I. INSTRUCTIONS

Complete this form in its entirety and email it to plig@rit.edu no later than November 1, 2013. Please note to save and rename this document substituting your name (in place of “NAME”) in the file name.

II. PERSONAL INFORMATION

Name: Raja S. Kushalnagar
Email: rskics@rit.edu
Phone: 5856436773

College: NTID
Department: Information and Computing Studies

Department head name, phone and e-mail: Elissa M. Olsen

Faculty rank: (full-time lecturer, tenured, and tenure-track faculty only): TT Assistant Professor

Proposed project name: Closed Visual Cues for Introductory Programming Tutorial Videos

Total funds requested: (Implementation grants of $3,000-$5,000 will be considered): 5000
III. BUDGET

Provide information on how the funds will be used, modifying the following categories as needed to match your project.

(Please note that the budget total must match the “Total funds requested” amount on page one of the application.)

<table>
<thead>
<tr>
<th>Budget item</th>
<th>Amount requested</th>
<th>Amount committed from other sources</th>
<th>Brief statement of explanation/justification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personnel (including course release, consulting support, etc.)</td>
<td>4500</td>
<td></td>
<td>Three students (each working 10 hours a week for 15 weeks) will work as a team to 1) assist in the recording and posting of closed cue videos for both hearing and deaf students; 2) develop multiple versions of eye-tracking generated visual cues; 3) run and analyze surveys with students to verify the efficacy of the visual cues.</td>
</tr>
<tr>
<td>Benefits (applicable rates for FY14)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equipment</td>
<td>0</td>
<td></td>
<td>Mirametrix portable eye-tracker that was previously purchased with seed grant money. It will be used to record visual cue coordinates for tutorial videos for introductory programming courses</td>
</tr>
<tr>
<td>Other resources (be specific)</td>
<td>500</td>
<td></td>
<td>Supplies to set up studio (HD Camera, tripods and boards) for recording tutorial lectures.</td>
</tr>
<tr>
<td>Total</td>
<td>$5000</td>
<td>$</td>
<td></td>
</tr>
</tbody>
</table>

IV. PROPOSED TIMELINE

Provide a high-level timeline for your investigation

(see the Dissemination Agreement section of this application for more details)

<table>
<thead>
<tr>
<th>Task</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project plan complete</td>
<td>Jan-May 2014</td>
</tr>
<tr>
<td>Technology Development and Preference Outcomes findings</td>
<td>Feb 2014</td>
</tr>
<tr>
<td>Study: Preference and Learning Outcomes</td>
<td>Jun 2014</td>
</tr>
<tr>
<td>Summary of final findings and Final budget accounting complete</td>
<td>Aug 2014</td>
</tr>
<tr>
<td>Course, activity, or tool (re)design complete (design and development support may be provided by the ILI Teaching &amp; Learning Studio)</td>
<td>Aug 2014</td>
</tr>
<tr>
<td>Faculty Teaching &amp; Learning Commons entry complete (development facilitated by the ILI Teaching &amp; Learning Studio)</td>
<td>Aug 2014</td>
</tr>
<tr>
<td>Participation in faculty panel event complete (event to be planned and facilitated by the ILI Teaching &amp; Learning Studio)</td>
<td>Aug 2014</td>
</tr>
</tbody>
</table>

Please note that the timeframe for milestone completion must align with the PLIG schedule.
V. STATEMENT OF UTILITY (TWO PAGES MAXIMUM)

**Explanation of teaching/learning problems that will be addressed**

Deaf and hard of hearing (DHH) students face excessive cognitive demands in processing multiple streams of visual information in introductory programming courses with accommodations, including tutorial videos. Without appropriate support, many do not succeed in introductory programming courses and are less likely to continue in the field. We aim to reduce DHH students’ cognitive demand in watching tutorial videos.

