Position Paper: Mobile Phones may be the Right Devices for Supporting Developing World Accessibility, but is the WWW the Right Service Delivery Model?

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ABSTRACT

In this paper we detail the synergies we have observed between the features and limitations of mobile phones, and the usability and accessibility requirements of rural developing world users. This includes support for sequential interaction, multimedia input and output, asynchronous messaging and a universally familiar numeric keypad. However, we argue that the WWW as currently conceived may be an inappropriate model for delivering mobile information services in this context. We highlight a number of tensions we have observed between the traditional web model, and the design synergies that we have uncovered. To demonstrate an alternative framework, we describe CAM — a platform for delivering mobile information services in the rural developing world. Supporting scripted execution, media-driven, tangible interaction as well as an offline usage model, CAM is uniquely adapted both to rural accessibility requirements and the inherent capabilities of mobile phones. By learning from the CAM design, we can either improve the design of existing mobile web standards and services, or implement a more appropriate framework altogether.

Keywords

mobile computing, mobile phones, novice users, rural development, ICT

1. INTRODUCTION

Over the past five years, we have been investigating the design of interfaces for a variety of rural Indian users - ranging from uneducated, semi-literate farm laborers to high-school and college-educated youth [10, 11, 12].

In this paper we detail the synergies we have observed between the features and limitations of mobile phones, and the usability and accessibility requirements of rural developing world users. These include a small screen — limiting decision-making requirements for novice users; audio feedback — found to be important for the subjective satisfaction of both literate and semi-literate rural users; a numeric keypad — familiar to billions of users and uniform across languages and cultures; and asynchronous messaging services, which are already immensely popular. Moreover, the very mobile nature of a mobile phone allows it to reach regions that are difficult for traditional computing devices.

However, thus far the user of mobile web services is dwarfed by voice calls and text messaging in both the developed and developing world. Part of the reason could be the poor usability of mobile web applications [2, 8]. In this paper, we argue that the WWW as currently conceived may be an inappropriate model for delivering mobile data services to rural developing world users. We highlight a number of tensions we have observed between the traditional web model, and the design synergies that we have uncovered.

To demonstrate an alternative framework, we describe CAM — a platform for delivering information services to the rural developing world[12]. Supporting scripted execution, media-driven, tangible interaction as well as an offline usage model, CAM is uniquely adapted both to rural accessibility requirements and the inherent capabilities of mobile phones. By learning from the CAM design, we can either improve the design of existing mobile web standards and services, or implement a more appropriate framework altogether.

2. MOBILE PHONES ARE THE RIGHT DEVICE FOR RURAL ACCESSIBILITY

In this section we detail the synergies we have uncovered between mobile phone user interface and device affordances and the accessibility requirements of rural Indian users.

2.1 Small Screen

In an early design experiment we observed that a user interface with small and discrete task spaces was more comprehensible to semi-literate rural users [10]. Later, we found that a scripted sequence of mobile data entry tasks was learned and used efficiently by both educated and uneducated rural users [11]. Other researchers have noted the suitability of sequential execution for small-screened mobile devices [9]. Presenting one task at a time reduces the potential for confusion or indecision on the part of novice users.

2.2 Audio Feedback

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Figure 1: The numeric keypad is familiar to billions of users around the world. The phone's camera is used to link mobile applications to ubiquitous paper-based processes, and to capture rich information and experiences without the need for typing.

We have repeatedly observed local language audio feedback as being the most important factor for the subjective satisfaction of rural Indian users. Initially, audio in the local language served as the bridge between poor rural users and an expensive foreign device [10]. Later, we found that the audio phrases uttered by our application were becoming local colloquialisms [11]. Voice-based input can also improve the accessibility of the system for semi-literate and illiterate rural users. A microphone and speakers are integral parts of any mobile phone.

2.3 Camera

Most medium to high-end mobile phones now come equipped with some kind of camera. Some may have several cameras, with high resolution and video capabilities. During our research in rural India we observed the importance of paper forms and ledgers in local information practices [10]. More recently, we have demonstrated the use of printed barcodes on paper forms as a way of navigating mobile form-filling applications [11]. A camera can also be used to capture rich information and experiences without writing or typing.

2.4 Numeric Keypad

The numeric phone keypad is immediately familiar to billions of users. When you include its inverted and cheaper cousin — the calculator, the number increases further. Exposure to the Qwerty keyboard pales in comparison. A numeric keypad also obviates the need for hardware localization or of using a foreign keyboard mapped to your native language. Moreover, significantly more people are numerically literate then textually. We have observed that numeric input is accessible even for illiterate and semi-literate rural users [10].

2.5 Mobility

For the foreseeable future, most of the world's people will not be able to afford their own digital device. Like other resources, technology will be shared by the family or community. Currently, there are two common alternatives for shared rural computing deployments. In one model, an Internet-connected PC kiosk is installed in some percentage of towns and villages [3, 7]. Villagers from other locations must travel there to access computing resources. In the other model, agents with handheld devices travel to collect information from and deliver information to villagers. This model has been already been implemented in microfinance [6], and for health data collection [5], just to cite two examples. The advantage of this model is that people can access information services at their doorstep. This is definitely the more accessible approach, given the time-consuming nature of travel in the developing world. The potentially lower cost of mobile handsets when compared to PCs contributes to the affordability of this approach.

