Interaction in Digitally Augmented Opera

Raine Kajastila, Tapio Takala

Helsinki University of Technology, Department of Media Technology, P.O. box 5400, FI-02015 TKK, Espoo, Finland

Abstract — This paper reviews an experimental opera production, where digitally augmented content was used interactively during the performance. Projected graphics and spatialized sounds were designed to support the story. The animated 3D graphics acted as virtual stage, narrative element, or reflection of thoughts of a character. The special effects were partly under performers’ direct control, which allows natural timing and gives more freedom for artistic expression.

Index Terms — Virtual opera, interactive performance, 3D graphics, embodied interaction, Wii remote.

I. INTRODUCTION

Digital effects are widely used in movie production, with applications ranging from 3D models of staging and characters to postprocessing and sounds. Comparable use in real live theatrical performances, especially opera, has been rather scarce, although it would bring the additional dimension of real-time interaction on stage. Some notable examples are Reaney’s early experiments on stereographic 3D sets at University of Kansas [1], as well as audiovisual interactive narrative in the play It/I [2] and Tod Machover’s hyperinstruments in the Brain Opera at MIT. A sophisticated combination of projected stage and costumes accurately registered to the actor’s movement was done by Art+Com in the opera Jew of Malta [3].

At Helsinki University of Technology, we started working on digitally augmented opera in 2005, partly inspired by similar work in Stockholm [4]. Together with the Sibelius Academy, Department of Vocal Music, we first made a demo with computer graphics backgrounds to the students performances of classical arias. Some animation effects were added, controlled by MIDI signals from the accompanying Disclavier piano and also signal processing was used to virtually change the stage acoustics [5]. The study continued with a novel miniopera, specifically written and composed with digital staging in mind, performed at the SibaFest festival in February 2008. This article reviews the digital techniques and artistic considerations behind the performance shown in Fig. 1.

In traditional stage performance effects and performers actions are carefully timed by a technician, creating the illusion of interaction. In this opera we gave performers more freedom and studied if the performance can benefit from real interaction with the virtual stage. Thus, the stage is not just a static background, but a narrative element which the performers can control and interact with.

II. SYNOPSIS

The libretto of the opera is loosely based on Anton Chekhov’s novel Expensive Lessons, where a rich young man suffers from inability to speak French in the 17th century. Libretto was rewritten to reflect foreign policies of Putin’s Russia, where a young Mafia gangster lacks interpersonal skills, preventing him to master international crimes. The opera tells a story of two characters with different backgrounds. Vorotov is the juvenile son of a Mafioso, restricted to operate illicit business only in Moscow. Vorotov hires Alice to teach him interpersonal skills, but falls fatally in love with her.

The opera begins with musical and visual introduction to the theme of the opera. Russian flag, reflecting the inner turbulences of the nation, is shaped and molded by the musical performance.

Vorotov enters the stage and he observes a view of the surface, where illicitly traded goods move on the surface, being part of Vorotov’s business. Vorotov feels trapped in Moscow and spins the world to show his frustration.

Solution to Vorotov’s problem is near as the innocent teacher Alice enters the wealthy apartment. Alice sees riches fly past her in the corridor and is staggered about the wealth, which Vorotov shows off to her. Alice begins her lesson to stubborn Vorotov. Against to Alice’s teachings Vorotov gets carried away and among other
things bombs Georgia, cuts electricity from Europe, and fouls the Baltic sea with radioactive waist.

Alice receives her salary and first time in her life she can enjoy finer things in life. She enters the Opera, but in the middle of the performance she gets a call of nature. Embarrassed, she leaves to toilet, but ends up in an oppressive warehouse: a start point of human trafficking. Alice loses her clothes and is almost thrown into a van. Vorotov, in love with Alice, sees her and confesses his feelings. Desperate Alice throws herself to Vorotov’s arms.

Time goes past and Alice and Vorotov live together seemingly happy, excluding minor raids of Interpol agents. Alice suspects the true state of Vorotov’s business and lures him to write a memoir. The whole truth is revealed to Alice, who calls for help without succeeding. Alice frustrates and something changes in her.

Alice and Vorotov go to opera and they decide to slip secretly to the warehouse where they had previously met. Vorotov finds bombs taped to Alice’s waist and tries to escape. It is too late and the explosion blast them away. The opera ends as it started: in a metaphor of Russia, where the flag flies in nothingness without a purpose.

