OPTIMAL CLASSROOM VIEWS FOR DEAF STUDENTS

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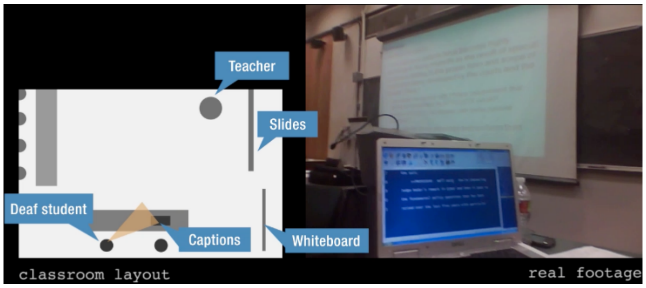

Figure 1: Example of a visually hard-to-access classroom

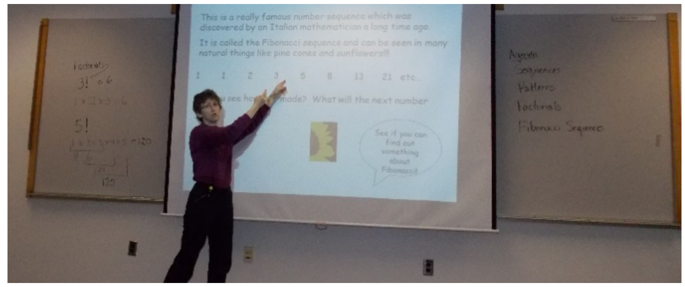

Figure 2: View of Entire Lecture Using Distant Camera

ABSTRACT

The Americans with Disabilities Act mandates aural-to-visual access for Deaf and Hard of Hearing students who request these accommodations. These students have to either watch the accommodations close and clearly, or be far away to see everything but not clearly. We tested an automated tracking video system that enables video to be captured close-up and clearly. We present the results of a study evaluation of two videos, one at 5 feet with pan and zoom, and the other at 10 feet. We set this up such that the pan-capable camera does not rely on any classroom infrastructure, or any special accommodations by the lecturer or the institution. The participants preferred the close-up video, but were bothered by the constantly changing background, which suggests that an alternate approach that has less lag time such as digital swiveling, may be more suitable.

BACKGROUND

Federal law requires educational institutions to provide equal learning access to deaf and hard of hearing students (Kushalnagar, 2008). Therefore, most accessible technology research related to deaf and hard of hearing consumers in higher education focus on leveraging existing institutional and classroom infrastructure to provide equal access.

Classrooms are optimized for audio transmission and secondarily for visual transmission; visual space and line of sight of for deaf and hard of hearing individuals and sign language interpreters are rarely considered. If the classroom has good acoustics, class discussion is not impeded. Visual noise is less important than bad acoustics for hearing participants as they rely on auditory context to fill in their gaps in visual learning, but this is not the case for DHH participants, who rely far more, if not exclusively on visual learning.

The impact of visual accessibility on learning for deaf students is well documented (Antia, Sabers, & Stinson, 2007; Kushalnagar, Kushalnagar, & Manganelli, 2012; Kushalnagar, Trager, Beiter, & Kolash, 2013; Kushalnagar, Trager, & Beiter, 2012; Marschark, Lang, & Albertini, 2002; Marschark, Sapere, Convertino, & Pelz, 2008).

Only 16% of DHH students complete a bachelors' degree, far less than the 30% hearing student graduation rate (Erickson, Lee, & Von Schrader, 2013). Part of this disparity can be attributed to lack of visual accessibility. We investigate viewer preferences for video capture distance for people. Even with visible accessibility, the viewing distance may be an impediment to learning.

<u>Visual Noise</u>

Most classrooms have visuals spread around and at varying distances, which reduces visual access as shown in Figure 1. The spread and varying distance of visuals can be an impediment to learning (Cavender, Bigham, & Ladner, 2009). The deaf student has to keep all visuals in their peripheral vision and choose and switch between them.

The naïve way for the student to keep all visuals within the peripheral vision is to be positioned further away as shown in Figure 2. Then the student can see all visuals, but the distance often prevents students from reading the slides or understanding fingerspelling consistently. As a result, the signer will sign with more restrictions to be clearly understood.

In addition, with multiple visuals within the student's view, the student's cognitive demands considerably increase. The student has to monitor all visuals within their peripheral vision and decide which one to focus on, and to ignore the others. This visual attention management process occurs simultaneously with the student's learning process. As a result, many deaf and hard of hearing students can become mental fatigued.

