EmbeddedSPARK 2010 Challenge Proposal

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This is my proposal for the EmbeddedSPARK 2010 challenge. I am proposing an entertainment music player, and scratch table for kids. Physically it is a small boom box with a camera pointed down at a tabletop. A kid can play music, like with other music players. But he can also 'scratch' the music backward and forward. In addition, the entire playback controls – e.g. the volume level, pausing, scratching the music – are done by a child moving paper shapes on a tabletop.
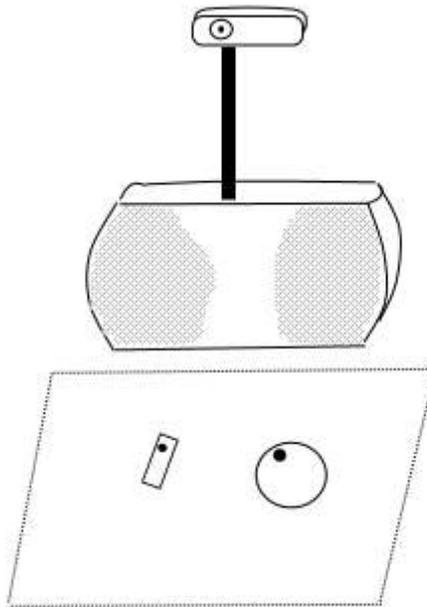
The proposed device

Figure 1: *System overview*

Note: The term "prototype" is used to distinguish from the ideal productized version.

1 Description of Kids play

I'll start with a description of how kids play. I will then describe the underlying techniques that make it possible in the next section.

The music box is operated by touching, moving and spinning things – behavior natural for kids. The child plays with the pieces, exploring the rules of play. In addition, – very importantly – he can show other kids the neat tricks he has figured out, as well as the play pieces he has created. This style of interaction and exploration is inspired by the Montessori philosophy.

Sliders, control knobs, and scratch disks on the surface of a table control the music playback. These controls are nested shapes, usually circles and rectangles of various sizes. For example, a solid circle within a rectangle might be a volume control slider or a button to pause or play music. A circle or rectangle within a circle may be a knob or a scratch disc, causing the music to skip ahead or back by a relative amount.

Controls

The child creates his own controls from paper or cloth, giving him a create influence beyond exploring the sound. He could glue these shapes together, print them from a computer file, or sew them from felt cloth and buttons. (There will be a printable template to get them started.) Other materials may work as well: my son thinks it will work with Lego create shapes. There is supposed to be something both silly and personal in creating his own controls, intended to build self-esteem and foster sharing (*"I made this! Look what I made!"*).

Role of personal craft

Note: The prototype will have some limits on the kind of surface that can be used. For instance, the surface must be a solid color tone (no wood grain texture). Later generations could be more flexible.

2   Technical Profile

The device is styled like a small boom box with a power cord, with a video camera mounted on the top and a handle. Size is important – it is intended to be used and carried by a kid. The prototype will need a few switches, such as an on/off button, and hidden access to the IO/video port to debug the system. The ideal device would not have any physical switches.

Physical form

The camera is pointed at the desktop area. I may need to add a lamp to illuminate the desk.

There are three basic kinds of controls that may be made and used on a table's surface:

Kinds of controls

- Sliders: volume sliders, time position

- Knobs that control play speed, relative play position, etc

- Buttons – that are connected to actions, e.g. pause, play, net, on, off, etc.

The software to do this is complex but does not involve inventing new techniques. Instead, it is a matter of stitching together algorithms such as thresholding, segmentation, edge detection, affine matrix transformation, determinants, image scaling (e.g. doing the primary processing at lower resolutions), hierarchical scene description, and object tracking. Windows CE's DirectShow / DirectSound architecture is critical as it provides access to the video camera and sound playback.

Algorithms

The software watches the shapes, inferring the control movement and their changes, and connects these to actions such as playback. Rectangles and circles are easy for software to recognize, determine the size, center, and orientation. This makes it possible to determine changes in their relative positions and orientation.

Songs are preloaded in the prototype. A real product would either download or accept a CD, scanning it music.

3   Principles of experience

To review, these are the principles that the music player is attempting to embody

1. A *child* is a key part of the overall experience. He shares his experience with other kids.

Principles

2. The role of *personal creation* is important to the fun as well. A kid creates his own pieces (silly and otherwise) to control the music box. Although the kit comes with a template of controls, everyone is encouraged to make their own.

3. The third principle is that the music box should provide a *responsive experience*, encouraging open exploration with appropriate feedback.

4. The primary interaction is mediated by a video camera. The prototype will have a couple of switches, for practical purposes. (The ideal device would not have none.)

5. Finally, a child should be able to lift and move the music box around.