DIGIWALL – AN AUDIO MOSTLY GAME

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Figure 1. *DigiWall prototype 1*

ABSTRACT

DigiWall is a hybrid between a climbing wall and a computer game. The climbing grips are equipped with touch sensors and lights. The interface has no computer screen. Instead sound and music are principle drivers of DigiWall interaction models. The gaming experience combines sound and music with physical movement and the sparse visuals of the climbing grips.

The DigiWall soundscape carries both verbal and non-verbal information. Verbal information includes instructions on how to play a game, scores, level numbers etc. Non-verbal information is about speed, position, direction, events etc.

Many different types of interaction models are possible: competitions, collaboration exercises and aesthetic experiences.

1. INTRODUCTION

DigiWall is a hybrid between a standard, artificial rock climbing wall and a computer game. The interface concept is based on three main components:

1. Custom designed climbing grips equipped with sensors that react to hands and feet, and light emitting diodes (LED's) to light the grip.
2. An eight channel sound system.
3. A computer system to which all the grips and the sound system are connected.

This large-scale tangible interface together with a sound system forms a highly physical computer game interface. We present here a report on a prototype climbing wall measuring 6m wide and 2.6m high and equipped with 144 climbing grips. DigiWall includes no ordinary computer monitor or TV screen, instead the climbing grips on the wall act as a very low-resolution, mono-chrome display. Feedback from the computer system comes through sound and music rather than through

visuals. When the user does not have to keep her eyes on a screen, she is free to move over the whole wall while remaining immersed in the gaming experience. Sound carries the game.

Climbing demands strength, body coordination and control, endurance and flexibility. DigiWall interaction models build on this idea adding to the joy of playing games the sense of presence and immersion sound is capable of creating.

Following are brief descriptions of several DigiWall interaction models existing today; some general observations about the function of sound and music in these models; and evaluation of the sound design in this context.

2. DIGIWALL INTERACTION MODELS

DigiWall interactions require the player/climber to respond to sound cues by touching grips or positioning themselves on the wall. Sound provides most of the necessary information to play a game. The existing interaction models can be divided into three categories – competitions, collaboration exercises and aesthetic experiences. The differences between these categories can be indistinct and a competition can be used as a collaboration exercise and vice versa. Five interaction models are described below.

In Catch The Grip the task is to collect as many lit climbing grips as possible in one minute. The game starts with a spoken short description of the task. One grip in the centre of the climbing wall is then illuminated and background music starts to play. When the player touches the illuminated grip, a new grip to catch is illuminated. The grips between the touched grip and the next grip to catch illuminate in rapid sequence. For each grip that illuminates, one note of a melody is played in sync with the light. This indicates, both audibly and visually the direction and distance to the new grip to catch. The musical intensity of the background is constantly increasing and after one minute it reaches a climax denoting the end of the one minute round.

Scrambled Eggs is a ten level game. “Eggs” denoted visually by illuminated grips and audibly by sound icons, start to fall from the top of the wall. The task is to save the falling eggs before they smash into the floor. Each level lasts for thirty seconds. Music signals the progression of time, a sound effect signals the end of a level, a speaking voice and new background music signals the beginning of the next level. Three smashed eggs on the same level ends the game.

In Memory the task is to find pairs of climbing grips that trigger the same sound. The grips with sounds attached are illuminated. When a pair is found, that sound is added to the background music. In this way, the player or players, step by step, build a song. When all the pairs are found a rewarding melody is played.

Follow My Leader is a two player game where player one creates a path of illuminated climbing grips on the wall and player two climbs the same path avoiding all dark grips. Climber one illuminates a grip by touching it and turns it off by touching it again. Player two must only use the illuminated grips and as soon as she touches a dark grip the game is over. Background music is used to indicate remaining time, sound icons are used to denote grip positions.

Pong is like the old TV console game. Each player has a virtual “paddle” with which to catch the ball. A paddle is defined by a straight line between the lowest grip the player is standing on and the highest grip she is holding on. The ball is denoted by lit grips. The speed of the ball depends on the length of the paddle it bounced on last. If the ball bounces on a short paddle, it gets a higher speed than if it bounces on a long paddle. Each time the ball bounces a sound is played. The speed of the ball is marked by the pitch of that sound, higher speed gives higher pitch. The first player to score five points wins.

Figure 2. *Two girls playing Catch The Grip*

3. DIGIWALL PLAYBACK SYSTEM

The DigiWall sound system consists of seven mid-high range loudspeakers and a sub-woofer. The sub-woofer is located behind the wall and the placement of the seven mid-high range speakers is shown in figure 3.

