Workshop Proposal: Toolkit Support for Interaction in the Physical World

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1 Biographies and Research Interest

Rafael Ballagas is a computer science doctoral candidate in the Media Computing Group at RWTH Aachen. His research interests include tangible interfaces for ubiquitous computing environments and interactive media applications. Rafael has developed the iStuff [2] toolkit for prototyping physical user interfaces and the Patch Panel [3] intermediary to support incremental integration and reconfiguration of toolkit components. He has an MS in electrical engineering from Stanford University and a BS in electrical engineering from Georgia Institute of Technology.

Scott Klemmer is a computer science doctoral candidate in the Group for User Interface Research at UC Berkeley. His research employs user-centered design methods to explore tangible user interfaces that integrate the physical world and electronic media including handheld and wall-scale applications and the Papier-Mâché toolkit. He has an MS in computer science from Berkeley, and a dual BA from Brown University in computer science and art-semiotics.

Jennifer Sheridan is a computer science doctoral candidate in the Innovative Interactions Lab at Lancaster University's Department of Computing. Her research explores types of interactions that occur with non-task based interactive uses of technologies, including physical or tangible objects. She has an MS in Human-Computer Interaction from Georgia Institute of Technology and a BS from the University of Waterloo.

2 Themes and relevance:

The innovative work of Wellner's DigitalDesk [14], and Ishii and Ullmer's Tangible Bits [7] have pioneered exploration of post-WIMP (Windows, Icons, Menus, Pointers) tangible interfaces. Ubiquitous computing applications have motivated these novel physical interfaces even more. However, they are difficult and time consuming to build, requiring a technological expertise that has limited rapid prototyping and iterative design for tangible user interface researchers and developers.

The difficulties involved in building physical interfaces today echo the experiences of the GUI community twenty years ago. In 1990, Myers and Rosson found that 48% of code and 50% of development time was devoted to the user interface. One of the earliest GUI toolkits, MacApp, reduced Apple's development time by a factor of four or five [10]. We believe that similar reductions in development time can be achieved by a toolkit supporting tangible interaction. GUI toolkits "help reduce the amount of code needed to produce a user interface, and allow user interfaces to be created more quickly. This, in turn, enables more rapid prototyping and, therefore, more iterations of iterative design that is a crucial component of achieving high quality user interfaces"[9].

Several tools have been developed in recent years to prototype tangible user interfaces. These include hardware platforms such as Smart-Its [6] and Motes [4]. Although originally targeted towards sensor network applications, these platforms have greatly eased hurdles associated with prototyping tangible user interfaces for ubicomp [11, 13], combining sensors and actuators with wireless connectivity in small form factors with low power consumption.

More recently, toolkits for physical-world interaction have begun to emerge. The Context Toolkit makes context-aware applications easier to build; it "separates the acquisition and representation of context from the delivery and reaction to context by a context-aware application"[12]. Phidgets contributed physical widgets; programmable ActiveX controls that encapsulate communication with USB-attached physical devices [5]. The Switcharoo [1] toolkit provides more product design capabilities for form exploration and Macromedia Director support. The iStuff [2] toolkit combines physical widgets and a flexible, event-based software infrastructure to facilitate prototyping multi-user, multi-modal physical interactions in heterogeneous, distributed environments. Papier-Mâché [8] supports tangible input with computer vision, RFID, and barcodes using a high-level event model for portability. Yet, prototyping interactive physical user interfaces is still non-trivial. What aspects of physical prototyping have not been addressed by existing toolkits? What are the strengths and weaknesses of each? How can the strengths of these toolkits best be combined? And lastly, possibly the largest challenge facing toolkit developers is: how can these tools be evaluated?

3 Workshop attendance, submissions, participant selection:

This workshop will be a collaboration between tangible user interface designers and toolkit developers. We will target submissions from each category. Tangible user interface designers will give perspectives on domain, existing prototyping techniques, and difficulties in prototyping. Toolkit developers will position their toolkit solution, its significance, and its strengths and weaknesses. Ideally, we would have around 10 workshop participants but will consider taking a few more.

4 Workshop structure and product:

This field of research is becoming a hot topic and is reaching critical mass. This workshop is intended to foster collaboration and establish a research community around this area. We will first examine the design space of TUI toolkits and categorize existing toolkits by their effectiveness in each of the potential usage domains within ubiquitous computing, which we identify with the help of the designers present. We will then form an evaluation framework for TUI toolkits including technical metrics, hardware considerations, examination of system architectures, and what types of prototyping the toolkits afford. As a part of the workshop presentation to the rest of the conference, we are encouraging each of the toolkit participants to demonstrate their toolkits live, allowing a broader audience to experience the toolkits first-hand.

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