Optimal Viewing Distances for Deaf Students

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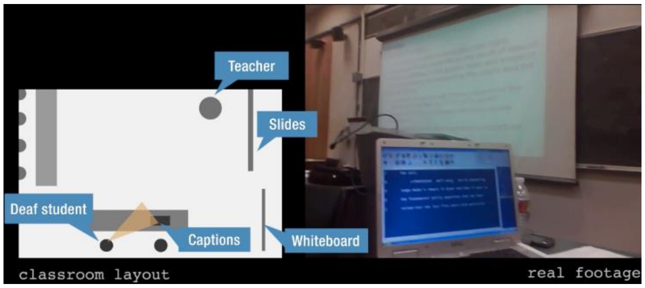

Figure 1: Example of a visually hard-to-access classroom

ABSTRACT

In the United States, the Americans with Disabilities Act mandates aural to visual access for Deaf/Hard of Hearing students who request these accommodations. These students must 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 set at 5 feet with pan and zoom, and the other at 10 feet. We set this up such that the 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.

Categories and Subject Descriptors

K.3.1 [Computers in Education]: Computer Uses in Education; K.4.2 [Social Issues]: Assistive technologies for persons with disabilities.

General Terms

Design, Economics, Human Factors.

Keywords

Deaf, Hard of Hearing, Swivl

1. INTRODUCTION

Federal law requires educational institutions to provide equal learning access to deaf and hard of hearing (DHH) students. 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 DHH individuals and sign language interpreters are rarely considered.

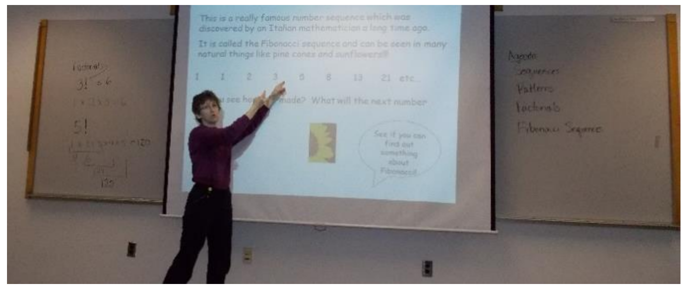

Figure 2: View of Entire Lecture Using Distant Camera

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 [1, 3–7].

Only 16% of DHH students complete a bachelors' degree, far less than the 30% hearing student graduation rate [2]. 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.

1.1 Visual Noise

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. 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 mentally fatigued.

Also, if there is too much information, “tunnel vision” is induced which reduces sensitivity to the changes occurring within the periphery [8, 9]. We explore an alternate approach in which the goal is to increase the visual resolution and to reduce the amount of visual information presented.

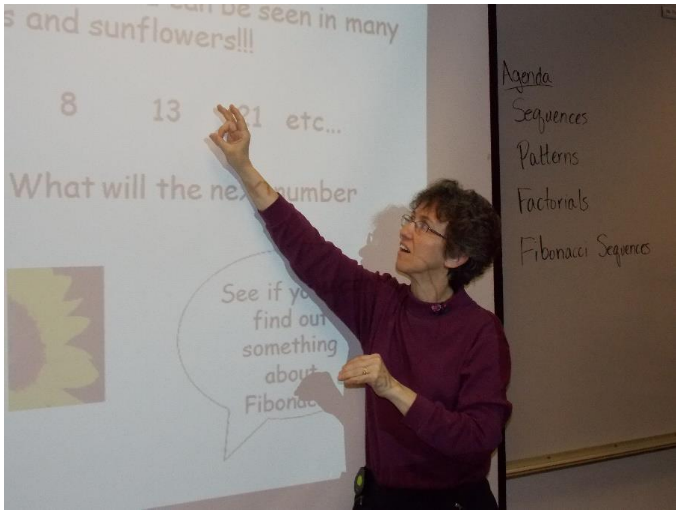

Figure 3: Close up and Focused View Using Tracking Camera

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.

2. 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?

3. METHOD

3.1 Subjects

The population of interest for this study consisted of 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 the study that typically requested accommodations in the classroom.

3.2 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.

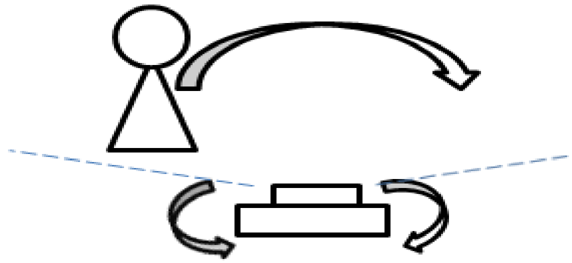
Figure 4: Diagram of a tracking camera, using Swivl.

3.3 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?”

Next, we also asked students one open-ended question, with the aim of soliciting 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.

4. 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: $\chi 2 = 16.81$, $p < 0.001$.

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: $\chi 2 = 10.37$, $p < 0.005$.

In the open-ended question, one common theme emerged in that 12 of 18 participants 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 participants) was that the changing background sometimes became disorienting for the viewers.

5. CONCLUSION

The results from this study with automatic tracking, has implications for all classroom signers, whether they are teachers or interpreters.

Deaf and Hard of Hearing students who follow American Sign Language in the classroom clearly prefer to have the signer at an optimal viewing distance; most signers and interpreters are normally situated further away than this optimal viewing distance. Further research is needed to ascertain the optimal distance for viewing signers in a classroom that has other visuals such as slides or whiteboard.

6. FUTURE WORK

The project is in its early stages and the user interface development for deaf and hard of hearing students is an on-ongoing project with deaf and hard of hearing faculty and students as authors. Demonstrations will allow the deaf and hard of hearing accessibility researchers to give feedback on evaluating and extending usability and functionality.

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

The first idea is to acquire or develop a physical swiveling tracker that moves faster and more smoothly.

The second idea would be to explore the development of a digital tracker. It would involve using a high-resolution camera to allow for the full view and then use digital software to zoom in on the signer with the trackable device.

The third idea would explore the feasibility of two windows on the laptop screen, one showing the close up view using trackable technology on the signer and the other window displaying the PowerPoint/whiteboards directly without any movement involved. This would allow the students to view the PowerPoint and or the whiteboard information while the signer pauses so that they have enough time to process both information sources at the same time.

The fourth idea, an extension of the third idea, is to display three windows on the laptop screen. The first window would show the close up view using trackable technology on the signer. The second window would display the PowerPoint/whiteboards directly without any movement involved. This would allow the students to view the PowerPoint or whiteboard information while the signer pauses. The third window would be the view of the instructor as he/she points to the PowerPoint or whiteboard information.

An alternate option, if captioning were also available, would be to have the captioned transcript streamed directly to the third window. A preliminary study that was conducted by Fadi Haddad and Raja Kushalnagar has shown a high interest among the participants for this idea with 13 out of 13 subjects showing a definite preference for this idea over the regular mainstream classroom environment.

7. ACKNOWLEDGEMENTS

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