3. BUT IS THE WEB THE RIGHT SERVICE MODEL?

In this section we describe some tensions we have observed between these synergies, and the traditional WWW model.

3.1 Spatial vs. Temporal Layout

While HTML was originally intended for defining the structure of web content, in practice it has been largely used to specify the spatial layout of web pages. The WAP (and more recently, XHTML) standard continues to be steeped in this tradition. In contrast, sequential presentation of tasks and content may be more appropriate for the limited screen space of mobile devices, and also for the limited interaction vocabulary of novice rural Indian users.

3.2 Textual vs. Multimedia Interaction

While audio and video are part of many web sites, and digital media is available for sale or distribution over the web, presentation and interaction on the web is still largely a textual affair. Screen readers allow the disabled to browse the web, but the underlying markup is designed for graphical presentation, making it cumbersome to browse aurally. In contrast, capturing, transmitting and emitting audio (and now, video) is fundamental to the design of a mobile phone. Current mobile web services do not take advantage of these features.

3.3 Direct Manipulation vs. Numeric Selection vs. Tangible Interaction

The user interface of the web is based on the point and click world of the desktop WIMP GUI. Due to the small screen and limited input options, it has been difficult to adapt this model for mobile devices [1]. Similarly, novice rural users have found it difficult to understand and accept the many abstractions inherent in the WIMP model [10]. In our research, we have explored several alternatives. These range from the simplicity of numeric selection, to the potential for tangible, paper-based interaction. We discuss some of these in the next section.

3.4 Online vs. Offline Access

While there have been some attempts to implement local, searchable web caches that can be accessed via a proxy [13], the web is still mostly intended to be used as an online medium. Web sites are not designed with the intention of providing offline, disconnected access. Many rural villages in the developing world are only weakly connected to the telecommunications infrastructure, if at all. Internet connections in these locations can be expensive, unreliable, or both, at least using current technologies. While mobile phones are intended to provide real-time voice communications, asynchronous messaging-based services are also very popular. These include message-based data services (for example, see [4]). Users do not need to continuously be online to access these services. Using asynchronous protocols, messages are automatically cached and delivered when the phone has an active wireless connection. In the next section we describe how we have developed a robust application layer on top of these lower level messaging protocols.

4. CAM APPLICATION FRAMEWORK

CAM is an application framework for developing and delivering mobile information services in the rural developing world. The CAM architecture has been described in detail in a prior publication [12]. Here we discuss the advantages of this system in relation to the previous section.

- **Scripted** - CAM programs are built using scripted actions and functions rather than spatial layout primitives. The display limitations of mobile phones, and the interaction limitations of mobile users, both dovetail nicely with this approach.

- **Support for Rich Media** - CAM user interaction is driven by a scripted sequence of prompts and actions. Each of these can be associated with arbitrary audio and graphics. In early usability tests, the audio was so essential that some users didn't even refer to the screen [11]. CAM also provides functions for capturing audio clips and images. This dramatically increases the possibilities of user input, partially compensating for the difficulty of mobile text input, especially for native languages.

- **Tangible and Numeric Interaction** - CAM applications can be accessed and navigated using barcodes or numeric strings printed on paper forms and other artifacts. In this way the process is more familiar to users accustomed to paper-based tasks, while overcoming the limited screen navigation area of mobile devices. Barcodes and numeric strings also serve as convenient persistent references to applications and data.

- **Can be used Offline** - Using asynchronous messaging services like SMS and MMS, CAM applications can be accessed without an active Internet connection. CAM provides an interactive, multimedia client on top of these lower level transport protocols. In a different sense, CAM is like online Interactive Voice Response (IVR) services, except that CAM applications work offline and also take advantage of the mobile phone's screen and other UI features.

5. CONCLUSION

One of the reasons that we have been able to design and develop a new framework for delivering mobile information services to the rural developing world is that we do not have to support a large, existing application and content base such as the WWW. If the creators of the mobile web did not need to support access to these resources, clearly they would have designed different protocols and systems.

In this paper we have presented how a mobile services framework might look if it were designed from the ground up to be accessible to rural Indian users, while taking full advantage of the mobile phone's inherent features and capabilities. Even we have been surprised by the synergies that have emerged between these requirements.

We believe there are lessons to be learned from our experience. Several of the approaches and techniques we have described could be applicable to other novice users around the World. In the future, we plan to conduct more experiments with diverse user groups to assess this potential. Moreover, given the fundamental differences between a PC and a mobile phone as a hardware device, we hope that our paper encourages others to envision entirely new models of mobile information service delivery. By learning from these experiments, we can either improve and extend existing web standards to incorporate new and successful techniques, or we may reach a point where we have something better altogether.

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