B.E.A.C.O.N. - Beacon Emits Audio from Color, Or Not

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ABSTRACT

People who suffer from dementia are often isolated due to lack of ways of communication. In many cases verbal communication can be difficult to perform at all. We created Beacon with the goal to let people with dementia interact with a very simple and intuitive control interface to give them a means of non-verbal communication, and let them take control over the soundscapes that Beacon is capable of producing. In this paper we describe our concept Beacon, its physical form and how the design makes it possible for a person with dementia to control the software by moving around items of different colors and sizes on its surface to create synthesized and sampled sounds. We hope that Beacon will produce positive results among people with dementia, and that the interaction will be rewarding.

Keywords

interactive sound, interaction design, dementia, music therapy, color, real-time synthesis, openFrameworks

1. INTRODUCTION

The Beacon project was initiated during a collaboration with the memory clinic at Hässleholm hospital, in the south of Sweden. Our task there was to create something that would use sound to help people who are suffering from dementia to become active and give them a tool to express themselves with and explore their surroundings and their own creativity. In other words: music technology for health improvement. After studying the effects and causes of dementia and talking to the staff at the memory clinic, we decided to focus on something fun and engaging rather than educating and utility-based. We wanted to prevent patients from becoming isolated [2] and gives them a means of non-verbal communication by stimulating them and giving them an exciting experience with an almost infinite number of variations depending on their input.

The effects of dementia [5] that we focus on and hope to improve with our Beacon project are memory problems, speech and language difficulties and confusion. By giving the patients a way of expressing themselves we hope that Beacon can give joy and maybe help to open them up from their isolation.

The use of technology such as iPads with patients with dementia has proven to be positive in most cases. It has been shown that iPad interaction increased communication with other patients, staff members and family. It enhanced interactions both directly – through activities involving the iPad - and indirectly – by talking about the iPad [14]. With Beacon we wanted to create something similar but more basic where the technology was completely hidden from the user to make it more accessible to people with little or no experience with electronic devices. This was achieved by making Beacon out of wood and plexiglass, and the items that you put on the surface to control the sounds can be made of any material. The key feature here is that you have to place real, physical objects on Beacon to make it produce sounds.

It was very important that the interface was to be simple and intuitive for any user, regardless of age or previous technical or musical experience. Since it is very difficult or even impossible to create an interface that everyone can interact with, we had to choose a method that is available to most people and that still offers a meaningful range of variables that can be changed by the user. Picking an object up and placing it on a surface is an action that most people have experience with and can perform to some extent. We decided that basing the interactivity on this relatively simple act was a good way to reach a wide group of users.

2. METHODS

Our method is based on practical situations in the lives of people with dementia. Since it is common that these people are often in a state of apathy or wandering back and forth we wanted to find a way to enable them to compose music, which has a reducing effect on anxiety [13]. This would in turn also engage them in a stimulating, creative activity.

The idea to take any physical object and make it produce a sound was something that we fell quickly for, and one of the first things that came to our minds was to use a visual sense to recognize the attributes of an object, a bit similar to the reacTable [6]. We could for example look at a fruit and get an approximation of it's size and color. And these attributes could then be translated to become parameters of synthesis or a selection of notes and recordings being played.

2.1 Design

Beacons physical form is a rectangular box where the top surface is somewhat transparent. By placing items of different colors and sizes and moving them around on this surface you control the software that in turn creates synthesized sounds or plays sampled sounds.

It was evident that a camera was required to capture images of the objects that would be translated into sounds, and that we needed to connect that camera to software that could perform the translation and generate the audio signals.

The first sketch (see figure 1) was quite different from how the actual prototype is designed. It consisted of a board where the user interaction would take place, and the camera suspended above the board at a distance that allowed the entire board to be captured in a frame. This would lead to the possibility of the user blocking the cameras view, and both the mobility and structural integrity would be reduced.

We then went for the current design, where the camera is placed on the bottom of a rectangular box, pointed upwards to capture objects placed on the transparent top surface, creating a “black box” which makes the camera less vulnerable to changes in the outside lighting conditions while also hiding the inner workings of Beacon from the user.

The tone of voice when interacting with people with dementia is certainly of importance, and gets more important as the clients dementia gets worse. Since the meaning of the words being said by the carer can be hard to understand by the client, the tone of voice gains importance. A soft and warm tone of voice produces positive results and can calm the client and relieve them from stress [4]. We wanted to apply the same philosophy to the sound design of Beacon to encourage the user to continue to play with it.

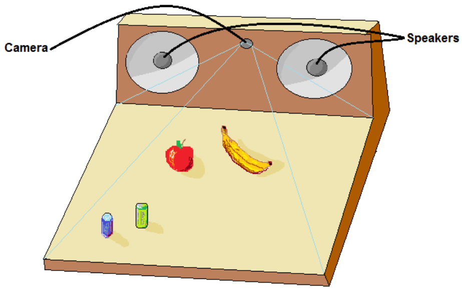

Figure 1. A first sketch of Beacon.

2.2 Hardware

Because of a tight budget, we needed to find a camera that was cheap but still offered a decent image quality. After some research we settled for the Logitech C170, and immediately removed the plastic casing to make it easier to work with. After some testing, we found that the camera would have to be positioned at a distance of about 30 centimeters from the transparent surface in order to capture it entirely while still keeping the size of the surface big enough to provide a meaningful interaction experience (30x20 cm).

