. Conclusion

This study analyzed actual student movement during class by using depth video from above the classroom. The value of change is calculated in depth information between each frame per pixel. Ratios of depth data change were calculated for each calculation area. Ratio changes compared to actual student movement.

Analysis shows that depth data can be used to separate movements. Especially, it has possibility to separate movements just above the desk, movements at shoulder height, and movements where the head changes position. By setting the calculation area appropriately, depth data may be used to estimate physical interactions with neighboring student. However, the data with interactions is few. In addition to that, it cannot be estimated in complex situations. For example, it was observed that students were not analyzed because of going through the calculation area.

In order to estimate the isolated learner, the system has to capture more clearly the movement of individual students. For example, determine the head position and the body orientation by using depth data. We are planning to develop a system to guide TAs to active support for isolated learner.

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