Final Report for Period: 05/2008 - 04/2009
Submitted on: 06/30/2009
Principal Investigator: Starner, Thad .
Award ID: 0511900
Organization: GA Tech Res Corp - GIT
Submitted By:
Starner, Thad - Principal Investigator
Title:
Telesign: Towards a One-Way American Sign Language Translator

Project Participants

Senior Personnel

Name: Starner, Thad
Worked for more than 160 Hours: Yes
Contribution to Project:

Post-doc

Graduate Student

Name: Brashear, Helene
Worked for more than 160 Hours: Yes
Contribution to Project:
Helene is the principle architect of the gesture recognition system used in the project.

Name: Henderson, Valerie
Worked for more than 160 Hours: Yes
Contribution to Project:
Valerie is designing the qualitative studies we are using to compare methods of communication between the deaf and hearing communities.

Name: Lee, Seung
Worked for more than 160 Hours: Yes
Contribution to Project:
SeungYon Lee helps design interfaces for the project and run the necessary studies

Name: Minnen, David
Worked for more than 160 Hours: Yes
Contribution to Project:
David is working on theory of activity discovery which we are using to discover which types of disfluencies exist in sign language (like coughing, sneezing, or false starts in speech recognition)

Name: Yin, Pei
Worked for more than 160 Hours: Yes
Contribution to Project:
Pei has created a new algorithm, Segmentally Boosted HMMs, that is improving our recognition performance up to 20%.

Name: Kim, Jung
Worked for more than 160 Hours: Yes
Contribution to Project:
JungSoo maintains the gesture recognition toolkit we are using.

Name: Weaver, Kimberley

Worked for more than 160 Hours: Yes

Contribution to Project:

Created and ran the Telesign technology comparison study and wrote the ASSETS paper describing the results

Undergraduate Student

Name: He, Jiasheng

Worked for more than 160 Hours: Yes

Contribution to Project:

Helped create the sensors used in the project

Name: Wilson, Gregory

Worked for more than 160 Hours: Yes

Contribution to Project:

Explored using RFID technology as another way to reach young deaf children through games and interactive media

Technician, Programmer

Other Participant

Name: Schoner, Don

Worked for more than 160 Hours: Yes

Contribution to Project:

Don provides instruction for the PIs and students in conversational American Sign Language

Name: Howse, Cameron

Worked for more than 160 Hours: Yes

Contribution to Project:

weekly ASL lessons; consultant on usability/usefulness of project

Research Experience for Undergraduates

Name: Radafar, Cyrus

Worked for more than 160 Hours: Yes

Contribution to Project:

Explored more uses for project results

Years of schooling completed: Junior

Home Institution: Same as Research Site

Home Institution if Other:

Home Institution Highest Degree Granted(in fields supported by NSF): Bachelor's Degree

Fiscal year(s) REU Participant supported: 2006

REU Funding: REU supplement

Organizational Partners

Atlanta Area School for the Deaf

AASD is the local deaf school serving the Atlanta community

Other Collaborators or Contacts

We bring in deaf consultants to help ground our research in

practical problems for the community. We also have weekly private sign course for beginners and experienced signers related to the project. Of course, we also involve deaf subjects in our experiments, recruited from deaf events like AASD's homecoming and Silent Dinners.

Activities and Findings

Research and Education Activities:

2008 (through 2009):

We have completed the Telesign technology comparison study and submitted the results to ASSETS 2009. The study was run by a new PhD student, Kimberley Weaver, who is in the process of learning ASL. She is also involved in the continuation of many of the projects discussed.

We continue to develop the SBHMM algorithm for sign language recognition.

We have demonstrated TTYPhone, a way for deaf mobile phone users to contact 911 services, to the National Emergency Number Association (NENA) and to California's Deaf and Disabled Telecommunications Program (DDTP). The system is currently running self-contained on a OpenMoko mobile phone. Our demonstration included live two-way TTY conversations with the Georgia Tech police 911 center. As discussed in previous years, this project came from our studies and contact with the Deaf after a shooting victim died because a Deaf person could not directly dial 911. The project is now being developed by NIDRR's Wireless RERC; however, we are seeking more support for large scale deployment.

We have started a seedling project co-funded by DARPA and NSF, that attempts to recognize sign language directly from brain activity.

We have identified a real need for the mobile English-to-ASL one-way translator/educational system for parents to communicate with their deaf children. We now call this system SmartSign.

2007

We have renamed GT2K to GART (Gesture and Action Recognition Toolkit) to reflect the significant advances made to the toolkit and the new focus of providing a tool to users with little knowledge of pattern recognition. GART has been released to the web at large and is being used as part of academic projects around the world. It has been used as a basis for several papers in our own research.