III. Digital effects of the performance

Writing of the libretto, composition of the music and virtual stage development started at the same time and were advanced in parallel. This way music could affect the story and virtual effects, and vice versa. The actual performance included a conductor, two percussionists, two pianists with grand pianos, and two singers playing the roles of Alice and Vorotov. Lights, virtual stage and subtitles gave work for three extra persons. Physical setting of the performance hall is depicted in Fig. 2.

A. Technical aspect

The virtual stage system was built using Pure Data [6] and its graphical extension GEM. Pure Data (PD) is a open source real-time graphical programming environment developed by Miller Puckette. PD contains many ready made tools that facilitate the creation of a virtual stage. The whole system was built to work on a single ordinary computer running Linux. Surround channels of the loudspeaker systems were directly controlled by PD and also the microphones were connected to PD.

Nintendo Wii remote control (Wiimote) was connected to PD, from which data of three acceleration sensors, buttons and IR-camera can be wirelessly acquired via Bluetooth. Further control logic was programmed using PD, allowing the control of the virtual stage. Wiimote was chosen because it is easy to use, an off the self product, and it fits to the story as a sceptre of power, which intermediates the might of Vorotov to the world.

B. Interactive effects

The opera performance consisted of several scenes that combined traditional and new interactive ways of control. Each scene had individual functions that could be controlled either from computer or by using Wiimote.

In the beginning the virtual earth shows the view of the world that Vorotov is controlling, stating the power of him and Russia. The illicitly traded goods were animated on the surface of the earth and also the movement of night was created. The visual interactions with the world were composed in to the music before any work on them had been done. This created a challenge to realize them as they were planned. For example the sounds imitating a light switch were written in musical score where Vorotov cuts electricity from the Europe.

The world could be spun with Wiimote, giving it more speed with hand gesture or more precisely rotating it with arrow buttons. Wiimote buttons could be used for zooming and also triggering animated effects, such as throwing an oil barrel to earth shown in Fig 3. The use of Wiimote had to be developed robust against errors, since in this scene the performers were arguing over the Wiimote. For example button combinations were used to trigger effects.

Other main visual concept was a 3 dimensional octagon (more precisely rhombicuboctahedron), which could hold different images on it's 18 faces. The textures could be changed to the each side of the octagon generating a platform that was used in several scenes of the opera. In the story the octagon can be seen to have many metaphors. It's development begun from an idea of a traditional rotating theater stage which is used to change the scene in the opera. The random spinning of the octagon can be also seen as reminiscent of a Russian roulette or wheel of fortune. The metaphor of roulette is made stronger by using audio effect of wheel clicks and spinning revolver cylinder. Vorotov can be seen to spin the octagon to show off the wealth placed outside of the octagon. He is in control of the world and the octagon behaves as he wants. On the other hand the female character Alice is imprisoned inside the octagon and subjected to inhumane treatment by the persons controlling the octagon.
Control of the roulette was handled with the Wiimote. First a way to spin the roulette to any direction of acceleration was developed, but more useful for the performers was using only horizontal and vertical spinning. The speed of the gesture was analyzed using the acceleration sensors of the Wiimote, and the octagon was spun accordingly giving it a certain speed and random stop position. Inside the octagon the spinning was made more arbitrary by using the pitch and roll of the Wiimote.

C. Virtual stage

The interaction with the performers is only one reason of using technology. The opera performance contained various scenes that worked as narrative element, visualized the environment or revealed the thoughts of the characters, as depicted in Fig 3. This way complex interpretations of the story could be presented to the audience. The visual expression was also linked to musical interpretation.

In the scene where Alice enters to the opera, the music of performance starts with traditional opera which fades to contemporary sounds. As Alice sings: I know of nothing more beautiful than intertwining musical notes. But why must they part, cross, and gnaw at each other like two enemies? The visual scenery starts with rock-solid figures of mountains which slowly fades to rain of secretory products of a human.

A good example of narrative use of the visual background is the scene where Alice incites Vorotov to write his memoir. In the scene the whole truth is revealed to Alice, who then tries to call for help without succeeding. The spinning and translucent roulette shows Vorotov’s life as he sees it: golden statues of a great Vorotov. Meanwhile Vorotov concentrates on telling his story, Alice tries to contact interpol through their web page. Alice writes with keyboard and the Interpol pages are seen to pop up when roulette stops spinning.

