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Classroom Social Signal Analysis

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ABSTRACT: We present our efforts towards building an observational system for measuring classroom activity. The goal is to explore visual cues which can be acquired with a system of video-cameras and automatically processed to enrich the teachers' perception of their audience. The paper will give a brief overview of our methodology, explored features and current findings.

KEYWORDS: video analysis, computer vision, tracking, intrusiveness, body motion, head pose, classroom, students' synchronization, orchestration

1 INTRODUCTION

As much as humans developed as social animals, our perceptional and cognitive abilities still put a limit to the comprehension of our interlocutor(s). While we are capable of interpreting unspoken signals in a one-to-one conversation, the task becomes much more challenging when faced with an audience of thirty or more students, with minimal amount of interactions. We aim to enrich the classroom ecosystem with information about the state of the audience's attention which could be presented to the teacher in order to raise the awareness of how the students are receiving the lecture. The research is rooted in the concepts of observational data gathering, meaning that our main source of information is not based on probing the information from the students (e.g. using an application to state their attention), but rather that we analyze the cues that we can gather from the body language and deduce the state of the audience based on that.

The data gathered is captures with a system of cameras positioned around the black-board in the classroom. The video material captured is processed with Computer Vision (CV) techniques such as motion detection, head detection and head orientation estimation. Our current efforts are aimed at determining meaningful patterns of behavior and finding the most salient features. Second part of the research is trying to model the students behavior and finally to discuss how to present the information back to the teacher in order to encourage the reflective practice in teaching.

a) b)

Figure 1: a) Motion vectors visualized on top of the students. Individual vectors are grouped into motion paths depicted as lines of different colors. b) Head detections and estimated gaze directions for a group of students in the classroom.

Our efforts are building on the concepts of classroom orchestration (Dillenbourg, Jermann (2010)) and teacher-centric structure of the classroom. The main difference from the current approaches such as the usage of clickers (Caldwell (2007)) is the principle of unobtrusiveness (Webb (1999)), which constraints our interventions so that they will enrich the teaching process, without imposing a specific format of the class or adding another feedback tool to the classroom.

2 METHODOLOGY

We conducted a series of experiments for capturing students behavior during class. Given the complexity of the classroom ecosystem, we conducted a holistic analysis of the classroom (Raca, Dillenbourg (2014)), capturing many aspects of classroom life including:

- videos of student behavior – from which we extracted motion intensity and head orientation for each student over time (shown in Figure 1a, b),
- video of teacher actions / lecture slides – we applied tracking algorithms to find the position of teacher over time and annotated events during the lecture (slide changes, question/answer periods),
- questionnaires – we distributed questionnaires on which the students reported their level of attention, perception of the classroom attention, material importance and teacher energy,
- interviews – a smaller subset of students participated in the interview sessions, in order to evaluate the students perception of the system and validity of the questionnaires,
- eye-tracker – the teachers wore a portable eye-tracker during the lectures, from which we extracted the gaze patterns of the teachers.

3 RESULTS

Our initial set of experiments on motion showed no direct connection between the motion of the students and their attention levels (reported in the questionnaires), but gave grounds to the definition of the concept of "motion lag" (Raca, Tormey, Dillenbourg (2014)) – the idea that the high-attention students will be more likely to be synchronized in actions, from where we hypothesize that the synchronization influence comes from the external environment, and that the dominant signal in a good classroom will be the teacher. We also observed that the spatial arrangement is also manifested in the results, neighboring students being more likely to synchronize and that the intensity of the motion decreases with the distance from the teacher (Raca, Tormey, Dillenbourg (2013)).

Our next steps are directed towards refining our head-pose estimations (Raca, Dillenbourg (2014)) and analyzing the observations received from this data stream, before merging them with earlier findings into a unified model.

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