A Sustainable Information Kiosk Driven by Sound

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***Abstract*—In this paper we describe nibble.io, an offline information kiosk that has been designed for deployment within the rural communities of developing countries. We show how a pervasive technology such as sound can be used as a method of interaction between low-end feature phones and information kiosks built using standard PC monitors. By connecting an embedded computer to a monitor we show how we are able to create an interactive experience driven by the user's phone using a variety of interfaces ranging from music players to web browsers.**

I. Introduction

In the rural communities of developing countries, villagers might walk distances up to several miles to a local community centre where they can access a limited range of technology [1]. The technology available could be supplied through government schemes or charitable donations and will often lack a persistent connection to the Internet. We intend to supplement the technology available in community centres with an interactive information kiosk that can be controlled by any mobile phone or device that is capable of playing sound files. The kiosk will be built from any existing PC monitors (e.g. CRT or LCD displays) and will be connected to a low-cost Single Board Computer (SBC) which will host and display the information content. Content might include agricultural information for local farmers or more general services such as a medical information for the community.

Currently, most kiosks in public service utilise a touch-based approach, however a body of research has been growing in the area of alternative kiosk interaction methods, including a multimodal approach that makes use of multiple inputs and outputs for a richer user experience. Kiosks can be categorised depending on their intended purpose. Borchers et al. [2] defines four different categories of kiosk; information kiosks, advertising kiosks, service kiosks and entertainment kiosks. Although touch screens are typically used for each of these purposes other more novel interaction methods have proven useful to end-users. Bergweiler et al. [3] describe Calisto a system that enables users to connect their mobile devices to a large public terminal and share interesting facts and media via an intuitive multimodal interaction. This seamless combination of a touch-screen kiosk and mobile device (a ubiquitous device in both developed and developing countries) presents a novel approach to the traditional kiosk interaction paradigm. We will explore similar interaction between mobile device and kiosk, however we will use standard PC monitors and support a variety of mobile clients. The interface used on the mobile client will range from simple music players to file browsers and web browsers and will include support for menu-driven feature phones.

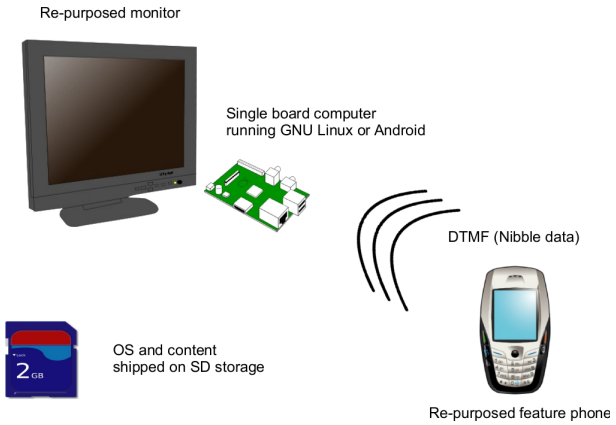

Fig. 1. nibble.io architecture

Our work builds upon a Work In Progress (WIP) paper we presented at TVX 2014 [4]. We will demonstrate a fully functional product based on this work that is ready for deployment.

II. System Description

Figure 1 provides a high-level overview of our kiosk design. The kiosk itself consists of a standard PC monitor connected to a SBC running GNU Linux. We currently use a Banana Pi which is based on the Raspberry Pi but provides more processing power and includes an onboard microphone. The system boots directly from SD card into a fully working kiosk. The software running on the Pi includes a web server to host the offline content, a web browser to display this content and our nibble.io software to process sound received from the microphone and drive the web browser.

A user with a mobile phone interacts with our kiosk by playing sound files (WAVs) that correspond to individual pages to be displayed on the PC monitor. A WAV file is generated from the first 8 hexadecimal characters of an MD5 hash of the URL encoded into a series of DTMF phone tones that last approximately 1 second. Figure 2 describes the audio format in more detail which will refer to as a nibble.