One of the scenes begins with especially static background, which is reminiscent of a wallpaper. Among other thing, the scene can be seen as an adaptation of A Doll's House, play by Henrik Ibsen, where 19th century marriage norms are criticized and at the first part of the play everything seems externally to be fine. The static background is slowly zoomed out revealing the truth that the wallpaper is actually a garden of cannabis plants. The political state of Russia, the marriage of Alice and Vorotov and the condition of the cannabis garden is seen to deteriorate as Pacman like radioactive symbols eat holes to the plants and turn them unhealthy brown.

Towards to the end of the opera the roulette is seen from inside, combining the images of wealth and oppressive pictures. The words of Alice and Vorotov have joined and they both are in captivity. Vorotov finds bombs taped to Alice’s waist and and tries to escape. He is not in control anymore and roulette explodes in the final spin revealing slowly changing, familiar but shattered images reminding of their lives and the opera performance.

The Finnish and English subtitles created with PD were projected to screen for the convenience of the audience.

D. Sound effects

In the first scene the Russian flag was molded by the music recorded by a roof microphone. The music was analyzed and the transients generated the fluctuating bubbling of the flag using a physical wave propagation model, see Fig 4.

The sound reproduction system was used to modify the acoustics of the performance hall. The goal was to create enhanced acoustics for each scene, supporting the narration and creating entity with instrumental music. The enhanced acoustics of each scene were experimented with the composer, and predefined settings were used during the performance. The reverberation was changed on the location or mood of the story and in some places it creates a dialog between instruments and sound production system. A time-variant reverberation enhancement system [6] implemented with feedback delay network was

![Fig. 4. Screenshots from the opera performance.]()
used to modify reverberation in the hall, allowing higher gains without causing instability of the system.

The effect of spinning sound around audience was used with the roulette. The illusion of spinning sound around the audience was created by playing clicks in only one 5.1 loudspeaker group at a time. The sound spun to the direction defined by the visual octagon. Original idea was to use VBAP [7] to control the exact position of the sound. This was tested in research facility, but the loudspeaker system in the performance hall did not allow separate control for surround speakers.

IV. DISCUSSION

Technology can also bring new problems. In this opera the performers were in control of the virtual stage. The use of technology can raise the mental load of the performers, since they have to concentrate on new things. More rehearsal time would have been needed for the performers to get acquainted better to the technology. The rehearsal time was limited to about 45 hours, and technology was not present in all rehearsals. In ideal situation technology adopts to the performers need and not vice versa.

The functions of the Wiimote were discussed with the performers during the rehearsals. The first rehearsals revealed that the gestures and button combinations should be as simple as possible. The time allotted to the rehearsals defined which actions performers had time to adopt and which were controlled from a computer. The performers did not want too much responsibility, being afraid of making mistakes. Bigger changes in the virtual stage, such as changing of the scene, were controlled with a computer.

The use of smaller sensors than Wiimote could be more useful. In this opera production the performers complained that in some scenes with a lot of action, the Wiimote was inconvenient. Optimal solution would be to integrate acceleration sensors and buttons to the performer's sleeve, where they seamlessly integrate to the clothing. This way the hands of the performer are free for expression, but their motion can still be accurately tracked.

The use of virtual stage gave more freedom when choosing the set for each scene. Also changing the time and location of the story could be made instantly. Since very few physical sets were used, the actual building of the opera became fast. The virtual sets could be designed on one computer without physically being at the performance location. Also the future portability of the opera is easier, because the whole stage can be carried inside a computer.

V. CONCLUSIONS

This paper reviewed an opera production where performers controlled digitally augmented audiovisual effects interactively during the performance. The use of large scale digital effect in opera is still rare and the problems of embedding the technology as part of the performance was studied. Two small opera productions have already given us insight to the use of technology in opera art, and this knowledge will be used in the next larger ongoing opera production. The effects for this opera were designed in tight cooperation with director and composer allowing fruitful exchange of ideas. The digital effects were primarily based on artistic views which the technology faithfully served.

ACKNOWLEDGMENT

The production was made in collaboration between Helsinki University of Technology, Helsinki Institute for Information Technology, The Theater Academy, and Sibelius Academy. The virtual opera technology was done as part of CALLAS project (IST-034800) funded by EU. Line up: Inkariina Simola (libretto, direction, lights), Ville Raasakka (composition), Raine Kajastila (virtual stage and sound design), Nazanin Aghakhani (conductor), Eija Mizohata (costumes), Ann-Marie Heino (Alice), Waltteri Torikka (Vorotov), Emil Holmström (piano), Risto-Matti Marin (piano), Ville Syrjälläinen (percussions), Jussi Markkanen (percussions).

REFERENCES