



sonus paper

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1. *sonus:portals*

1. Story

You and your competitors are trapped in the dark between space and time. The only way to get home is to be the first. Your journey leads through unknown dimensions where you experience new forms of sound and touch. Left with no sight at all, your only help is your electronic emergency device. Reach the dimension portals by locating their unique sound and feel the force fields to avoid them.

2. Game

sonus:portals is an innovative game that relies on a haptic controller as the only input device. With the help of three-dimensional audio and the haptic feedback it is possible to navigate through levels without seeing anything! Throughout five different levels you have to learn to solely rely on your hearing and sense of touch. Your objective is to access the portal of each level in order to reach the next dimension. The organically shaped levels can be imagined as labyrinths with obstacles in place. In order to pass you will have to "feel" them with the help of the haptics-enabled controller. The dimension portals themselves are sending out three dimensional soundtracks which are unique for each dimension. You will hear a base of instruments no matter where you are but the closer you get to a portal the more instruments you will hear it sending out. The five tracks in the game exclusively have been produced and set up for *sonus:portals*. It is also possible to play *sonus:portals* with other people. The game supports an unlimited amount of players that can take part in one round where the goal is to reach the portal first. Which makes it kind of a race.

3. How to play

When you start the game you will hear a base soundtrack. This is the ambient sound which you will hear no matter where you are. The goal is to locate the portal specific sound and navigate to the portal. With your haptic device you are able to move your player. The further you push the controller to the front the faster you will move. The same is for walking sideways (strafing). As soon as you are moving you will feel a haptic feedback from your controller representing your walking movement. To rotate use the left and/or the right button.

In the beginning it may be helpful to rotate around a few times to extract the portal sound out of the soundtrack. If an obstacle is in your way you will recognize it by two circumstances: There will be no haptic feedback for walking since you are not moving and you will feel the texture and the direction of the obstacle. You may push against the obstacle and slide along it causing you to feel the texture as you are moving.

If you reach a dimension portal you will feel a strong vibration of your haptic controller and hear a warping sound indicating that you have reached the dimension portal. As soon as you hear a new soundtrack you have reached the next level and are ready to play.

2. Technology

1. Novint Falcon

Novint Technologies, Inc. has released an innovative input device, the *Falcon*. It features three-dimensional control (x, y, and z-axis) - a form of control only achieved in games by combining the mouse (x- and y-axis) and the keyboard (z-axis). The grip is best described as a sphere with several buttons for input actions. Furthermore, the *Falcon* is capable of transmitting haptics - making virtual objects and obstacles become tangible. You can find more information on the *Falcon* on Novint's website: www.novint.com

2. OpenAL & EAX

Spatial audio is substantial for orientation in *sonus:portals*. The sound processing and generation is optimized to make use of state-of-the-art game audio standards like OpenAL combined with effects from EAX Advanced HD 5.0 to give you the best three-dimensional audio experience possible.

In order to get to know the true promise spatial audio in *sonus:portals* it should be played with an EAX-enabled soundcard and headphones or a surround speaker setup.

Note that the actual usage of effects and features should be considered as Beta. There are still many things that are not yet integrated (e. g. Occlusion and Obstruction Effects) and things that should be optimized.

3. Architecture

1. Software Architecture

The software itself is built on a kind of blackboard architecture. The level, containing the world in different versions and the player, is the global object which is passed around to each module. There are two different types of modules: read-only and read-and-write modules. Read-only modules read the new data out of the level every step and writing modules can alter the level and player data. Since every module works within its own workspace the level data is transformed and scaled for each module. Current existing modules are: Physics, Graphics, Haptics, Sound & Replay. The global class Application combines all modules and provides a simple menu. For detailed information refer to the API Documentation (built with doxygen).

2. External Libraries

Box2D

For physics we chose the Box2D physics engine by Erin Catto. First we thought about using a 3D physics engine but then we came to the conclusion that our levels are nothing more than 2D labyrinths. We chose this engine because it has a good performance and fits our needs. Used in the Physics module.

Irrlicht

For graphics we make use of the Irrlicht Engine. We chose Irrlicht because it is relatively small and easy to use. It is also responsible for the window

management and keyboard event listening. Used in the Graphics module and for input event processing.

Novint SDK

Since we were sponsored by Novint with four Falcons we chose to use the Novint SDK. Used in the Haptics module.

OpenAL

OpenAL delivers the standards and functionality we needed for three dimensional sound. Used in the Sound module.

TinyXML

We chose to use TinyXML for XML parsing because it is small and easy to use. Used in the SvgLoader module.

4. Development

1. General information

We would like other developers to profit from the work we have done in order to realize *sonus:portals*. What we can offer you is the infrastructure the game is based on. It is not yet a framework but we gave our best in documenting the source code and writing manuals.

Please make sure to meet the system requirements and to read our instructions carefully in order to set everything up right.