**Brief description of integration with activities at RIT**

A combination of transitional programming course and tutoring support has improved DHH students’ academic success. Specifically, DHH students showed improved passage rate in an introductory IT programming course. Before the introduction of a transition course that offered direct instruction, the passage rate in the introductory course was only 28%; after the introduction of a required transition course, the passage rate improved to 60% [1]. We believe the addition of tutorial videos with closed visual cues will further improve DHH student outcomes. Student learning and engagement is complex, and there are many intrinsic and extrinsic factors that significantly impact learning and outcomes. Our accessible cues proposal addresses part of the extrinsic accessibility factors. Enhanced access to multimedia often yields improved outcomes, such as increased engagement or interaction.

Existing accommodations for DHH students are not optimal. Although current accommodation services such as interpreters and captions significantly improve access to spoken information for deaf students, significant but subtle barriers related to multimodal learning remain. They usually miss lecture information as they include multiple simultaneous information sources, such as the teacher, interpreters, captions and slides. Hearing students can simultaneously listen to the instructor and read the slides, while deaf students have to switch between the visual translations of the audio (captions/notes or interpreter) and the slides as shown in the figure above. In addition, students often encounter visual noise, such as large viewing distances, line of sight interference or obstruction, poor lighting or viewing angles. Visual noise tends to be a mere annoyance for hearing students, but can significantly interfere with the visual learning for deaf students, which reinforces the importance of visual cues for deaf students. Moreover, the visually translated information may not always be accurate as not all interpreters or captioners are familiar or competent with computing terminology, which increases the importance of the displayed information.
Project Objectives
We will leverage functionality for PI Kushalnagar’s Accessible Viewing Device (http://www.rit.edu/avd) to develop an easy-to-use process to add visual cues to multimedia tutorial videos and to enable DHH students to watch the videos with on-demand visual cues. An eye-tracking device will capture and record a hearing student or notetaker’s gaze on the video. We will display visual cues that can be turned on or off, based on the recorded gaze coordinates, to guide deaf and hard of hearing students’ gaze. This approach is original and has not been used in online education before. The objective is to reduce DHH students’ cognitive load in watching multimedia lectures with visual accommodations via on-demand visual cues. We will leverage Co-PI Bailey’s extensive work on gaze manipulation strategies (https://sites.google.com/a/g.rit.edu/gaze-manipulation/) to develop effective cues for guiding the student’s attention.

Project Need
Increased cognitive load in watching multimedia presentations has been well documented (Marschark, et.al., 2008; Antia, et.al., 2007; Lang, 2002; Stinson, et.al., 1999). Deaf students struggle to effectively “manage and shift attention” among multiple lecture information sources. When this attention is poorly managed, loss of contextual cues and content information is likely to occur, and cognitive effort is shifted towards managing lower level attention management at the expense of higher order thinking skills (Mayer & Moreno, 1998). The cognitive effort that is focused on managing attention rather than learning can potentially result in poorer performance. In addition to missing content information, deaf students also miss out on audiovisual cues. Using evidence-based guidelines of cognitive load theory in the design of instruction (Clark, et.al, 2006; Sweller, 1999; Sweller, 1994), the multimodal lecture approach enhances and aids hearing students’ learning process, but can be detrimental to deaf students’ learning process. Hearing students benefit from audiovisual prompts to switch focus, which allows them to manage cognitive load and maintain a comfortable level of working memory to process and retain information. In addition to juggling multiple visuals, deaf students likely miss out these audiovisual prompts. As a result, deaf students are forced to overtly attend to the interpreter or captioning on the screen while covertly attending to changing stimuli in the learning environment. We find that when other factors are kept constant, effective use of interpreters or captioners is maximized when visual overload and associated cognitive demand are minimized. We have introduced approaches that have reduced visual overload such as view consolidation [2] and live playback [3] that have improved student ratings and response accuracy in studies.

Student outcomes/experience
We anticipate that the addition of closed cues to tutorial classroom videos for introductory programming courses will have a positive impact on students’ access to multiple classroom information sources. We expect students will be more active learners. Closed cues will reduce cognitive load for deaf students using accommodations. The confidence that they can locate relevant information more quickly can have an important impact on perceived classroom success, especially where retention is an issue.

