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The focus of my research lies in Human-Computer Interaction (HCI) and Ubiquitous Computing (ubicomp). In general, I am interested in the design, implementation and evaluation of novel, off-the-desktop, interactive computing systems that I believe will be commonplace in five to ten years and the appropriate techniques for interacting with them. My research approach involves an examination of the usability and social issues surrounding the proliferation and adoption of mobile and ubiquitous computing applications. This step allows me to explore important design issues related to the development and deployment of pervasive technologies in authentic settings.

My research since joining the University of Toronto at the end of 2005 has focused primarily on enhancing the mobile user experience with ubiquitous computing technologies. Advances in computing combined with an increasing dependence on technology in everyday activities have yielded continual increases in the consumption of computational devices. These devices come in a variety of shapes and sizes. They have the potential to offer a variety of useful automated record-keeping and context-sensitive services for the users. Thus, my research themes have included 1) the design of novel techniques for interacting with ubicomp technologies, 2) the development of location-aware and context-aware services to enhance the usability and usefulness of ubicomp applications, and 3) studies of not only how people use ubicomp systems, but also their understanding and usage those technologies. Over the last four years, I have begun to notice that while ubicomp devices offer many benefits to the user, their increased consumption has resulted in problems of sustainability and disposal. In particular, the average consumer continues to consume newer technology for only a short usage lifetime, despite its potential for a longer functional lifetime. I believe there is an opportunity to research how to repurpose technologies that are typically discarded today, extend their usefulness in ways beyond their primary purpose, and minimize the need to produce new hardware. In this research statement, I describe my current research themes and future direction.

Interacting with Ubiquitous Computing Technologies

As mobile and ubiquitous computing become more common, the way in which people use computing services inherently changes also. No longer are people interacting with digital information only while seated at their desktop. Instead, people often can be seen using handheld devices while on-the-go and interacting with public machines when there are ones freely available.

My research in this space thus far has focused on (1) studying how user mobility impacts user interaction on handheld devices [3, 17], (2) designing novel input techniques for small mobile devices (such as a new way of performing target selection on phones [18] and eyes-free interaction techniques using tactile feedback [8] and kinesthetic memory [9]), and (3) developing a software framework for creating public display applications that can be used by Bluetooth-enabled mobile phone without requiring the installation of special software [11]. The long-term goal of my research is to develop interaction methods that allow users with disabilities or other special needs to interact with ubicomp technology in a more intuitive manner, for example, turning eyes-free interaction techniques into better ways for individuals with visual impairments to use ubicomp devices.

Context-Awareness of Ubiquitous Computing Technologies

An important aspect of ubiquitous computing is the ability for computers to adapt their behavior based on the user's current activity without requiring any artificial intelligence. These systems can do so by automatically sensing the context related to the interaction between the user, the application, and the surrounding environment as implicit input that the systems then use to adapt their functional behaviors.

Over the past few years, my work in this space has examined a specific kind of context information—location. Researchers have strived to improve the location awareness of ubicomp technologies traditionally by developing more accurate sensing techniques and algorithms. Instead, I have explored (1) when it is needed by the user [5], (2) how estimate errors in location sensing and visualize that information to enhance the usability of ubicomp applications [16], and (3) how to leverage existing infrastructure (such as the powerline in the home) to detect user location inexpensively [19]. Currently, I am investigating how to infer user activity based on context extracted from community generated content such as user generated reviews of businesses. The long-term goal of my research is to enable the development of ubicomp applications that are aware of the user's past activities as well as infer current and future context.

Understanding & Acceptance of Ubiquitous Computing Technologies

Too often, designers focus on only the potential benefits that can be offered to the user by a new piece of technology. However, the novelty and unfamiliarity of a technology can cause people to react in ways unexpected by the designers. People's understanding and perception of a technology can impact its usage and acceptance. Thus, it is important for designers to gain insight into people's reasoning processes about ubicomp technologies. The reasoning process about any given technology must be treated as a series of contemporary and situated phenomena, highly contextualized and intertwined with not only the abstract beliefs of the individuals involved but also their conceptions of the people, places, and interactions of the moment.

My research in this space thus far has focused on (1) developing techniques to study how people construct their expectations about and understanding of pervasive technologies, such as for studying privacy reactions to ubiquitous memory aids [1, 7, 10, 20]; (2) uncovering the reasoning processes used by people and the holes in the information available to them, such as people's understanding to various recording systems that they encounter in their daily lives [2, 6]; and (3) identifying the specific impact of user perception on the usage and acceptance of technologies, such as social desirability and biased reporting of AIDS/HIV information collected through handheld computers [15, 22]. The long-term goal of my research is to develop methods to bridge the gap between the user's conceptual model and designer's system model.