We have created a new algorithm, Segmentally Boosted Hidden Markov Models, which increases accuracy up to 20% on some of our sign language test data sets.

Our continued work with the deaf community has born substantial fruit. Based on preliminary work from last year, we have received a grant from IES to research using our recognizer for creating a sign language based educational game to help young deaf children improve their language skills.

More directly related to Telesign, our research in exploring deaf-to-hearing communication needs has revealed an urgent task - access to 911 services when the deaf user is mobile. Last year in Atlanta, a person died last year because a deaf person could not make a 911 phone call! The crux of the problem is that 911 service centers do not have access to SMS (the primary mode of communication of the Deaf when mobile). Even if SMSs could be sent to 911 centers, an SMS can not be localized using the e911 system , there is no guarantee that an SMS will be delivered, and it may take up to 20 minutes to arrive. In response, we are investigating creating a software application for current smart phones that allows the deaf user to communicate to the 911 centers using the current baudot TTY standard. Basically, one can think of the software application as converting SMS to real-time character-by-character TTY, which is both immediate and trackable with e911. We have sought funding with NIDRR's Wireless RERC to further develop the idea, and we have gotten interest from AT&T, RIM, and the city of Los Angeles Office of Disabilities to promote the prototype as a possible near-term solution to the problem.

Our primary sign language recognition researcher, Helene Brashear, has taken maternity leave. Thus, the project is focussing on training our more junior pattern recognition students to take her place (and this is one reason for our request for a no-cost extension).

2006

We have finalized the IRB for the major study, obtained approval for

the revised version, and we have completed the software needed to perform the study. We expect more amendments to be filed for the IRB as the project progresses and as we chase new opportunities.

We are modifying the GT2K recognizer to perform continuous recognition (as opposed to the batch processing we have performed in the past). We have employed a team of undergraduates to segment video and native signers to annotate the segments. The additional training from this effort should significantly improve our recognition rates. We also expect this video to improve our understanding of sign in less constrained situations. For example, we have become interested in sign 'disfluencies,' which are similar to the 'uhs,' false starts, and coughs in spoken language.

As part of our research into deaf and hearing communication, we have identified a possible new aid. Most deaf children are born to hearing parents, and many of these parents do not learn to sign. These deaf children often do not get enough exposure to sign or English to become facile in either language. Instead of examining a sign-to-English phrase translator for adults, which is the main goal of this project, we are modifying a commercial English-to-sign translator for the parents to use when communicating with their children. We are attempting to make a mobile version of this system so that parents can use it in everyday communication with their young child. For example, a parent might type in 'go to bed' or 'are you hungry?' and the system then plays video showing the sign for this utterance. The hope is that the system will be easy enough to use that parents will use it often and that this extra exposure to sign will help the child's linguistic development. Such a system has not been viable in a small form factor previously, though our library of high end wearable computers has helped us make a quick prototype. We do not know what promise this system might hold, but, with the help of our sign linguist, we are performing a quick pilot study with volunteer families from AASD to see if the system is at all usable (IRB is approved, and we have 20 volunteer families).

Finally, we have identified the potential for a new deaf education aid that could serve as a 'grand challenge' task for sign language recognition research. Given that deaf children of hearing parents often lack the exposure to language received by deaf children of deaf parents or hearing children of hearing parents and that most deaf children are born to hearing parents, we are exploring using our recognizer as part of an educational game where children play by signing to the computer (and the computer interacts by playing videos of sign to the children). Pilot studies indicate that this task may be possible, both from an HCI and a pattern recognition perspective. Using other funds, we have temporarily hired more personnel to explore this opportunity and have submitted a proposal on the subject to both NSF and the Department of Education.

2005

Working with the Atlanta Area School for the Deaf, we have performed a diary study on how deaf teenagers communicate with 'important people' in their lives - mostly deaf and hearing friends and family. This study helps establish which techniques and technologies are currently

used in the deaf community to interact with the hearing community.

We are also extending our previous studies on mobile keyboards to investigate which are the fastest and most appropriate to the task of typed communication between deaf and hearing conversants.

We have re-configured our sign language recognition engine to recognize entire phrases of sign instead of individual signs. This work is expected to improve recognition accuracy.

We have sought IRB approval for our study comparing pen and paper, typing, and gesture recognition for communicating between deaf and hearing conversants. The original study was returned for further consideration (mainly due to the video recording involved and lack of details on subject recruitment). At this time, the analysis of the deaf teen study was complete, and we had begun working with sign linguists on the study. We have reformulated the original study and are now waiting on IRB approval on the revised procedure.