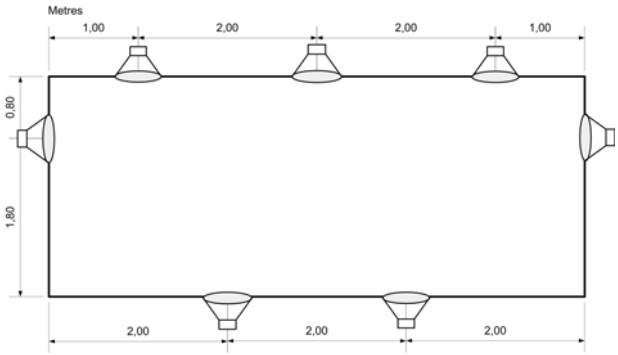

Figure 3. *Loudspeaker placement on DigiWall*

The sub-woofer was placed behind the wall for climber security reasons. This placement has proven functional from both safety and sonic perspectives. The low frequencies are transferred well to the climbers on the front side of the wall. The two lower loudspeakers are used for background sounds that do not carry information about position or direction. The five upper speakers are used to play all foreground sounds. This includes speaker voice-overs, sounds that carry horizontal position or direction information and general sound icons that do not carry position or direction information.

Since climbers can be positioned anywhere on the climbing wall, the sound designer can not assume the listener to be positioned in a "sweet spot". The aim is therefore to create a sense of if the sound is positioned to the left or the right on the wall. The sound system does not take climber position into account when positioning sounds.

4. FUNCTIONALITY OF DIGIWALL SOUNDS

In the DigiWall interaction models, most of the feedback to the user is based on sound and music. Illuminated climbing grips give visual cues, but these are reinforced by sound or complemented by game pertinent sound information. The perceptual and musical attributes of the sounds are integral to game design.

Sounds have specific functions in DigiWall games. Some sound functions link with the interface and some are connected to specific interaction designs. A number of these functions are similar across the interaction models. These generic functions include:

- Pre-recorded voice-overs giving basic instructions, scores, introducing new levels or stages in games.
- Music with increasing intensity/density signaling remaining time.
- Sound and music to create moods and atmospheres.
- Sounds signaling success or failure.
- Sounds signaling positions, speed and distances on the wall.
- Sounds marking events.

The speaker voice-overs are one to three sentence long (4 – 14 second) long instructions giving the basic premises for the chosen interaction model. Spoken word was chosen to give the users a sense of human presence and to shorten the time needed to understand and get started with the games.

Music with increasing intensity or density serves two purposes. It is used to denote time, especially time remaining of a level or round. This way the music acts as a sonic counterpart to the graphic progress bar. Music is also used to set moods and atmospheres of the different interaction models. This plays on various associative relationships that color our musical expectations such as knowledge of genre, convention or social semiotics that we bring to the experience of listening to music.

Tapping into similar associative processes, sounds are used to signal success or failure. Often a rising pitch signals success and a falling pitch signals failure. Timbre or category of sound may also convey pertinent success/failure associations, for example, through sound icons like applause or a sound resembling an electric shock.

Sounds are used to signal position, direction, distance and speed. Changing perceptual attributes of the sound communicate the desired information. Horizontal motion is indicated by changing volume balance between pairs of adjacent loudspeakers. Vertical position is harder to represent and is generally signaled through sound pitch. Direction is indicated by dynamic positioning of the sound following a moving target grip. Distance is signaled through number of notes played. When a target grip is moving over the climbing wall it generates notes. Each time the target moves from one grip to another, a new note is played. The number of notes played reflects the distance the target has moved. Speed is signaled in one of two ways: musical tempo or pitch. The tempo of notes played when a target grip moves over the wall, reflects the speed of the movement. The pitches of notes played can also reflect speed. Higher speed gives higher pitch.

Sounds are used to mark events, for example, when the virtual ball in the Pong game hits one of the virtual paddles or when an egg crashes to the floor in Scrambled Eggs.

The sound sources are a mix of pre-rendered audio-files and DLS-synthesizers. Audio-files are used when no interaction based control over the sound is needed and the sound can be fully rendered in advance. Sounds from DLS-synthesizers are used when fine tuned control is needed and the sound cannot be fully rendered before hand. Situations where audio files are used include voices and background music. Examples of DLS-synthesizer sounds include situations where a variable length melody is to be played to signal distance or speed, or when synchronizing individual notes with the "graphics" created by illuminating climbing grips.