Sustainability of Ubiquitous Computing Technologies

Along with the increased proliferation of ubiquitous computing devices is the emergence of a "disposable technology paradigm." Ownership of today's technology comes with the expectation of a short usage lifetime, despite the potential for a longer functional lifetime. For example, in 2007, American consumers used their mobile phones on average for only 17.5 months. In many instances the phones being discarded are still functional or partially functional. Furthermore, today's mobile phones embody far more computing power than a standard desktop machine from even ten years ago.

An approach to addressing this problem which has been adopted by many in the HCI and Ubicomp community is to facilitate the reflection about decisions made by the user on the environment. This discourages the user from engaging in environmentally harmful actions and encourages them to adopt greener practices. My work in this space takes a slight departure from existing research. Instead of fighting human nature and people's desire to want new items, I view this growing number of unused phones as an opportunity to repurpose these devices for groups of users who lack the resources for acquiring useful assistive technologies.

My first step towards the goal of improving the sustainability of ubiquitous computing technologies was to undertake a qualitative study on device ownership and disposal practices [13, 21, 23]. The findings from the study yielded design lessons and opportunities for the sustainable interaction design of mobile devices (nominated for best paper award at CHI 2008). Since then, I have begun to consider how to support the repurposing of used phones. I have begun to design an online community for supporting the redistribution and repurposing of unwanted mobile phones as assistive technologies for individuals with disabilities or other special needs. These users often lack the resources to acquire custom software that meet their specialized needs; as a result, I believe that repurposed hardware coupled with open source software that is free in cost and open to modification lead to the most effective form of assistive technologies. Overall, this work pulls together my current interest in sustainability, assistive technology [14], and open source software development [12] and is the basis for my future research endeavors.

Selected Publications

The following are a subset of my recent publications since 2005 that are significant with respect to the research statement outlined above. A complete listing of publications can be found in my *curriculum vitae*.

Books, Book Chapters & Edited Proceedings

[1] Patel, S.N., Truong, K.N., Hayes, G.R., Iachello, G., Kientz, J.A., Abowd, G.D. The Personal Audo Loop: A Ubiquitous Audio-Based Memory Aid. In the Handbook of User Interface Design and Evaluation for Mobile Technology. Joanna Lumsden (Ed.) IGI Global, 2008, 1240 pages. ISBN: 978-1-59904-871-0

Journals & Scientific Magazines (Peer reviewed)

[2] Massimi, M., Truong, K.N., Dearman, D., Hayes, G.R. Understanding Recording Technologies in Everyday Life. (Accepted; To appear in) IEEE Pervasive Computing. Roy Want (Ed. in Chief) IEEE Press, 2009.

[3] Yatani, K., Truong, K.N. Evaluating the Effect of Mobility on Stylus-Based Text Entry Methods for Handheld Devices. In the Pervasive and Mobile Computing Journal. 2009. doi:10.1016/j.pmcj.2009.04.002

[4] Huang, E.M., Yatani, K., Truong, K.N., Kientz, J.A., Patel, S.N. Understanding the Situated Sustainability of Mobile Phones: The Influence of Local Constraints and Practices on Transferability. In IEEE Pervasive Computing, Volume **8**(1), pp. 46-53, January-March 2009. doi:10.1109/MPRV.2009.19

[5] Dearman, D., Inkpen, K.M., Truong, K.N. Mobile Map Interaction During a Rendezvous: Exploring the Implications for Automation. In Personal and Ubiquitous Computing. March 2008. doi:10.1007/s00779-008-0195-2

[6] Hayes, G.R., Poole, E.S., Iachello, G., Patel, S.N., Grimes, A., Abowd, G.D., Truong, K.N. Physical, Social, and Experiential Knowledge of Privacy and Security in a Pervasive Computing Environment. In IEEE Pervasive Computing, Volume **6**(4), pp. 56-63, October-December 2007.

[7] Abowd, G.D., Hayes, G.R., Iachello, G., Kientz, J.A., Patel, S.N., Stevens, M.M., Truong, K.N. Prototypes and Paratypes: Mixed Methods for Designing Mobile and Ubiquitous Computing Applications. In IEEE Pervasive Computing, Volume **4**(4), pp. 67-73, October-December 2005.

Conference Papers & Notes (Peer reviewed & appeared in conference's ***main*** proceedings)

[8] Yatani, K., Truong, K.N. SemFeel: A User Interface with Semantic Tactile Feedback for Mobile Touch-screen Devices. (Accepted; To appear) In the Proceedings of UIST 2009: The 22nd Annual ACM Symposium on User Interface Software and Technology (October 4-7, Victoria, Canada), 2009.

[9] Li, F., Dearman, D., Truong, K.N. Virtual Shelves: Interactions with orientation aware devices. (Accepted; To appear) In the Proceedings of UIST 2009: The 22nd Annual ACM Symposium on User Interface Software and Technology (October 4-7, Victoria, Canada), 2009.