Findings:

2008 (through 2009)

We compared a Wizard of Oz version of Telesign (to avoid the effects of recognition errors) to pen and paper and texting as a way for the Deaf to communicate with the hearing. The Telesign system was the most preferred communication method, and it resulted in a lower task load (as determined by the NASA Task Load Index) and better sen¡tence quality (as rated by 3 native English speakers). Interestingly, however, Telesign was not faster than pen and paper. This result may be due to the novelty of the interface.

The SBHMM algorithm seems to perform best not only on our sign language recognition system but also many other pattern recognition tasks. In addition, the SBHMM algorithm has now been shown to be useful in determining the most discriminative features and parts of a sign. The results are published at ICASSP2009.

Demonstrations of the working Telesign system at Deaf conferences has resulted in a sense of amazement by attendees. However, the required wearable hardware is definitely a barrier to adoption according to our formative studies. A mobile camera phone system is more acceptable. This sort of hardware can also be used to do a mobile video relay service, which Sprint is now attempting as a product. This service, as it becomes available, will address many of the same issues as Telesign (and, given our study mentioned above, should be a preferred way of communicating serendipitously with a hearing person). Thus, we have been attempting to apply the sign recognizer technology in Telesign to other domains (as suggested in the original proposal).

We have identified sign language verification (for educational games in ASL) as a 'grand challenge task' for the community. Such a system would watch a child signing a phrase and then determine how well the sign was performed. The game would respond appropriately to encourage better signing by the child. This task is well-grounded, has immediate application in deaf education, is well accepted in the Deaf community (we were invited to give a keynote address at NIH's EHDI conference on the subject), and exposes much that we do not know about sign language recognition and modeling. For example, to our knowledge and those of sign linguists in the field, no one has done an analysis of sign disfluencies (the equivalent of sneezes, false starts, 'uhs', etc. in speech). Helene Brashear, who has returned to the project, is exploring recognizing disfluencies, and its effect on overall recognizer performance, as her PhD dissertation.

Our work on the HCI side of Telesign has revealed two particular needs in the Deaf community that are quite striking. The first is communication with emergency services while mobile (TTYPhone). Our exploratory work has taken on a life of its own. NENA, the organization responsible for 911, has been vigorously pursuing our prototype as a way for mobile phones to bridge the gap between the Deaf users of 911 and the hearing operators. Most of the 911 system hardware manufacturers have volunteered their systems for compatibility checking, and we have offers from literally hundreds of PSAPS (911 centers) for testing the system.

The second need revolves around hearing parents (who often do not know sign) to communicate with their deaf children. We have created a preliminary system, SmartKick, where hearing parents can ask, in English, for a sign or phrase to show their children (e.g. 'go to bed'). Instead of parents using the system as a communication aid, they use it as a way to learn sign! We are now pursuing a longer term project, SmartSign,

where we use mobile phones both as an immediate communication aid ('Smartsign: Are you hungry' results in video of the sign HUNGRY YOU?) and as an education aid throughout the day.

Thus, Telesign was successful on both the pattern recognition and the HCI fronts. We have identified compelling tasks for the fields and core problems that will drive development in those fields. We have also completed the technical tasks in the project: creating and demonstrating a phrase-level one-way translator and comparing such a service to current practice. Most importantly, the offshoots of the project such as TTYPhone and SmartSign, are getting surprising amounts of traction in the community, addressing the needs of underserved populations.

2007

In our pattern recognition research, we have discovered that Segmentally Boosted HMMs provide a significant improvement in sign language recognition accuracy. We have also identified the recognition of sign disfluencies as an important way to improve sign recognition. We are working to incorporate these principles into our recognition engine.

For deaf-to-hearing communication, we have identified mobile 911 services to be an urgent need. While Telesign itself is not appropriate for this task, our work in comparing Telesign to current communication technology suggested that a software-based TTY system on a mobile phone is an appropriate, and possibly immediate, stop-gap measure. We are demonstrating our prototype, TTYPhone, to industry leaders and government officials who are stakeholders in the problem (including Nokia, RIM, AT&T, T-Mobile, city of Los Angeles, Gallaudet University E911 committee members, and several others).

2006

Most of our work this year has been in building infrastructure, training our recognizer, and preparing for our studies. In investigating sign disfluencies, we have been surprised to discover very little research in this area. The literature and the sign linguists who advise the project all suggest that this is an open area of research. While we may investigate disfluencies for our computer phrase recognition purposes, characterising disfluencies may be useful to sign linguists in the future. We are contacting more leaders in the field about this 'hole' in the research.

