SenseEgg: A wireless music controller for teaching children with special learning needs

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1. INTRODUCTION

Creation of new interfaces for musical expression can be especially challenging when targeted at end users having complex learning needs [1]. Such users have sensory, cognitive, or physical impairments, which affect their ability to play traditional instruments, leading to a diminished music making experience. Technology can often help bridge the gap between the user and their musical intentions [2]. However, its use in schools introduces additional constraints, such as, affordability, acceptance by staff and acceptable learning time. We developed the SenseEgg system to address these issues.

2. BACKGROUND AND REQUIREMENTS

Several interactive musical devices for users with complex learning needs are already available as commercial products. Examples include the Soundbeam, the Skoog, MIDICreator, the Squeezables, and the Musical Ball Project. These are sensor-based systems, which acquire data from a variety of physical interactions, and control sonic parameters [3]. We worked in collaboration with several schools specialising in education of children with special educational needs (SEN), to identify limitations with current products and the need for additional features and capabilities. On this basis, we derived a specification for a novel fully integrated, interactive wireless, multi-sensor system for musical exploration and teaching.

3. SYSTEM DESIGN

The requirement for a robust, hand-held device that was also friendly and engaging meant that package design had high priority. We developed various prototypes and sought feedback from end users. The SenseEgg concept shown in Figure 1 proved to be the favourite design with children and teachers alike.

We evaluated a wide range of sensors and actuators to assess their size, cost, tactility, sensitivity, operational range, power and interfacing requirements. For the prototype, we selected five types of sensor / actuator:

- Button
- Slider
- Tri-axial accelerometer
- Wind Sensor
- Ultrasonic Range Finder

The button, slider and accelerometer devices ensured that users could rapidly elicit responses to simple physical interactions and movement ensuring quick engagement in situations where attention deficit is often an issue. Inclusion of the wind sensor enables breath control, which is beneficial for users with limited limb mobility. However, this leads to the potential problem of ingress of moisture. Consequently, this further complicated package design due to the need for sealing around the wind sensor and the need for cleaning and disinfecting to prevent possible cross infection. The range finder sensor was included to provide a more challenging control mechanism as users increased their experience with the device.

Figure 1: Prototype SenseEgg controller

The SenseEgg device incorporates an Arduino-FIO embedded microprocessor, which acquires data from the sensor / actuators. The data is then encoded and sent to an onboard low power XBee transmitter module. This provides a wireless link to a remote computer or tablet that hosts software to produce the sound or music generated in response to the user's interactions with SenseEgg. Figure 2 illustrates the architecture of the complete system. An integral lithium polymer rechargeable battery provides power.

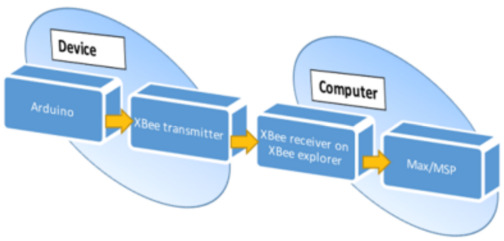

Figure 2: System architecture

4. SYSTEM EVALUATION

To evaluate the prototype SenseEgg system we designed custom Max/MSP patches based around four conceptual themes. An audio-visual interactive 'Farm soundscape' theme allowed exploration with animal sounds triggered on/off via level thresholding of any sensor output. This approach was then adapted to allow simple rhythmic composition by using the sensors to trigger drum sounds in a 'Play the Drums!' patch. For the 'Wobblegg' patch a motion to audio mapping strategy was developed to allow the accelerometer and slider to control additive synthesis. In the 'Pitcher' patch a Theremin simulation was achieved by using the range finder to control pitch. To enable an SEN teacher to monitor a child's interaction with SenseEgg without unduly influencing the interaction, a custom iPad application mirrored the display on the child's computer. Figure 3 shows the arrangement with a sample patch running.

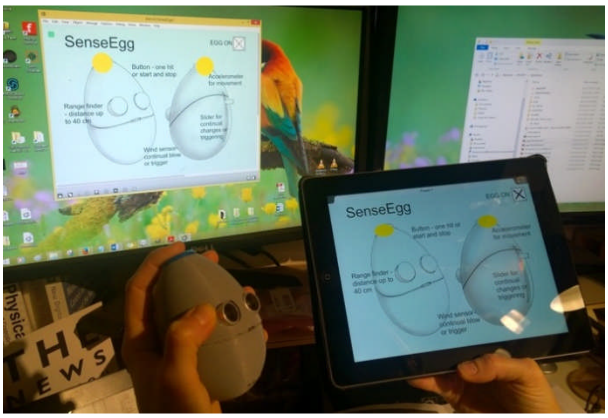

Figure 1: The SenseEgg System

We obtained ethical approval from the BU Research Ethics Committee to perform a pilot evaluation of SenseEgg with staff and ten children in two, SEN Schools. Teachers completed a questionnaire at the end of each session.

5. RESULTS / DISCUSSION

The results of the pilot study provided empirical evidence of a positive response to the SenseEgg system by SEN teachers and children. It was evident that the ease of interaction and accessibility of the handheld device and the characterful design quickly engaged users in exploring the capabilities of the system. Teachers quickly became confident in taking control of the software settings to cater for the needs of particular students. During testing, we tuned the motion-mapping algorithms to achieve an acceptably repeatable user experience without requiring excessively precise physical control by the user.

6. CONCLUSION AND FUTURE WORK

The development of the SenseEgg system has demonstrated the efficacy of providing a low cost hand held wireless controller to enable exploration of sound and music by children with special educational needs. Initial results demonstrate that the system is useful in engaging SEN children and enabling educational assessment by their teachers.

Future work will focus on:

- (i) Further improving the reproducibility of the system response.
- (ii) Providing additional software patches to meet educational requirements.
- (iii) Adding a microphone for a vocal channel.
- (iv) Wireless networking of SenseEggs to allow ensemble compositions by several users through user collaboration.

7. REFERENCES

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