VI. STATEMENT OF CREATIVITY (THREE PARAGRAPHS MAXIMUM)

Provide a brief description of how this is a novel approach, or a new application of an existing mode or model of teaching and learning, or represents an entirely new paradigm. (Please note that special consideration will be given to proposals that demonstrate a new use/application of a model, system, or technology already in use at RIT.)

Current Work
We will enhance the Accessible Viewing framework previously developed by PI Kushalnagar to enable an easy process to add visual cues to multimedia tutorial videos. Our eye-tracker will capture and record a hearing student or notetaker’s gaze on the video. We will display visual cues that can be turned on or off, based on the recorded gaze coordinates, to guide deaf and hard of hearing students’ gaze. This approach is original and has not been used in online education before.

Related Work
Several accessible technology solutions have been developed to minimize the deaf student’s cognitive demand in the classroom.

Francis, Stinson and Elliott (2008) implemented a Tablet PC that was connected to a captioning device. Deaf students viewed an overlay of the captions and lecture slides on the Tablet PC screen, and were able to write notes on the same screen. Qualitative reports by these student participants were positive due to increased autonomy and class participation. However, the Tablet PC solution was problematic in that the captions and lecture slides were overlaid over each other with transparency. Deaf students had to selectively focus on the relevant information and inhibit irrelevant information within the same view, which made it harder to read either the captions or the lecture slides fluently.

Cavender, Bigham and Ladner (2009) developed ClassInFocus, a videoconferencing system that utilized remote captions or interpreters. This system used Adobe LifeCycle Collaborative Services (LCCS) to capture and place each source (lecturer, slides, whiteboard and remote captioner or interpreter) onto a single screen. An advantage of this approach is the view layout flexibility and reduced visual dispersion. The major limitation was the low video resolution that resulted in hard-to-read views of the slides and whiteboard. Additionally, the requirement of high speed internet connectivity capable of handling multiple video streams is not widely available in many classrooms.

Kushalnagar et.al. (2012) evaluated shared eye-gaze collaboration in which deaf students were able to observe in their classroom video, transparent overlays of where their hearing classmates were looking at. The participants found this very helpful and there was a significant difference in preferences and learning outcomes for the participants.

Kushalnagar and Bailey (2013) extended the AVD platform to enable eye-gaze controlled live replay. Participants watched 3 video windows: teacher, interpreter and slides. Students were able to pause the interpreter video by a few seconds to study and analyze slides or other classroom visuals. The study showed a significant difference in preferences and learning outcomes with real-time pause.

Our next step to add closed visual cues to multimedia lectures is consistent with our design philosophy of developing a student-centric model for learners, especially those who use visual accommodations such as sign language interpreters or captioners. These features will extend accessibility and will contribute RIT’s image as a national model for cutting edge accessible technology.
VII. STATEMENT OF EFFICACY (TWO PAGES MAXIMUM)

Provide a brief description of the experiment/research design, methodology, and methods of data collection you will use to gauge efficacy.

The goal of the project is to reduce perceived DHH students’ cognitive load and to improve ability to copy programming demonstrations by capturing visual cues in multimedia tutorials. The main objective of the project is to create and present on-demand visual cues in tutorials for introductory programming courses.

The goal of the project will be accomplished in 2 stages:
Stage 1 (Intersession 2013-14):
Capture and record notetaker’s gaze of tutorial videos for introductory programming courses
  Incorporate recorded gaze as closed visual cues in tutorial videos

Stage 2 (Spring 2013-14):
  Offer tutorial videos with closed visual cues to DHH students in introductory programming courses
  Conduct and generate formative and summative surveys and assessments

Evaluation of Closed Visual Cues
We will gather statistics on overall DHH student performance in introductory programming courses in the past 3 years.

Formative Assessment
DHH students will be asked to comment on difficulties they had in watching prior classroom videos that included visual accommodations.
DHH students will be asked to view prior classroom videos and we will analyze the data to identify percentage of missed information and delay.