Upon visiting Gallaudet, we observed that many students walk through campus with their eyes focused on their mini-QWERTY style text messaging device. Anecdotally, the attention needed for the keyboard and display seem to be a limitation to the usefulness of the device. Perhaps the Deaf community may benefit from a mobile messaging device with a head-up display and a Twiddler keyboard (for blind typing)? Certainly, the community would be a good test market for a device manufacturer investigating new form factors for mobile phones!

As stated above, we have identified two possible new projects:

1) a mobile English-to-sign translator for aiding communication in the home between hearing parents a young deaf child.

2) a sign-based education game to assist language learning by deaf children

We are performing some preliminary studies on each as we continue moving forward on Telesign.

2005

The deaf teen study showed that deaf children of hearing parents are surprisingly isolated from their peers. Because many of these teens

are bussed from outlying areas and may require up to several hours of transportation, few participate in extracurricular activities. Several expressed reluctance to take summer break because they no longer had their school peer group with which to communicate.

Most parents are aware of this social isolation and give their children permission to use SMS messaging to communicate with their peers even after curfew. While disallowed in school, mobile messaging is a key 'lifeline' for these teens socially. There is peer pressure to have the latest mobile texting device - Sidekicks at the time of the study. Parents were very tolerant of the devices. For example, parallel conversations can occur at the dinner table. Almost no instances of TTY use were reported. Teens had few elder relatives who could sign. Vocalizations or pen and paper was often used to communicate.

Our keyboard studies have shown that expert rates on both the mini-QWERTY keyboards and Handykey's Twiddler can reach desktop rates (over 50 words per minute). This result is encouraging for the possibility of using a mobile texting device to communicate between deaf and hearing (however, the language translation issue remains). We have shown that our teaching software for the Twiddler can be an effective way to reduce the barrier to entry for novices to the device, and our previous studies suggest that the Twiddler is faster to learn than QWERTY. However, most deaf are familiar with the QWERTY keyboard early, which makes mini-QWERTY keyboards easy to adopt. While originally a sideline to this grant, mobile text entry may prove to be an effective communication tool. We will investigate further.

Using phrases for the sign recognizer seems an effective way to reduce the error rate and still provide a useful service. At CEASD2005, we demonstrated the 'phrase book' translator to a mixed audience of deaf and hearing. The explanation itself was signed by the demonstrator in pre-determined phrases, and the Telesign system translated these phrases into English. While there is still much work to be done for a stable (and usable) system, the demonstration caused quite a bit of excitement!

Training and Development:

2008 (through 2009)

As mentioned below, Telesign has touched many more students than those listed as being > 160 hours. Several of the undergraduates (such as Jiasheng He) who have worked on various parts of the project have transitioned to being Masters students. Stephen Hamilton, a high school student working in the project, transferred to Georgia Tech to continue working on the project and is about to graduate with an undergraduate degree in Computer Science. Kimberley Weaver, a new PhD student, took over the HCI tasks for the project and will probably propose one of the spin-off projects for her thesis. We expect four other PhD theses (Henderson-Summet, Yin, Zafrulla, and Brashear) to include parts of the Telesign project in the dissertation.

Due to Telesign (and now the spin-offs such as CopyCat, TTYPhone, and SmartSign), many undergraduates, graduates, and even unaffiliated staff, are becoming familiar with Deaf culture and ASL. ASL classes have resulted in students and staff communicating in occasional sign in internal meetings and at Deaf conferences. Students are learning continually to communicate with deaf children during science lectures at AASD. We have written a book chapter discussing the issues of performing user studies in ASL and with deaf children. The projects' students have been learning how to communicate their work at many levels, from a sophomore presenting his work at the UROC research symposium to the senior ASL recognizer student discussing our projects with the Deaf Community to a 300 person audience as a keynote at CDC's Early Hearing Detection and Intervention conference. Telesign has also created many class projects in the Mobile & Ubiquitous Computing class,

prototyping what would eventually become TTYPhone and SmartSign. Students are learning to write grant proposals themselves ranging from REU supplements to new multi-year proposals to the Dept. of Education.

2007

This year we have begun training a new set of PhD students to work on sign language development. Zahoor Zafrulla is being trained on both the HCI and pattern recognition sides of the project. He also co-created the TTYPhone prototype. Valerie Henderson is continuing her work in a new direction, using mobile phone technology to increase the number of hearing people who can communicate in sign language. She is also spending considerable time teaching related subjects in preparation for a job at a top level teaching university. Helene Brashear, the senior recognition student, was the keynote at the CDC's conference Early Hearing Detection and Intervention in 2007 - a 300 person conference.

We continue substantial efforts in mentoring undergraduates. Two have recently been accepted into Georgia Tech's Masters program and continue to work with the project.