We constructed a 312x224x312 mm box out of plywood with a sheet of plexiglass for the transparent top. We placed the camera in the center of the bottom, along with 8 white LEDs inside the box to provide good lighting. In order to control what the camera could see, we frosted the plexiglass with coarse sandpaper to diffuse objects that were not placed immediately on top of it.

2.3 Software

The initial idea was to implement the entire software in C++ using the open source library openFrameworks [10] for the low level functionality such as audio playback and camera input. The ofxOpenCv plugin [8] is used to capture the images from the camera and detect any objects by comparing each frame to a reference frame. After writing a crude but functional sketch using only C++ we decided to implement the synthesizer and sampler parts in a Pure Data-patch [11] and link everything together using the openFrameworks plugin ofxPd [9], which makes it possible to run Pure Data-patches within openFrameworks. Messages about the objects (x and y coordinates, RGB-values and area) on the surface of Beacon are sent to a Pure Data-patch where the messages are handled and a corresponding sound is put into a sequencer [7], or in the case of blue and green objects, a sound is played continuously. Pure Data was chosen because we all had previous experience with it and because it allows for very short development time, giving us more time to focus on the creative process rather than the technical challenges.

3. DISCUSSION

The goal with Beacon was to create a device that would encourage people with dementia to be active and express themselves musically through an easy to use and exciting interface.

Testing it has come to show that Beacon works best in an environment with as little ambient light as possible. As long as the surroundings are dark enough, the camera captures only what we want it to capture, creating an experience that behaves as intended. Placing Beacon in a dark space will also create an atmosphere that enhances the experience, when all the user sees is the area that is illuminated by Beacon itself.

In figure 2 below we see how the user can interact with Beacon. When the user puts a red object on the surface of Beacon, its representation in sound is a drum sound. We currently use samples from a drum machine of the brand Vox which has a nice warm sound.

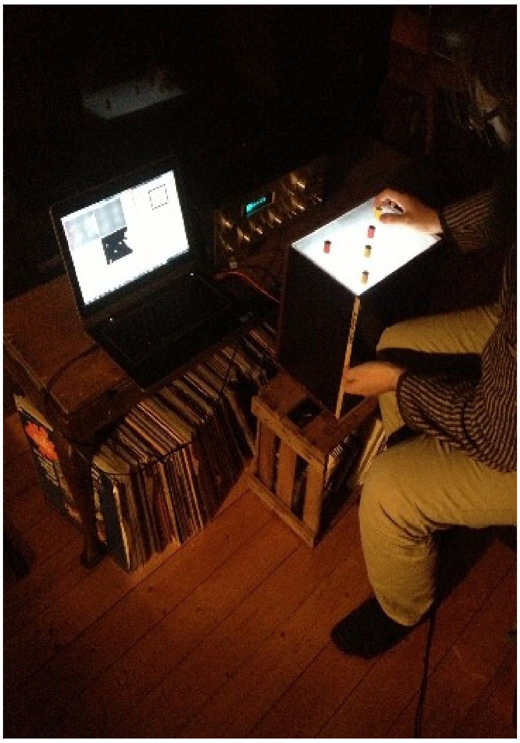

Figure 2. Beacon in action. The user programs/composes by placing items of different colors on the surface of Beacon.

A yellow object triggers a synthesizer made out of a couple of saw tooth oscillators and an envelope for amplitude and filter modulation resulting in an analog-like, warm synth sound.

A green object triggers a recorded ambient sound, and a blue object plays a sustained sound that is synthesized in real time for as long as the object remains on the surface. However, as soon as the outside light becomes too bright, Beacon starts behaving in a more chaotic way and it becomes unclear to the user how the interaction affects what is happening. This leaves us in a situation where we must choose between placing Beacon in a relatively dark room, which could possibly be uncomfortable for some users, or placing it in a well lit area where its behavior is difficult to control.

4. CONCLUSIONS

Beacon requires extensive testing with its intended user base, which will be performed at the memory clinic at Hässleholm hospital and documented in a future paper where its performance will be presented and evaluated. One of our goals was to make a simple interface that is intuitive and easy to understand, this is something we demonstrate in a video that is available online [3], where a musical piece is improvised. The physical appearance of Beacon invites the user to interact in some way with the glass, such as touching or placing objects on it, which triggers sounds. The act of musical composition is thereby spontaneously initiated, and encourages the user to continue playing.

5. FUTURE WORK

The prototype is currently connected via USB to a laptop computer which runs the software, which is not ideal from a user perspective. The ideal, finished version should have the software running on a single board-computer such as the Raspberry Pi [12] or Parallella [1], which could be mounted inside the box, requiring only outlets for power supply and audio output.

Shape recognition is something that we plan to implement in the finished version. We are currently processing each object as a rectangle which the object can fit inside, which severely limits the way an objects shape can be translated into sound. Using the information about an objects contour as a parameter for sound synthesis would allow for some very interesting possibilities. That could be used to recognize the shapes of the objects placed on Beacon and also their relative rotation. In this way a user could place a certain object on Beacon which would then respond with the corresponding sound.

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