# Now you see it, now you don't – making technology invisible in the developing world.

## *Introduction*

Those of us who live in the developed world dwell in an ecology where information is literally everywhere. Besides physical forms such as newspapers, books and magazines, the air around us is crammed with signals carrying information that we can access and use almost without thought on our smartphones and other devices. Information, and the technologies that allow us to access it, are so convenient that we scarcely think about them. They are mostly invisible to our conscious mind.

However, for those living in the developing world, information is less than ubiquitous. Although many of people in the developing world have a cellular handset, issues around cost of access and user literacy barriers mean that accessing information is a deliberate, complicated and expensive undertaking. People living here cannot effortlessly pluck invisible information from the air but must go to great lengths to find the information they need.

In the rest of this article we shall explore three separate projects that seek to make access to information ubiquitous for these users. We will highlight systems that fit naturally into their ecologies effectively making the technology invisible and allowing users natural, convenient access to information sources.

## *Spoken Web*

Our first example is that of the Spoken Web [KUMAR] from India. Realising that many people in India are denied access to information due to low textual literacy, Spoken Web seeks to create a hyperlinked information service based on spoken voice rather than written text. It consists of an interconnected Web of "voicesites", which can enable information creation and access purely through voice and local languages. Key features of Spoken Web are content creation, linking and browsing. Content creation, and hence VoiceSite creation, is completely over voice using any phone instrument, thus ensuring that content creation can be done by the masses. Linking VoiceSites enables traversal and browsing across Voicesites. Hyperlinks in Spoken Web use an underlying Hyperspeech Transfer Protocol [AGARWAL-2007]. The job of HSTP is to preserve and transfer the context when the call is transferred from one voicesite to another. Browsing is performed through the Spoken Web browser, which enables users to navigate across voicesites, issue commands to move back and forward, and save bookmarks. Since the Spoken Web has to be accessible from any phone, the browser is implemented as a server-side entity.

So now, using the ubiquitous phone, instead of just talking to people they previously know, farmers are posting questions and answers on spoken fora, and companies are able to reach out to sugarcane farmers to schedule the next crop

drop. Elsewhere, people are using it as a platform to show-off their singing talent and sending voice greetings to each other [AGARWAL-ITID-2010]. Since the interaction is all spoken and in their local language, the technology remains both invisible and usable. As the number and nature of voicesites increases, we are faced with a real challenge: the increase in complexity should in no way hamper the invisibility of the technology. With more sites and more content, will there be natural and simple ways to search and interact with the content? Will it be forced to become visible?

This move from invisible to visible computing is already being observed in the smart phone era. In some ways, smart phones are making computing much more visible. Unlike other tools to hand, like a notepad or wristwatch, they can draw us in, away from the world around us, to marvel at the digital, computational sphere at our finger tips. The physical form factors of the smartest of smartphones and the sleek interaction design, especially the touch screens they exhibit, enchants us.

Recongising this, recently the Spoken Web team has explored ways of providing smartphone interaction features to dumb, very low end, phones. The TapBack method allows callers to tap on the back of their simple phone to navigate content. The tapping is picked up by the phone's microphone, transmitted over the telephone line and processed remotely on the Spoken Web server. Our initial prototype considered simple audio gestures on the phone's cover [ROBINSON]. There is potential for more complex scratching or by using different surfaces of the phone where the acoustic signal might be altered by the varying materials used in the casing.

When the prototype was deployed we discovered the challenges of robustly recognizing the audio gestures on the phone's "touch screen". However, despite technical issues in the trials, people liked having something that was more like the smart phones that they aspired to attain. In the "developed world" most people have their own phone; meanwhile, in rural India, people still often share phones. With mobile technology being more 'communal' than 'personal', there are technical and interaction design considerations. In our case, the tap-models used need to be tuned not just to individual phones but the set of users that might use that phone. We have seen some users put the phone onto speaker mode so that a group of villagers could access the Spoken Web together. To take advantage of this communal use, it might be possible to use surfaces around the phone - such as the table - for a wider set of gestures, as suggested by Chris Harrison in his "scratch input" work [HARRISON].

### *Big Board*

In South Africa, a research group from the University of Cape Town has been working with NGOs who wish to spread information to many people in low-income communities – typically this is health or educational material presented in a multi-media format so that it is comprehensible to people who are not textually literate. In South Africa the pricing structures for cellular access are significantly different to India, affording completely different forms of

communication and information sharing. In this context, voice and SMS are prohibitively expensive, so a solution like Spoken Web is untenable. Data download costs would also be too great for multi-media material. So how can one distribute digital media in a natural way at no cost to the user?

