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# Visualization Method of Movement of Teachers and Students in Classroom using OpenPose

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**Abstract:** This study proposes a method to visualize the movement of teachers and students in a classroom using OpenPose. With the Proposed method, the activities such as sitting, joining the class late, moving, and discussing in pairs were visualized. The method has those two advantages: human movement can be visualized semi-automatically from video data and as a single image, thus saving time spent on watching long videos.

**Keywords:** Classroom walkthrough, teachers' self-reflection, OpenPose, Learning Analytics

## 1. Introduction

Teachers often make reflections after their classes for improving them. However, it is difficult especially for inexperienced teachers or trainee teachers to make reflections by relying only on their memories. Feedback after demonstration class is one of the common ways to assist teachers' reflection. However, this needs other teachers who provide the feedback. On the other hand, there are also studies that attempt to support teachers' reflection without any other teachers. For example, Kubicek (2015) indicates that classroom walkthrough observation using video recordings promotes the development and improvement of educational practices.

Furthermore, some studies attempted to semiautomatically visualize and analyze the videos to reduce workload of watching and analyzing the recorded video. Some of these studies use OpenPose. OpenPose is an image processing library that can estimate the skeleton coordinates of 25 joints and their reliability using deep learning (Cao, Simon, Wei, & Sheikh, 2017). Chan, Ochoa and Clarke (2019) exhibit several multimodal techniques including OpenPose to analyze the learning activities in a laboratory classroom. Against this background, this study proposes a method to visualize the movements of teachers and students in a classroom by using OpenPose to analyze videos during class. The study aims to understand the kind of behavior that can be visualized from OpenPose data.

## 2. Methods

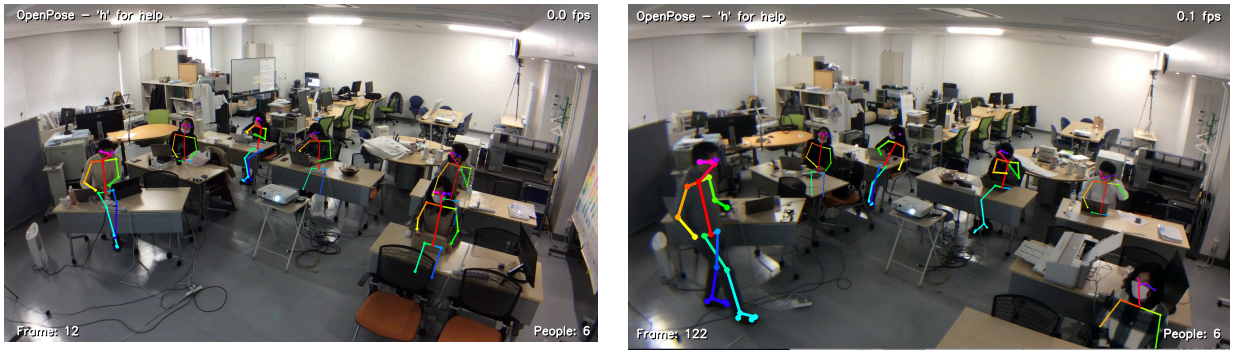
### *2.1 Data Collection*

We recorded the movements of teachers and students during class using an iPad positioned optimally to capture the entire classroom. The recorded video was processed by OpenPose and the skeleton coordinates data were acquired. Figure 1 shows the snapshot of one frame from the OpenPose skeleton coordinates data. When OpenPose is used to analyze videos, the transition of skeleton coordinates can be acquired in chronological order. This study uses only the coordinate data of the neck joint.

### *2.2 Visualization*

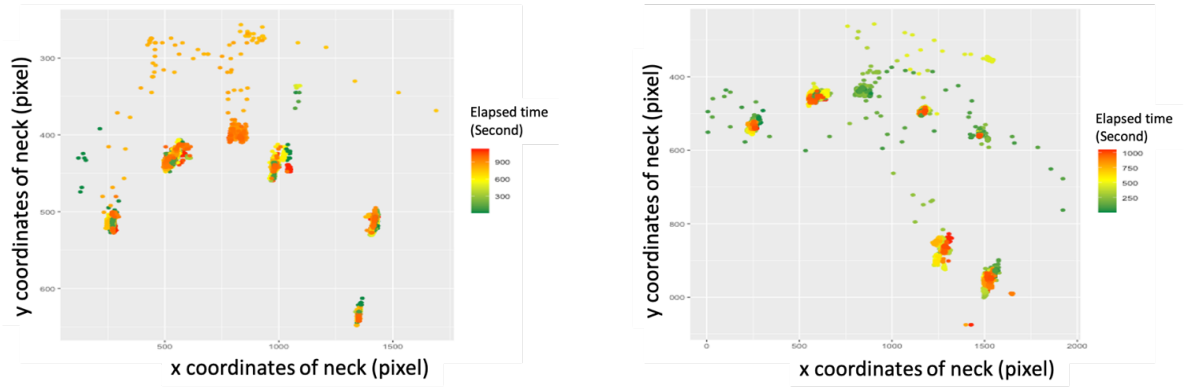
The plots in Figure 2 show the neck coordinates data obtained from the video. Its x- and y-coordinates are plotted on the horizontal and vertical axes respectively. We converted the video into one fps so that