5. DISCUSSION

In the DigiWall concept, sound is used to give both game play and climbing information as well as motivational or emotional feedback and guidance. The aim has been to create a musical soundscape. A guiding principle has been to make a soundscape that at the same time gives information and evokes emotions.

5.1. Game Play and Climbing Information

Since spoken instructions are played each time a new interaction model is chosen, it is necessary to balance interaction complexity with a means of communicating instructions that the player can follow. For the least complex interaction models, a one-sentence (four seconds) instruction played once before the game begins, has proven sufficient for the target groups. More complex interaction models demands more elaborated methods for conveying instructions. Different ways to split up instructions in several parts are being tested. For more complex interaction models, an initial instruction is given. The interaction model is then divided into two or more steps. Each step is introduced by a separate instruction. We are currently experimenting with ways to give the users possibilities to replay instructions if needed.

The absence of a computer screen with the possibilities it gives to convey textual information potentially limits the possible level of complexity a DigiWall game can have.

5.2. Motivational and Emotional Feedback

Background music acts like a sonic counterpart to the graphic progress bra. DigiWall interaction models are based on time durations, specifically a round, level or part lasts a certain amount of time. Changes in musical intensity and density are carriers of information about time. Intensity is changed by adding or removing musical instruments from the score and by playing softer or louder. Density is changed by altering the number of notes played per time unit. Both these parameters not only tell about time, but also have qualities that add to the drama, enhances game play and add to the musical variety.

Working with musical qualities like genre and instrumentation and changing intensity and density within these, a large variability is possible.

5.3. Sound positioning

It is sometimes said that the ear guides the eye. This idea is used in most of the interaction models to direct players' attention. Two methods for directing attention are used:

1. Positioning sound with volume balancing between pairs of adjacent loudspeakers.
2. Pitch shifting sound. Lower pitch means lower position on the climbing wall.

Sound positioning is problematic with moving users. To direct climbers horizontally, sound positioning by volume balanced between pairs of adjacent speakers is used. This gives the climbers a sense of left/right direction, but will not give an absolute position since climbers can be located at random positions on the wall.

The current loudspeaker placement around the perimeter of the climbing wall (figure 3) makes horizontal positioning of sounds by volume balancing troublesome and vertical positioning impossible. Instead vertical position is indicated through pitch in such a way that lower position on the wall results in lower pitch of the sound and higher position results in higher pitch. The height of the prototype wall is 2.6 metres and pitch is altered over a two octave span. This corresponds to approximately one half tone per 10 cm.

We are currently developing a new, scalable loudspeaker placement model based on loudspeakers placed in rows and columns. Both the number of rows and the number of columns of loudspeakers will be variable to allow for DigiWalls of different sizes. This new model will make sound positioning by volume balancing possible both horizontally and vertically.

In the interaction model Pong, pitch is used to indicate energy instead of vertical position. When the virtual ball of the game hits one of the virtual paddles, it is given a new level of energy depending on the length of the paddle. A long paddle gives the ball a low level of energy and a short paddle gives the ball a high level of energy. The energy is reflected in the speed of the ball across the wall and in the pitch of the sound of the bounce. Higher energy gives higher speed and higher sound pitch.

In Scrambled Eggs, musical tempo is used to signal the falling speed of the "eggs". Each time an egg falls from one grip to the next below, a note is played. Each egg has its own sound and the pitch of that sound indicates the current vertical position of the egg. The more egg sounds played per time unit, the higher the falling speed of the egg.

In the interaction model Catch The Grip, the length of a melody (number of notes) played corresponds to the distance between the last climbing grip to catch and the next. The horizontal direction is indicated by volume balancing. Together this indicates to the climber where to look for the next grip to catch.

To summarize the sound properties used to indicate position, speed, distances and time on the wall:

- Sound volume is used to indicate horizontal direction and position (left/right).
- Sound pitch is used to indicate vertical position on the wall, energy and speed.
- Musical tempo is used to indicate speed.
- Melody length or note count is used to denote distance.
- Musical intensity and density is used as a sounding counterpart to the graphic progress bar.

6. FUTURE WORK

As a gaming environment, DigiWall offers numerous opportunities for exploring the potential of sound as a principle driver in game play. Both the perceptual and associative attributes of sound present the possibility of relying solely or mostly on conveying game crucial information to the player. Developing the potential of functionality is central to our on going research and the focus of designing new interaction models. Several new interaction models are currently under development that are based on narratives where the sound design will incorporate classes of musical narrative functions, particularly those developed by Wingstedt [6]. Acknowledgements

7. ACKNOWLEDGEMENTS

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