Summative Assessment
DHH students will fill out online quizzes before and after watching these videos to assess improvement in their proficiency

Risks
Multiple features of the Accessible Viewing Device have been established over the past three years; the eye-tracking component has been developed over one year and has accurately captured eye-gaze and incorporated into video. See http://www.cs.rit.edu/~rskics/AVD/Videos/AVD_EyeTracker.wmv
VIII. STATEMENT OF EFFICACY (TWO PAGES MAXIMUM)

Provide a brief description of the experiment/research design, methodology, and methods of data collection you will use to gauge efficacy.
# IX. Dissemination Plan (Optional)

If applicable, provide details about the journal, conference, show, other external vehicle with strong potential for dissemination of your results. Include supporting documentation such as preliminary interest or acceptance with your application, if available. *(Please note that special consideration will be given to proposals that have a defined opportunity for external dissemination, such as an academic journal or professional conference.)*

We will present the results of the closed visual cues at the following conferences and/or journals:

<table>
<thead>
<tr>
<th>1. Conferences:</th>
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<tr>
<td>c. Web Accessibility for All (W4A) – April 2015</td>
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<tr>
<th>2. Journals</th>
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<tbody>
<tr>
<td>a. ACM Transactions of Accessible Computing (TACCESS) – Fall 2014</td>
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<tr>
<td>b. Journal of Deaf Studies and Deaf Education (JDSDE) – Fall 2014</td>
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<tr>
<th>3. RIT Dissemination</th>
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<tr>
<td>a. Imagine RIT - May 2014</td>
</tr>
<tr>
<td>b. ILI Teaching and Learning Studio – Aug 2014</td>
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<tr>
<td>c. Intersession presentations – Jan 2015</td>
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X. ADDITIONAL CONSIDERATIONS
Please address these questions, if needed.

- Will your project require assistance for extensive or unusual media, multimedia, simulation, and/or software development? If so, please explain?

  No.

- All courses offered by RIT must be accessible to students with disabilities, according to Section 504 of the Rehabilitation Act of 1973 and Title II of the Americans with Disabilities Act of 1990 (rit.edu/diversity/title-ix). Is your proposed teaching approach accessible to all students, with reasonable accommodation? If not, please explain.

  Yes. All videos will include a sign language interpreter or closed captions. The videos will include a new accessibility feature called closed visual cues, which will aid DHH students who use visual accommodations to better follow multimedia presentations.

- RIT abides by the Family Educational Rights and Privacy Act of 1974 (FERPA), which prohibits instructors from making students' identities, course work, and educational records public without their consent (rit.edu/xVzNE). Will any data gathering or sharing for your project raise any FERPA issues? If so, please explain.

  No.
XI. DISSEMINATION AGREEMENT

By completing this grant application, I agree to provide the materials described here, in support of disseminating what is learned from this project to other faculty at RIT.

I also agree to return all/a portion of the funds that I receive for this project to RIT if I fail to complete or provide the materials described here.

- Project plan (including roles and responsibilities, milestone dates, and pertinent project details)
- Overview of preliminary findings (may include experiment/study design, lessons learned, initial data collection, and/or literature review summary)
- Final project summary (including data collection, lessons learned, implications for further study, and which may be in the form of an article abstract, conference presentation outline, or short report)
- Course, activity, or tool (re)design (Materials that will allow other faculty to adopt the mode of model of teaching and learning effectively and efficiently. Design and development to be supported by the ILI Teaching & Learning Studio)
- Faculty Teaching & Learning Commons entry (excerpts from research findings summary, the development of which is facilitated by the ILI Teaching & Learning Studio)
- Participation in faculty panel event (presentation of a brief summary of project and lessons learned and response to faculty questions. Event is planned and facilitated by the ILI Teaching & Learning Studio)
- Final budget accounting (reconciliation of budget provided with your application and the actual project expenses)

By submitting this application, I accept this agreement