A start tone, that is not part of the DTMF standard, is used to wake up the receiving kiosk application. The next 8 tones contain the 32bit payload or data used to encode the URL and the final 4 tones provide a checksum to test whether the message was received. As there are 8 tones to represent data

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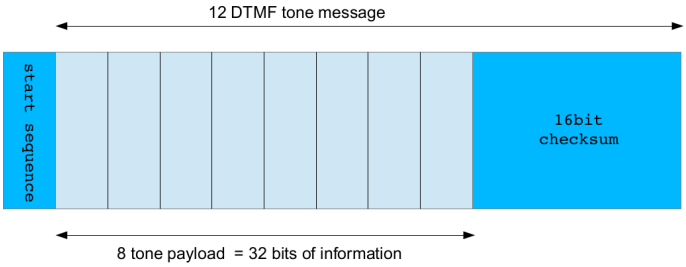

Fig. 2. Nibble audio format

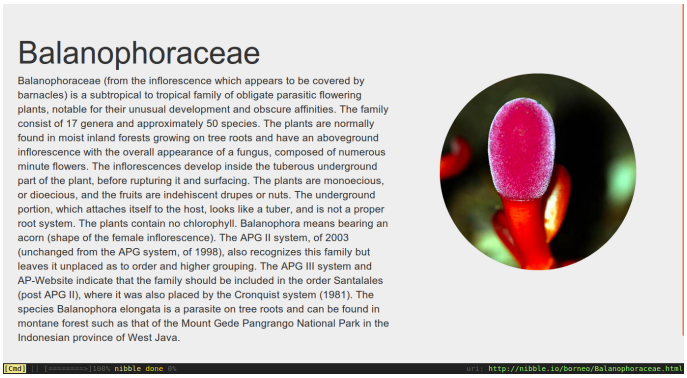

Fig. 3. Demo kiosk page

we can represent 32bits of information per exchange or map to 2^{32} different pages on our kiosk.

When the kiosk receives a nibble it must first carry out some signal processing on the audio to retrieve the original 8 character hexadecimal string that was encoded. This string is used as the key within a Berkeley DB database to lookup the corresponding URL. Having obtained the URL our software is able to direct the Uzbl web browser to the corresponding page by controlling the browser via a Unix pipe. We chose the Uzbl browser for its light-weight minimalist design and ability to be externally controlled. The Chromium browser also provides this feature but is not well supported on embedded Linux.

Figure 3 provides an example of the sample content that ships on the demonstration SD card image we provide. We also provide a web application to test the kiosk which is available at http://nibble.io/borneo. Although this currently might not seem an accessible technology in some regions of the world, companies such as Google and Mozilla are entering the market place with affordable smart phones. Therefore, we will also design for this emerging market.

III. Design Goals

A key design brief for the kiosk is to be low-cost and where possible re-use existing equipment that might be available through donations. For this reason, we have designed a system which is simple enough to run on low-end hardware but yet is capable of carrying out the required signal processing. Therefore our kiosk has been designed to fully run on a low-cost embedded device such as the Raspberry Pi. Similar novel technology developed such as chirp.io utilise processing power from an Internet connected backend server to carry out the signal processing. As previously highlighted, we intend to support offline use to enable deployment within community centres in developing countries without requiring an Internet connection.

The ability to allow content to be easily created and deployed without requiring extra investment in equipment is crucial to the sustainability of an information kiosk within an ICT4D context. For this reason we have designed a system that is not only capable of running in kiosk mode but is also capable of being used to generate new content. The software running on the kiosk hardware comes with the required tools to add new web content as well as tools to generate the corresponding nibble audio files needed by the client.

Finally, we wanted to use a pervasive technology for communicating data that does not require any networking setup. Many devices are capable of playing audio files. We have tested our system on cheap handheld electronic organisers as well as a range of low-end feature phones. Local communities are already exchanging multimedia content amongst the feature phones that they own using simple offline techniques including the swapping of memory cards [5]. We wanted to build on these existing practices by using audio files. It is even possible to exchange sound files using sound itself which opens up some interesting peer to peer networks. We have successfully tested playing a sound file from one phone to be recorded on another and then used to interact with the kiosk. However, we will use the community centres as the focal point of file exchange as we do not want to disrupt this hub of social activity.

IV. Conclusion

In this paper we have described nibble.io, an information kiosk which can be controlled using sound files played on a mobile phone. The purpose of the project is to build a low-cost, sustainable solution that could be deployed in areas that lack network connectivity. We aim to utilise existing widespread technologies to build a system that complements established social interactions that take place within the rural community centres of developing countries.

References

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