Telesign is also used for generating class projects in our Mobile and Ubiquitous Computing, now taught yearly (TTYPhone started as a project in this class). The project provides a lure for the top students in this class.

2006

Valerie Henderson spent the summer in Australia with a research group that investigates new technology adoption by small population segments. We expect the methods and techniques she learned there may help in how we present Telesign (and our keyboard work) to the Deaf community.

Our demonstrations of the various projects with AASD continues to attract new undergraduate researchers. We are attracting freshman, which is particularly satisfying as traditionally early exposure to research helps with retention, grades, and progression to graduate school. We expect another round of masters and undergraduate capstone projects this year related to the Telesign effort. Students are beginning to use our new rapid prototyping laboratory (3d printer, laser cutter, electronics, etc.) to build devices for use at AASD. We hope this practice continues.

The Telesign project has proven to be a good teaching aid in AI, pattern recognition, and computer vision. For example, at the end of the Fall 2006 semester, I lectured on 'perplexity and computer vision through time' for the introductory computer vision class. Telesign was the major focus, and the students were motivated by the problem and enjoyed seeing the problems of computer vision in a new light.

2005

Even with the cut in original budget, Telesign employs a small army of deaf consultants and student researchers. As PI, I have cut my own funding on this project to gain access to the deaf consultants we need. In 2006 the situation will be alleviated somewhat - our sign language tutor will become a full-time employee as an administrative assistant. We hope that his official duties can be expanded to include the current sign classes.

One of the study's main researchers, Valerie Henderson, has been awarded a 2006 NSF summer internship in Australia. Without her, the main comparative study may be slowed, but we hope that the research group she is joining will bring a new perspective to the research.

Our interactions with AASD on this project has led to surprisingly many undergraduate 'capstone' projects and masters projects. Dr. Harley Hamilton, our sign linguist, is a never-ending source of bite-sized projects useful for training our students. One undergraduate project the 'Lone Sorcerer' by Cyrus Radafar won the 'People's Choice First Place' in the annual undergraduate research competition. Another, the 'RFID Video Farm' by Gregory Wilson will be used at AASD as an aid to teaching. Each of these projects brings Georgia Tech students in contact with the Deaf community and teaches them how to design for needs different from their own.

Outreach Activities:

2008 (through 2009)

As in evidence below, our outreach activities have been significant and on-going. In this final year, the PI has been giving a series of lectures on assistive technology for the deaf. These include the Wilson Lecture (opening keynote) for the Research Council on Mathematics Learning 2009, the Asprey Lecture at Vassar College, an invited talk at the University of Houston Computer Science seminar, an a panel session at the Computing@Margins conference. In addition, parts of the research were mentioned in a Google Tech Talk and lectures at the Universitaet Bremen and TU-Darmstadt.

Technology demonstrations were given at AASD, Georgia Tech internal women's recruiting events, high school science shows, and the annual UROC research symposium. Systems have been tested/shown at Deaf events and with hearing parents of deaf children.

TTYPhone and the issues facing Deaf->hearing communication have been discussed at NENA2009 (911 organization) and California's DDTP (Deaf and Disabled Telecommunications Program). Another demonstration/talk should be occuring at the time of this writing at Gallaudet University (the premier university for the Deaf community).

Beyond the normal dissemination of research through papers, we are also disseminating our pattern recognition work through the GART toolkit. Already this system has been downloaded over 200 times and has been used in sign language recognition projects around the world (including a Masters project in Saudi Arabia on Arabic sign language recognition).

2007

We continue our collaboration with AASD and have added a collaboration with the deaf community through the Gwinnett County public schools. We again demonstrated our work at Georgia Tech's Disability Days and at the CDC's EHDI2007 conference. We also demonstrate the project at the Wireless RERC's public events, Georgia Tech's GVU open houses, and at various corporations around the world. The project also provides opportunities to reach high school students through special events and at the recent International Science and Engineering Fair in Atlanta.

2006

The collaboration with AASD continues, with a continual stream of students conducting experiments and producing materials for deaf education. The project's work was demonstrated at 'Georgia Tech's Disability Days,' and Helene Brashear was contacted by the CDC to provide a lecture on our efforts. We were also contacted by a former 'Miss Black Deaf America' for a last-minute lecture substitution at the annual Black Deaf conference. Based on these lectures and demonstrations, we have been invited to give a plenary on our work at the National Early Hearing Detection and Intervention (EHDI) conference. This 'conference is attended by approximately 400 - 500 participants with a mixture of physicians, audiologists, public health nurses, and families of children who are deaf or hard of hearing.' We

have suggested, and the program committee has agreed, to accompany the talk with a demonstration the following day for attendees.