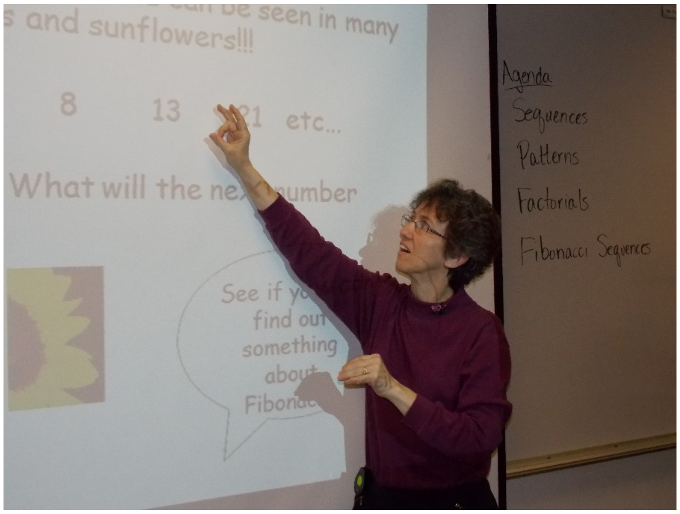

Figure 3: Close up and Focused View Using Tracking Camera

If there is too much information, “tunnel vision” is induced which reduces sensitivity to the changes occurring within the periphery (Schwartz et al., 2005; Williams, 1985). We explore an alternate approach in which the goal is to increase the visual resolution and to reduce the amount of visual information presented.

Specifically, we use an automatic tracking system to track a signer so as to always present a close up view of the signer. This makes it easier to comprehend what the signer is saying and minimizes the visual attention management process. In this approach, we present a close-up view acquired through an automatic tracking system on a screen. The close-up view as shown in Figure 3 allows the student to read slides or understand fingerspelling more easily.

PURPOSE

The purpose of this study was to answer the following research questions:

- What is the optimal distance for recording a signer during a lecture?
- What is the optimal distance for recording slides during a lecture?

METHOD

Subjects

The population of interest in this study was deaf and hard of hearing students who cannot understand audio and follow classroom lectures via sign language, either directly or via sign language interpreters.

We recruited 18 deaf participants ages 20-45 (11 female) for a study. We recruited students who typically requested accommodations in the classroom.

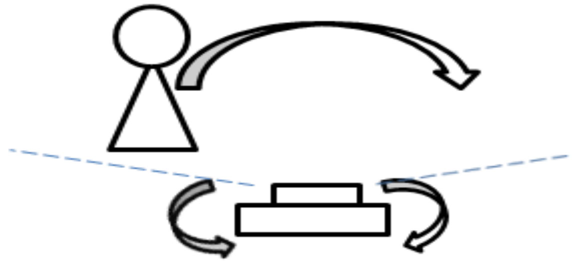

Figure 4: Diagram of a tracking camera, using Swivl.

Set-up and Text

To evaluate deaf students’ perceptions of optimal views obtained through close up video capture devices, we recorded multiple information sources using camera phones at a distance of 5 feet and 10 feet respectively. We processed the video of the instructor slides, sign language interpreter and instructor and presented them through multi-video interface as shown in Figure 4.

Setup

We mounted a WiFi camera on an automatic tracking device (Swivl) that synchronizes with a receiver unit wirelessly. This unit swivels such that it is always facing the receiver unit, which is worn by the signer as shown in Figure 4. The result is a video that is always close and clear: as the signer moves around to stay close with the current visual information, the device tracks and always captures the current visual in focus. This recorded video is presented as an optimal view as shown in Figure 3.

Procedures

Each participant watched the recorded lectures at two different distances: 5 and 10 feet. After viewing each video, each of the participants was asked to respond to the following questions using a Likert scale from 1 to 5, with 1 being very hard, and 5 being very easy. Each participant was asked to rate on the basis of the following questions:

1. “How easy was it to understand the signer?”
2. “How easy was it to understand the slides?”

We also asked students an open-ended question to solicit their thoughts and feedback at the end of each video, and then enforced a one-minute break to ensure that they were not mentally fatigued from the previous video.

RESULTS

We used a chi-square test to evaluate the students’ preferences at varying distances, as the sample size is large enough, and the variance was normal.

For first question on how easy it was to understand the signer, there was a significant preference difference for viewing at 5 feet versus 10 feet: $\chi2 = 16.81$, $p < 0.001$.

For the second question on how easy it was to understand the slides, there was a significant preference for viewing at 10 feet versus 5 feet: $\chi2 = 10.37$, $p < 0.005$.

In the open-ended question, one common theme (12 of 18) reported that they felt video was too jerky due to the fact that the automatic tracking device was too slow in tracking targets. Another common theme (7 of 18) was that the changing background sometimes became disorienting.

CONCLUSION

The results of this study with automatic tracking has implications for signers, whether teachers or interpreters. Students clearly prefer to have the signer and slides closer. This reinforces the recommendation that deaf and hard of hearing students would benefit from sitting in the front row.

FUTURE WORK

The feedback on the fact that the tracking device was too slow needs to be addressed. We have identified three possible ideas that may resolve the issue of slow tracking.

The first idea would explore physical swiveling tracker that moves faster and more smoothly.

The second idea would explore digital trackers. A high-resolution camera can capture a high-resolution image and use digital algorithms to swivel on the signer.

The third idea would explore feasibility of two windows on the laptop screen. The first window would show a close up view of the signer using the trackable technology. The second window would display a static view of the PowerPoint/whiteboards directly.

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