Accessible Viewing Device: Live Magnification in Classrooms for Low Vision Students

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ABSTRACT
We present a mobile multiple view platform that utilizes multiple smart phone cameras to be used independently by low-vision students or in cooperation with sighted students to obtain flexible, magnified views of lecture visuals, such as the presentation slides or whiteboard.

Keywords
Blind, low-vision.

1. Introduction
Sighted people have a wide field of view of up to 180° with a high resolution focus of about 2°, which is temporally multiplexed to give the illusion of high resolution focus everywhere, as shown in Figure 1. Most people with low vision either see a very narrow field of view with high resolution (fovea), or a wide field of view with low resolution (peripheral vision) [1]. As a result, most low vision people struggle to cope with situations where both kinds of view are needed, such in classroom presentations that use many visuals such as whiteboards and slides. Traditional low-vision aids can improve either central or peripheral vision, but negatively impact the other. For example, magnifying devices for increase resolution of the lecture visual but reduce the field of view of the whole presentation. On the other hand, minifying devices increase the field of view and enable students to see the whole lecture at a glance, but reduce resolution of individual visuals [2].

Presenters tend to present information both visually and aurally, e.g., by handwriting words and also saying them. A seminal paper by Mayer et al. [3] analyzed how the distribution of redundancy across two channels (visual and auditory) makes learning easier by processing in parallel in both channels and the effect is complementary. Presenters emphasize key terms or to explain in parallel. These words are usually dialogue-critical words and add meaning to the underlying visual representation [4], which reinforces importance of reading class visuals.

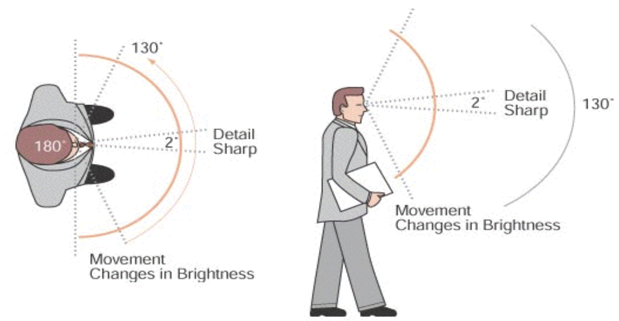

Figure 1: Field of View for Sighted People

We propose a multiple view approach that utilizes mobile devices to simultaneously provide access to both the wide field of view in the classroom and high resolution view of the presentation information sources such that the low vision student can follow both. We developed a set of applications (capture, streaming and viewing) for Android smart phones and tablets. Our approach uses one or more smart phone cameras acting as video recording and streaming devices which capture the missing visual component, either the high resolution or wide field, with the residual one. These applications enable students to use or share smart phones in classroom environments. We focus on optimizing classroom learning views and comfort, with the goal of making them more effective, intuitive, and easy to use. Also, as smart phones are ubiquitous, i.e., easily available it is easy for low vision students to use these devices in the classroom without drawing attention.

2. Related Work
Pure optical solutions such as mounted monoculars like Designs for Vision [1], can aid low vision (resolution) students by magnifying lecture visuals so as to read the visual more easily. However, this approach incurs a trade-off; their field of view becomes narrow. Therefore the student has to continually shift view to scan and orient to classroom visuals, e.g., re-locating the professor after looking at the whiteboard notes.

Electronic optical solutions such PhotoNote [5] use multiple classroom camcorders and a high definition camera. However, these devices are bulky and require prior set up in classroom, and the recording is not viewable in real-time.

ClassInFocus [6] uses multiple webcam equipped laptops to record and stream the classroom visuals in real-time. However, ClassInFocus does not support magnification within the application; and it requires cooperation from the teacher and providers.

Note Taker [7] does not require classroom infrastructure or prior setup in a classroom and does not require the lecturer to adjust the presentation. Its main disadvantage is that there is only one camera view, and the camera location is limited by wiring to be close to the student. Moreover, the equipment is not ubiquitous and has to be carried separately.

Figure 2: Low vision student's magnified view of classroom visuals

In response to the gaps identified by these studies, a design approach in evaluating important features for low vision students and for the underlying technology was pursued.

3. Development

AVD incorporates the following design principles: 1) incorporate ubiquitous, cheap personal devices to record and view to optimize convenience and sharing; 2) utilize classroom visual properties to accommodate personal smart phones and tablets that are limited in bandwidth, resolution and battery life [8]; 3) use open source software (Android) to develop a flexible interface that students can customize to fit their widely varying needs; and 4) to design the view capture and presentation to correct for lighting and viewing angles through image processing, camera placement and built-in lighting.

As a result, we believe the platform is simple, ubiquitous and multifunctional, which enables students to use their own phone or classmates' phones as accessible technology devices that can be used anytime and anywhere with minimal set up.

Figure 2 shows the student viewing the slides and whiteboard in a classroom on an Android tablet (Motorola Xoom Wi-Fi). The student is viewing video streams that are being received from two Android phones aimed at the slides (HTC Evo 4G) and at the whiteboard (Samsung Galaxy Tab 7). The platform is standalone and independent in that the student can immediately place the phone recorders on the lecture podium or table to capture and stream the video. The student then uses a personal tablet computer view the streamed software, and can magnify within each video window as needed. With practice, this setup process takes about a minute, and can be done as the MVP software starts and synchronizes. All devices are standalone and can run on battery and in ad-hoc mode.

4. Evaluation

Figure 3 shows the MVP student view interface for students, which consists of up to four windows that can be viewed, magnified or change contrast by the user. The student can pinch enlarge or tap create/remove a view. Additionally, the student can record the lecture for future review.

We invited two low vision volunteers to evaluate MVP. The first low vision student we saw commented that the most helpful feature was the ability to adjust the video contrast or use the smart phone LED lights so as to read slides that had poor contrast.

Figure 3: MVP Student View

Another low vision student commented that the Android supported pinch-magnify feature was very helpful, but did not like the fingers getting in the way of reading the text. The student suggested inserting a magnify button at the bottom of the screen.

5. Summary

MVP enables low vision students to view multiple presentation visuals simultaneously on the same screen. As a result the student only needs to remember the location of each visual on the screen. This memorization eliminates search time and the student can rapidly switch between visuals and can magnify the visual as needed. The MVP platform is scalable as it leverages general consumer smart phones to increase low vision student classroom accessibility.

The MVP project is in its early stages and the user interface development for low vision students is an on-ongoing project with a low vision researcher as an author. Demonstrations will give low vision accessibility researchers to give feedback on evaluating and extending usability and functionality.

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