We have applied for and received an RET supplement for involving teachers in our work. Our corresponding open call for participants has resulted in a quality of applicants that has been astonishing! We have also recruited new deaf participants who have been trained in sign linguistics at Gallaudet. While their participation was brief (due to moving back to Gallaudet), they have played an active part in improving the project.

My students continue their leadership roles in Women@CC and also in the graduate student council.

Our work is 'getting traction' in community. Unbeknownst to us, it was analyzed in a survey of current computer sign projects published in a major deaf journal. Our sign language recognition work continues to be the most cited work on citeseer and google scholar.

2005

Given the collaboration with AASD, Georgia Tech students are often interacting with the Deaf community. The Telesign PhD students gave guest lectures and demonstrations to the high school science class at AASD. Weekly sign classes continue, both for beginners and intermediate signers; the classes are beginning to attract students not involved in Telesign. We demonstrated 'Telesign: Mobile Sign Language Recognition' at CEASD2005, a major deaf educators conference held at the Georgia Tech hotel this year. We repeated the demonstration at RESNA2005. As the majority of my group are women, we also spend considerable effort on the 'Women@CC' program, an effort to attract, support, and retain top quality women in the College of Computing.

Journal Publications

K. Lyons, B. Gane, T. Starner, and R. Catrambone., "Improving Novice Performance on the Twiddler One-Handed Chording Keyboard", Intl. Forum on Applied Wearable Computing, p. 45, vol. , (2005). Published,

J. Clawson, K. Lyons, T. Starner, and E. Clarkson, "The Impacts of Limited Visual Feedback on Mobile Text Entry Using the mini-QWERTY and Twiddler Keyboards.", ISWC, p. 93, vol. , (2005). Published,

S. Lee, V. Henderson, H. Hamilton, T. Starner, H. Brashear, S. Hamilton., "A Gesture-Based American Sign Language Game for Deaf Children.", CHI, p. 1589, vol. , (2005). Published,

S. Lee, V. Henderson, H. Brashear, T. Starner, S. Hamilton, and H. Hamilton., "User-centered Development of a Gesture-based American Sign Language Game", NTID Instructional Technology and Education of the Deaf Symposium, p. IV-45, vol. , (2005). Published,

V. Henderson, S. Lee, H. Brashear, H. Hamilton, T. Starner, and S. Hamilton., "Development of an American Sign Language Game for Deaf Children", Interaction Design and Children (IDC), p. 56, vol. , (2005). Published,

Yin Pei; Essa Irfan; Starner Thad; Rehg James, " Discriminative Feature Selection for Hidden Markov Models Using Segmental Boosting", IEEE Conference on Accoustics, Speech, and Signal Processing (ICASSP 2008), p. , vol. , (2008). Published,

Books or Other One-time Publications

Gandy M.; Westeyn T.; Brashear H.; Starner T., "Wearable Systems Design Issues for the Elderly and Disabled", (2007). Book, Published
Collection: Smart Technology for Aging, Disability, and Independence: Computer and Engineering Design and Applications
Bibliography: Wiley, Volume 2, Chapter 3.9

Henderson-Summet V.; Grinter R.; Carroll J.; Starner T., "Electronic Communication: Themes from a Case Study of the Deaf Community", (2007). Book, Published
Collection: Human-Computer Interaction ? INTERACT 2007
Bibliography: Volume 4662/2007, 347-360

Kimberly Weaver, Valerie Henderson-Summet, and Thad Starner, "Telesign: Evaluation of an ASL-to-English Phrase Book Translator", (2009). conference paper, Submitted
Collection: submitted to ASSETS2009
Bibliography: ASSETS2009

Pei Yin, Thad Starner, Harley Hamilton, Irfan Essa, and James M. Rehg, "Learning Basic Units in American Sign Language Using Discriminative Segmental Feature Selection", (2009). conference paper (journal submission not working in Fastlane), Published
Collection: IEEE Conference on Accoustics, Speech, and Signal Processing (ICASSP 2009)
Bibliography: ICASSP2009

Web/Internet Site

Other Specific Products

Product Type:

Software (or netware)

Product Description:

GART: Gesture and Activity Recognition Toolkit

Sharing Information:

The toolkit is on the web

Product Type:

Teaching aids

Product Description:

Undergraduate Cyrus Radafar won the People's Choice Award at the annual Undergraduate Research Opportunities in Computing Symposium for Lone Sorcerer: A Gesture-based ASL Quest. This educational aid explored how to use our work to create educational games for deaf children created solely in ASL.