One solution is the Big Board system [MAUNDER], an electronic noticeboard which uses Bluetooth to download information free of charge to a user's handset. The user can select an item from the screen by taking a photograph of the item and sending that photograph, via Bluetooth, to the computer powering the noticeboard. That computer performs image recognition on the photograph, discovers what topic the user is interested in and then sends relevant information back to the user's handset. This information can be images, videos, music; essentially any media type the handset can process.

Whilst the system was trialled successfully in a variety of locations in the informal settlements around Cape Town (it was used to share community information in a training centre, school and library) concerns were raised about the high cost of a system designed for low income communities; 40" LCD displays and computers to drive them do not come cheaply. Furthermore, the system needs a constant source of electricity to power screen and computer, again limiting its application in developing regions.

## Patterns of Communication

Besides the technical shortcomings, we also identified that many of the people we were trying to reach could not visit the buildings in which the screens were installed. If our system was to be truly invisible then users should not need to go out of their way in order to use it. From studying the patterns of people's lives in urban and rural environments, we realised that the best way to reach the greatest number of people was to install the system in minibus taxis – the ubiquitous form of transport in sub-Saharan Africa. Taking all of these criteria together (low cost, ubiquity, intermittent power) we realised that we would have to port our system onto a cellular handset. Instead of the screen we would have to use stickers on the inside of the cabin. So, after trying various configurations we settled for a server running on a Windows Mobile handset and stickers that look like those in figure n. Our images required a barcode frame as the handset did not have the image recognition power of the desktop PC (we could not use standard QR codes as they would require a text description, which our target audience would be unable to read – therefore we have to incorporate an image in the bar code). So now, people who travel to and from work in these taxis have the opportunity to access information that does not require textual literacy, and they can do it without costs to themselves. It may seem a strange solution from the point of view of the developed world, but is a natural part of the ecology for the taxi commuters of Africa.

### *Pragati*

Returning to India, we face the same problem of NGOs wanting to make information available to users who cannot afford to access it. In this instance the NGO was Pragati, which is dedicated to assisting urban sex workers in the city. Pragati's primary goal is healthcare assistance (particularly HIV/AIDS), but they also provide a variety of ancillary services such as microfinance, counseling and advocacy. Pragati needs to communicate with the women they serve for notifications, announcements, reminders, and emergency services. However, this can be very challenging. Most communication is spread by word-of-mouth as community health workers physically make the rounds to talk to women (e.g., in areas where the sex workers typically solicit). Since most sex workers are non-literate, techniques like flyers or posters are not useful and normal broadcast media (radio or television) are too diffuse and expensive. To make matters harder, many sex workers are very poor, socially stigmatized and nomadic, so it's easy to lose track of individuals. However, mobile phone penetration among them was 97%, which is an unusually high number (the average wireless tele-density in India was 76% as of October, 2011). In fact, many sex workers maintain *two* separate devices or dual-SIM phones, one used for work and the other at home.

Ironically, the solution in this case is based on automated calling systems which in developed context remind us how irritating technology can be, as our telephone is assailed with everything from automated political ads through to reminders about dental appointments. However, the vast reach of mobiles in the developing world makes it possible to use such systems to communicate with people who are otherwise very hard to reach.

To see how this might work, researchers at Microsoft Research India employed this technology to help Pragati better connect with the women they serve [SAMBASIVAN]. They built a phone-based broadcasting system that could automatically dial workers' phones and play pre-recorded or custom generated messages. The system was used in two ways: 1) to widely broadcast announcements regarding HIV testing, training sessions and other events sponsored by Pragati; and 2) individualized reminders for microfinance loan deadlines.

Unlike the typical response to "robo-calling" in the developed world (i.e., hanging up), more than 80% of women we connected with listened to the messages in their entirety. Indeed, they often mistook the messages for live calls from the field coordinator at Pragati. And interestingly, the system managed to reach more people than we had actually called, because of secondary diffusion among the call recipients to non-recipient friends. Overall, both Pragati and the sex workers we interviewed found the system a useful tool for helping Pragati fulfill its mission.

Automated calling systems such as the one implemented with Pragati, can exploit an interaction that is familiar to the user (answering a call or accessing a voice mail) but is actually be a powerful way to bring a range of information to

people who, because of constraints on literacy, finances, or other social pressures, may not be able to access that information in any other form.

### *Rethinking Invisibility*

The cellular handset, as a device, has been wildly successful in the developing world. It has become an unremarkable and invisible piece of technology. However, if those handsets are to be a catalyst for social development, as many people hope, then the handsets must be able to access information that is locally relevant and freely available (both in a financial and geographical sense). The projects reported here have made an impact in a few, specific contexts, but for the majority of users, the information the need is obscured by the very visible technology barriers that lie before them.

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