[10] Nguyen, D.H., Marcu, G., Hayes, G.R., Truong, K.N., Scott, J., Langheinrich, M., Roduner, C. Encountering SenseCam: Personal Recording Technologies in Everyday Life. (Accepted; To appear) In the Proceedings of UBICOMP 2009: The 11th International Conference on Ubiquitous Computing (September 30-October 3, 2009, Orlando, FL), 2009.

[11] Dearman, D., Truong, K.N. BlueTone: A Framework for Interacting with Public Displays Using Dual-Tone Multi-Frequency through Bluetooth. (Accepted; To appear) In the Proceedings of UBICOMP 2009: The 11th International Conference on Ubiquitous Computing (September 30-October 3, 2009, Orlando, FL), 2009.

[12] Yatani, K., Chung, E., Jensen, C., Truong, K.N. Understanding How and Why Open Source Software Contributors Do and Do not Use Diagrams. In the Proceedings of CHI 2009: The ACM Conference on Human Factors in Computing Systems (April 4-9, 2009, Boston, MA) 2009, pp. 995-1004. [24.5% acceptance rate]

[13] Huang, E.M., Truong, K.N. Breaking the Disposable Technology Paradigm: Opportunities for Sustainable Interaction Design for Mobile Phones. In the Proceedings of CHI 2008: The ACM Conference on Human Factors in Computing Systems (April 5-10, 2008, Florence, Italy) 2008, pp. 323-332. [22% acceptance rate, *Best of CHI Paper Nomination*]

[14] Hayes, G.R., Gardere, L., Abowd, G.D., Truong, K.N. CareLog: A Selective Archiving Tool for Behavior Management in Schools. In the Proceedings of CHI 2008: The ACM Conference on Human Factors in Computing Systems (April 5-10, 2008, Florence, Italy) 2008, pp. 685-694. [22% acceptance rate]

[15] Cheng, K.G., Ernesto, F., Truong, K.N. Participant and Interviewer Attitudes toward Handheld Computers in the Context of HVI/AIDS Programs in Sub-Saharan Africa. In the Proceedings of CHI 2008: The ACM Conference on Human Factors in Computing Systems (April 5-10, 2008, Florence, Italy) 2008, pp. 763-766. [18% acceptance rate, *Best of CHI Note Award*]

[16] Dearman, D., Varshavsky, A., de Lara, E., Truong, K.N. An Exploration of Location Error Estimation. In the Proceedings of UBICOMP 2007: The 9th International Conference on Ubiquitous Computing (September 16-19, 2007, Innsbruck, Austria), 2007, pp.181-198. [19% acceptance rate]

[17] Yatani, K., Truong, K.N. An Evaluation of Stylus-Based Text Entry Methods on Handheld Devices in Stationary & Mobile Settings. In the Proceedings of MobileHCI 2007: The 9th International Conference on Human-Computer Interaction with Mobile Devices and Services (September 11-14, 2007, Singapore), 2007, pp. 145-152. [22% acceptance rate]

[18] Dearman, D., Inkpen, K.M., Truong, K.N. Target Selection on Mobile Devices using Display Segmentation. In the Proceedings of MobileHCI 2007: The 9th International Conference on Human-Computer Interaction with Mobile Devices and Services (September 11-14, 2007, Singapore) 2007, pp. 207-210. [22% acceptance rate]

[19] Patel, S.N., Truong, K.N., Abowd, G.D. Powerline Positioning: A Practical sub-Room-Level Indoor Location System for Domestic Use. In the Proceedings of UBICOMP 2006: The 8th International Conference on Ubiquitous Computing (September 17-21, 2006, Irvine, California, USA), 2006, pp. 441-458. [13% acceptance rate]

[20] Iachello, G., Truong, K.N., Abowd, G.D., Stevens, M.M., Hayes, G.R. Prototyping and sampling experience to evaluate ubiquitous computing privacy in the real world. In the Proceedings of CHI 2006: The ACM Conference on Human Factors in Computing Systems (April 22-27, 2006, Montréal, Québec, Canada), 2006, pp. 1009-1018. [23% acceptance rate, *Best of CHI Paper Nomination*]

Magazine Panels

[21] Huang, E.M., Truong, K.N. Situated Sustainability for Mobile Phones. In ACM Interactions, Volume **15**(2): pp. 16-19, March 2008.

Conference & Workshop Presentations without Proceedings

[22] Cheng, K.G., Ernesto, F.,Ovalle-Bahamón, R., Truong, K.N. Sociocultural Barriers to Acceptance of Handheld Computers for HIV/AIDS Data Collection in Sub-Saharan Africa. Presented at the 2009 AMIA (American Medical Informatics Association) Spring Congress (May 28-30, Orlando, FL), 2009.

[23] Huang, E.M., Truong, K.N. Understanding the paradigm of disposable technology: What happens to old mobile phones? Presented at the Workshop on Sustainability: Technologies for Green Values at UBICOMP 2007 (September 16-19, Innsbruck, Austria), 2007.