Sharing Information:

This system was presented at the UROC symposium where a Sony Digital Games developer took a serious interest. The work helped lead to a successful proposal with the Dept. of Education where our ASL recognizer is being used for developing games for children played in ASL.

Product Type:

Teaching aids

Product Description:

Interactive RFID Toys: One obstacle many deaf children face is a lack of language input at home, since many of their parent do not know sign language. One way to address this problem is to provide as many opportunities for the children to see sign as possible. We propose to create interactive toys that are coupled with

computer software. These toys have RFID tags to identify them. An RFID reader interacts with software to create a narrative play. The software may index videos describing the toy and informing them about it, such as ``This is a cow. The cow lives in the barn.'' If the child puts the cow in the barn, the system might then show the signed phrase, ``Good, now the farmer can feed the cow.'' The game was developed by undergraduate Gregory Wilson. He implemented software to interact with the RFID kit and modified the toys for the RFID tags.

Sharing Information:

The final system was shown at the annual Undergraduate Research Opportunities in Computing Symposium, where it recruited more undergraduates for the project. The system was also deployed and tested at AASD. It seems commercial companies are now in the process of making similar products.

Product Type:

Instruments or equipment developed

Product Description:

TTYPhone is a system that allows the Deaf to communicate with 911 services using a TTY emulator on a mobile phone. Because TTY is equivalent to a voice call, the system is localizable using E-911. It is also compatible with current hardware in PSAPs (911 centers)

Sharing Information:

The system has been demonstrated at NENA2009, California's DDTP, and several other forums. Mobile phone manufacturers and service providers are showing significant interest in implementing TTYPhone so as to provide 911 access to the Deaf community.

Product Type:

Teaching aids

Product Description:

SignKick and SmartSign are prototype systems that aid communication between hearing parents and their young deaf children. These systems have demonstrated a need in the Deaf community. Parents access a sign video dictionary through speech or typing on their mobile phone. In testing, SignKick was adopted as an educational aid for the hearing parents to learn sign.

Sharing Information:

We are preparing several grant proposals on developing SmartSign.

Contributions

Contributions within Discipline:

2008 (through 2009)

In pattern recognition, we have created a new algorithm, Segmentally Boosted Hidden Markov Models (SBHMM) and showed its usefulness in improving sign recognition results and in analyzing discriminating features of sign. We have identified a challenge task, sign verification for ASL educational games, and the problem of sign disfluencies for recognition. We have published a reference gesture recognition toolkit (GART).

In HCI and assistive technology, we have published information on how to perform user studies with the Deaf community, identified major needs in the community related to Deaf and hearing communication (TTYPhone and SmartSign), demonstrated the problem of social isolation of deaf teens, and performed a user study that showed the advantages of communicating in sign (through Telesign) as opposed to current methods of communication.

2007

The new version of the Toolkit, GART, has provided many universities access to high end gesture recognition technology. We have made the sensors used in the project 'open hardware'.

2006

Please see above. This year, we have released a new version of our gesture recognition toolkit that is easier for HCI researchers to use

without a background in pattern recognition. As the old version was downloaded over 200 times and used in universities ranging from Saudia Arabia to Denver, Colorado, we hope the new version will gain an even wider audience. Accordingly, we have begun creating a community feedback and bugtracking mechanism for the toolkit.

2005

Please see above. Within the discipline of pattern recognition, and specifically sign recognition, we have identified a challenge task that is grounded in a need in the deaf community. In HCI, we are providing refinements for conducting studies in the deaf community. We also have shown that mobile keyboard experts can achieve desktop speed and have begun elucidating some of the difficulties in mobile typing (e.g. blind typing).

Contributions to Other Disciplines:

2008 (and 2009)

Our spin-off work on TTYPhone has caused quite some interest in 911 access for the Deaf community. The SmartSign and CopyCat spin-offs are influencing the deaf education community. The work on sign disfluencies is of interest to the linguistics community, though we do not have enough results yet (continuing in CopyCat) for publication. The concept of recognizing sign language through brain activity has captured the imagination of Brain Computer Interface groups, and we now have seed funding from DARPA and NSF to prove the concept works. Recent results show 97% accuracy on signs recognized from a forced-choice pair. If successful, the system could allow ALS sufferers to communicate when they are 'locked-i' or could allow wearable computer users to communicate with their machines directly through BCI.

2007

Our recent focus on sign disfluences has gotten interest in the sign linguistics community. While we have yet to publish on the phenonmenon, several of our advisory board are quite enthusiastic about the current work.

The identification of a possible short-term solution to the 911 mobile service problem for the Deaf community is receiving much attention by high placed Deaf advocates. We plan to disclose the project to the larger community next Fall.