one dot is plotted every second. The upper part of Figures 1 and 2 represents the rear of the classroom and the lower part represents the front. The dense dots represent the places where the subject stayed for a long time and the scattered ones represent the places where they walked or stayed for a short time. The color of the dots represents the elapsed time from the beginning of the video. The dots at the beginning of the video are green, while those in the middle and at the end are yellow and red respectively.




(a) The face-to-face condition (b) The HyFlex condition

*Figure 1.* The skeleton coordinate data obtained using OpenPose. (Snapshot of one frame).




(a) The face-to-face condition (b) The HyFlex condition

*Figure 2.* The visualization of movement obtained from the OpenPose data throughout the video using neck coordinates. (All data in the whole video).

### *2.3 Experimental Settings*

The experiment was conducted in two seminars at Sophia University, Japan on December 10th and 25th, 2020. It involved 6 face-to-face participants (5 students and a professor) who expressed consent to be a part of the study. Of the two experiments, the first was a complete face-to-face condition in which the professor and students participated in person while the second was a HyFlex condition in which one of the students participated online.

Both seminars were weekly laboratory meetings where students presented their research and discussed it with each other and the professor. In the face-to-face condition, the screen was projected in front of the classroom, and the presenter students shared their screen from their own seats. In the Hyflex condition, the online participant attended the seminar through Zoom and shared his screen, which was also projected in front of the classroom. The classroom had a discussion space in the front while the entrance and personal desks of each student were at the back.

## 3. Results and Discussion

### *3.1 Face-to-face Condition*

Figure 2. (a) is a visualization of movement in the face-to-face condition. First, focusing on the dots in the figure, clusters of dense dots in the middle of the classroom (near the center of the vertical axis) are

observed. These indicate the places where the subjects stayed for a long time. Contrastingly, several scattered dots in the rear of the classroom (near the upper part of the vertical axis) are observed. These indicate the places where the subjects walked or stayed for a short time. Second, focusing on the colors, both green and red dots are observed in the places where subjects stayed for a long time. These indicate the subjects stayed from the beginning of the video to the end. Contrastingly, the dots representing the walking movement in the rear of the classroom are green and light orange. These indicate the subjects moved at the beginning and in the middle of the video.

Since the number of places where the subjects stayed for a long time is consistent with the number of subjects (six), it can be assumed that those represent the place they were seated. In addition, since the third from the left of these six places consists of only dark orange dots and no green or yellow ones, it can be assumed that the subject who stayed at this place joined the class late. Also, a series of dots from the door on the right rear side toward this place is observed, thus showing traces of movement to this place. The other scattered dots at the back of the classroom are assumed to be the movement between the personal desk at the back of the classroom and the discussion space in the front.

### *3.2 HyFlex Condition*

Figure 2. (b) is a visualization of movement in the HyFlex condition. First, focusing on the dots, clusters of dense dots indicating the places where the person stayed for a long time in the front and scattered dots indicating the movement among them are observed. The number of subjects who participated (six) is inconsistent with the number of places where the subjects stayed for a long time (seven). Of the seven places where the subjects stayed for a long time, the third place from the left consisted only of green, which means that the subject stayed here only during the beginning of the class. In addition, since the traces of movement are connected from this place to the second from the front right, it can be inferred that the subject who sat third from the left had moved to the front seat. This is assumed to be the situation where the graduate student was assisting the undergraduate student in the front.

## 4. Conclusion

This study proposed and verified a method to visualize the movement of teachers and students in a classroom using OpenPose to help teachers reflect on the quality of their classes. It visualized activities like sitting, joining late, moving, and discussing in pairs. Several different behaviors were observed between the experimental condition. However, it was assumed that these differences are not due to differences in class conditions, but due to those in activities and situations. Two advantages of this method are observed: human movement can be visualized semi-automatically from video data and the approximate elapsed time can be visualized as a single image with colored dots, thus saving time spent watching long videos.

However, this study had three limitations. First, this method does not distinguish between people. To that end, an appropriate visualization method must be considered. Second, whether showing the visualization to teachers will help them reflect on the quality of their classes remains unverified. Third, face-to-face classes with a large number of students were limited due to COVID-19 restrictions at the time of this study. Therefore, we aim to conduct experiments in the future under various conditions like classes with a large number of students, lectures, and classes that involve group work.

## References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