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BuzzBoards Demonstration - an X-Reality Toolkit for Creating Immersive Reality Educational Laboratories

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Overview. One challenge facing Immersive Learning environments is how to support teaching topics that involve laboratory activities and the construction of physical systems, especially in environments comprising teams of geographically dispersed students. In this demonstration we will present a tool kit designed by the authors called *BuzzBoards* that provide a set of network based modules, and their virtual counterparts, that can be assembled by students to build mixed reality systems. The toolkit is based around the *Internet-of-Things* enabling students to build embedded computing systems ranging from phones, through MP3 players to robots. The principles are based on deconstructionism whereby primitive functionalities of commonplace electronic and computing devices are decomposed into a set of network based soft & hard services which are shared within connected virtual environments and reassembled by students. We propose to bring this toolkit to iED Europe Summit and demonstrate it being applied to the assembly of mixed reality educational laboratory system. The demonstration will complement a conference iED paper, "End-user programming & deconstrutionalism for collaborative mixed reality laboratory co-creative activities" submitted by Anasol PEÑA-RIOS, Vic CALLAGHAN, Michael GARDNER and Mohammed J. ALHADDAD [1] which presents a model that allows geographically dispersed students to collaborate on mixed reality laboratory activities using combinations of cross reality (xReality) and virtual objects.

1. Introduction

Supporting physical laboratory work within immersive educational environments is very challenging. Current research on laboratory activities for distance learners has mostly focused on simulations, virtual laboratories and remote laboratories where there is no interaction with real equipment and the activity is performed with idealized datasets and restricted collaborative interaction. Interaction with physical systems is a vital part of science & engineering students' educational experience.

In our demonstration we will show an immersive education environment can be created to support laboratory teaching based around the *Internet-of-Things*, a computing technology that concerns the interconnection of countless networked embedded computing devices. In this world, almost everything in a person's life can be

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interconnected from bathroom scales through cookers to cars, the behaviour of which can be orchestrated by people or their agents. Some estimates of the Internet-of-Things market suggest that by 2020 it could be worth between 22 billion and 50 billion dollars made up of some 16 billion connected devices which, in turn, will drive the need to educate studentes in these skills. The *Internet-of-Things*, like Immersive Education is a network based technology. Thus this is a fitting topic to begin an exploration of how immersive education environments might support science and engineering laboratory work.

2. The Demonstration - The BuzzBoard Mixed Reality Toolkit

At iED 2012 we propose to demonstrate the *buzz-board* toolkit which is an open-system comprising some 30 pluggable hardware boards that can be interconnected together to make a variety of "*Internet-of-Things*" applications, see figure 1 for a few of these modules.

Figure 1. *Buzz-Board* Examples - From Left to Right Audio, Midi, KeyPad, Base (Processor), LED & Network

Notice how these modules have through-connectors enabling the units to be assembled (reconstructed) in various combinations, thereby allowing different functionalities and physical forms to be built. For example, a wheeled robot to be constructed (see figure 3a). In terms of use in an immersive learning environment the key feature is a network connection (based on I^2C) that threads through each board allowing the wider Internet (and immersive environments) to be notified what boards are plugged together and to identify what software functions exist for that module (plus other status information). The same principle is applied to the software (virtual) couterparts of these modules, thereby allowing a mix of soft and hard objects to be assembled by students to share connectivity and status within every single immersive environment, thus forming the building blocks of collaborative mixed reality immersive reality laboratory educational environments. The entire system is modularised and even the main processor board (the heart of the *Buzz-Board* system) is designed in such a way as to accept a daughter mezzanine board containing the processor of choice. One variation of this mezzanine board is a version that is pin compatible with the industry standard mbed (see Figure 2a) whilst another is aimed at the newly emerging $25 Raspberry Pi (see figure 2b). Other processors that the *Buzz-Board* system supports are AVR (Arduino), Coldfire, 68K, and PIC processors. As explained in the companion paper being presented to iED by PEÑA-RIOS [1], the above model is based on concepts of constructionist and co-creative learning.

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The mBed is based on the ARM Cortex-M3 Core running at 96MHz, with 512KB FLASH, 64KB RAM and various interfaces including Ethernet, USB Device, CAN, SPI, I2C

Figure 2a. mBed

The Raspberry Pi is based on an ARM1176JZFS, running at 700Mhz, with a Videocore 4 GPU. (BluRay quality playback) in a Broadcom BCM2835 SoC. The current best specified model has 256Mb RAM, 2 USB port and an Ethernet port.

Figure 2b. Raspberry Pi

3. The Immersive Education Environemnt

Our Immersive Educational Environment takes the appearance of a special virtual reality environment in the form of an study desk with an inbuilt semi-spherical sectioned screen that gives the student an illusion of being in the same room with other students (see figure 3b). The idea is that geographically dispersed students using these desks can come virtually together to collaborate in mixed reality learning exercises (eg. building a *BuzzBoard* robot). The iDesk supports both students and teachers using variety of agents to mediate both the users and learning content. The desk is not practical to transport and will not be included in our demostration (we will simply use a flat portable screen to illustrate how this system works). A more detailed account is given by one of the authors, Anasol PEÑA-RIOS, in another iED paper [1].

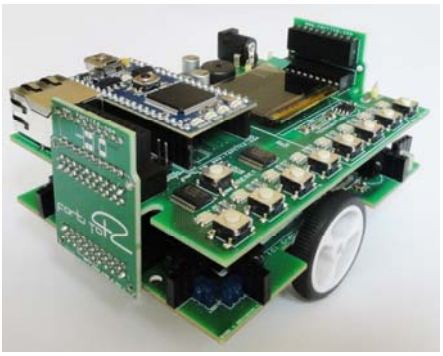

Figure 3a. The Buzz-Board Desk Top Robot

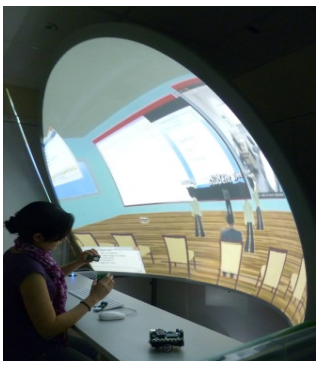

Figure 3b. The Immersive Learning Desk

4. Summary

At iED'12 we will demonstrate how the *BuzzBoard* toolkit we have designed and built (comprising some 30 modules) is able support teaching and learning of laboratory based activities inside an immersive educational environment. For practical reasons we will demonstrate the operation of mixed reality using a small portable screen (our large table is impractical to transport) but we support the the wider demonstrtion by a full iED paper and posters.

[1] Anasol PEÑA-RIOS, Vic CALLAGHAN, Michael GARDNER and Mohammed J. ALHADDAD "*End-user programming & deconstrutionalism for collaborative mixed reality laboratory co-creative activities*", iED Europe Summit 2012, Paris, France.

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