2006

See above. While this year has been focused on infrastructure building, we feel our research may contribute to sign linguistics in the future. In particular, our upcoming characterization of disfluencies for the sign recognizer may be useful to help categorize these disfluencies for linguists.

2005

See above. Our study on the communications of deaf teenagers may have an effect on telecommunication policy. For example, a larger study may confirm that mobile phone service providers should drop support for TTY in favor of better SMS services for the deaf. We also hope our upcoming study of communication mechanisms between the deaf and hearing populations may help illuminate some cultural differences the deaf have in education, business, and everyday life.

Contributions to Human Resource Development:

2008 (through 2009)

The Telesign project has contributed to the thesis projects of 5 students (3 female, 1 with a disability), 3 of whom are expected to graduate this

year. It has exposed many students to deaf culture and ASL and has provided class projects over several years that have led to spin-off proposals and projects. The project has been the basis for several entries into the annual UROC research symposium competition. Several undergraduate students affiliated with the project have continued on to graduate school (on average ~50% do). Telesign has also brought members of the Deaf community in intimate contact with state-of-the-art research, as advisors, mentors, or subjects. CopyCat, a spin-off project, has been funded by the Dept of Education and involves an even larger number of Georgia Tech personnel. The system has been proven to be effective at helping young deaf children acquire language skills.

2006

See above. Telesign continues to support a wide range of students. Due to the long term nature of the effort and the barrier of learning sign, we are concentrating on freshman and sophomores. Given that our group is mostly female, we also tend to attract women to the group. This year we are involving teachers more explicitly in the research, through an RET supplement. We are giving lectures for professionals - next year pediatricians and audiologists that attend our lecture at the National Early Hearing Detection and Intervention (EHDI) conference can receive continuing education credit.

2005

See above. Telesign supports a wide variety of students, ranging from undergraduate researchers to senior PhD students. It also supports members of the local deaf community as consultants, instructors, and test users. The collaboration with AASD results in projects which support deaf education, concentrating on deaf children of hearing parents.

Contributions to Resources for Research and Education:

2008 (though 2009)

Telesign has led to research on new teaching aids for deaf children (CopyCat, RFID toys, Lone Sorcerer) and parents of deaf children (SignKick and SmartSign). It has identified social isolation as a major threat for deaf teens of hearing parents. It has also provided a toolkit, GART, for developing gesture recognition interfaces.

2006

See above. Our release of the second version of GT2K should lower the barrier for HCI researchers to create gesture-based interfaces. Our identification of sign disfluencies as a research thrust may interest linguists and deaf educators to pursue the topic as both a research interest and a practical aid for helping deaf children learn sign. The two new possible deaf educational aids (English-to-sign at-home communication aid and the ASL tutor) may lead to new research efforts with a practical bent.

2005

See above. Our work with AASD is leading to several new teaching aids for deaf education. Our students volunteer for teaching science classes at AASD. The collaboration exploses Georgia Tech engineers and scientists to the culture and needs of the Deaf community. Our students learn to design for populations with needs significantly different from their own, and the teachers and students at AASD learn about he scientific process.

Contributions Beyond Science and Engineering:

2008 (through 2009)

As mentioned above, the spin-off TTYPhone is getting significant interest at a national level as a way to provide the Deaf access to emergency services. Policy researchers within Georgia Tech are investigating what some of the policy implications are with regard to the ADA and Telecommunications Act.

Presenting Telesign on national and international TV helps acquaint the populace with Deaf culture and some of the problems face by the Deaf. Exposing Georgia Tech pattern recognition and HCI students to Deaf culture and ASL provides a broadening of experience that would be hard to gain elsewise.

Our work has exposed several areas of need in the Deaf community and helps policy makers and researchers in the field articulate this need using the studies we have performed.

2007

Please see above. Our work continues to have an effect on deaf children and the Deaf community at large.

2006

We are convinced that much could be done to aid deaf children (especially of hearing parents) in acquiring language and have sought funding to modify our recognizer to create a sign language-based educational game. We continue to bring awareness of Deaf culture and needs to the public through television and radio interviews, demonstrations, and lectures. We also continue to bring Georiga Tech students in contact with the Deaf community both for educational purposes as well as awareness of this American sub-culture.

2005

Our work with AASD has focused us on the social isolation and educational needs of deaf children. We expect to explore this space in the future for new projects. Our work with the Deaf community also reveals how little the hearing community understands about signing and the Deaf culture. Students involved with Telesign are taught about these topics, often learn to sign, and can often be heard explaining the concepts to visitors.

Conference Proceedings

Categories for which nothing is reported:

Any Web/Internet Site

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