2. System Requirements

1. Hardware (you should be able to play *sonus:portals* on lower specs)

- a haptic device supporting the HDAL API (e.g. Novint *Falcon*)
- EAX-enabled Soundcard (Hardware EAX support and atleast 32 voices)
- Closed stereo headphones or a surround speaker setup (>4.1)

- 1.0 GHz Processor
- a graphics card with native DirectX 9.0c support and atleast 128MB
- a minimum of 512 MB RAM

2. Software

- Windows system (XP with SP2 or Vista – 32 and 64bit supported)
- Microsoft Visual Studio 2008 for development

3. „Step by Step“-Installation

- 1.** Download the source from our homepage <http://www.sonus-game.com>
- 2.** Download and install all external used libraries:
Box2D, Irrlicht, Novint SDK, OpenAL and *TinyXML*
- 3.** Add following system variables:
OPENAL_HOME = Directory of OpenAL
BOX2D_HOME = Directory of Box2D
IRRLICHT_HOME = Directory of Irrlicht

`TINYXML_HOME` = Directory of TinyXML

4. Make sure the system variable `NOVINT_DEVICE_SUPPORT` is pointing to the Novint SDK directory
5. Open the *sonus* project with MSVS2008

4. Documentation

For detailed information refer to the API Documentation (built with doxygen).

5. Contact & Support

Please visit our website <http://www.sonus-game.com> for detailed information on contact, support and bug report.

5. Former university project

1. Starting

The idea of developing a game that relies just on audio and haptics has been worked out in 2007 in preparation for the so called project semester that is part of the study course *Multimedia* at the University of Applied Sciences Augsburg. It took place from October 2007 until January 2008.

The main intention was to create a game that could be played by blind as well as seeing people and to make use of the new low-budget haptics controller, the *Falcon*, that we knew was to be released in summer 2007.

2. Team

The team consisted of eight *Multimedia* students that joined up the project because they were convinced that they could form a real project out of the starting idea. Half the team aimed to work on the project as "designers". The other halves work concentrated more on technical aspects like programming and developing.

Our team was supervised by Prof. Dr. Thomas Rist (Faculty of Computer Science) and Tobias Grewenig (Faculty of Design).

People that took part in the project were:

Raphael Estrada

Responsible for physics programming as well as SVG file import and level processing. Significantly involved in conceptual design, game design and the testing workshops.

Claudia Kobielski

Member of the design team, sponsoring.

Alexander Lawrence

As the lead programmer he overviews the team and coordinates the specific fields. His main tasks are programming graphics and haptics.

Roland Lösslein

Responsible for sound design and producing. Also involved in conceptual

design in several areas and game design.

Martin Möhwald

Accountable for the 3D audio and music programming. Furthermore involved in conceptual design as well as game design.

Simone Pötsch

Contact person for testers. Organized and carried-out the test workshops. Trailer production, general and conceptual design.

Florian Rieder

Responsible for the websites technical aspects such as the CMS. Member of the design team.

Michael Titze

Head of organisation. Assigned leader of the design team. Print and Animation

3. Sponsors

We found the first and really important sponsor for the project in Novint, who sent us four of their Falcons to make use of them in our project. The second sponsor was the PSD Bank. They helped us to finance the stand and to buy some equipment for our final project presentation. Last but not least we were of course supported by our University and their associates.

4. Conception

Since no one of us had experience in game design or such we did a research for about one month testing and reviewing different games (not only computer games). After we had collected good examples for each genre we took the main aspects we thought that were responsible for fun, excitement and short and long time interest.

Our results showed that the most successful games often had a concept being simple to understand but getting more complex the longer or the further you played the game. We also noticed that remakes and reinterpretations of simple and proven concepts were a good base for a successful game.

We decided to work on two different concepts:

The first one was a more or less abstract variant of sound rhythm games like *Guitar Hero* where the player uses the haptic device as an instrument to play different notes in three dimensional space and is able to create individual sound patterns. The second one was a labyrinth where the exit emits a sound and the player is able to navigate through the labyrinth and feel obstacles with the haptic device.

5. Workshops

We knew that making a game that would not make use of any visualization would need testing and proof. The fact that we were aiming for a game that could be played by visually impaired underlined just that.

We built prototypes and created questionnaires for each concept to test them on different people. At the end we wanted to decide which concept was the better one based on the results of the workshops.

First we asked common questions about computers and gaming. Then we let the participants play the prototypes. After each group of prototypes we asked them concept specific questions. Finally we wanted to know which concept was the better one in their opinion and what improvements they could think of.

We filmed the participants with two cameras, one filming their face to see their facial expressions in order to detect emotional change and the other one filming their hands controlling the haptic device. Besides that we captured the whole graphics output from the prototypes.

Overall we tested both concepts with eight participants, five of them visually impaired.

6. Results

In the end we compared the questionnaires and wanted to create a graph indicating fun and excitement. The questions could pretty easily be translated into numbers while measuring emotions turned out to be quite difficult. We developed a system where we measured excitement and success. The possible values were -2, -1, 0, 1, 2 where the success graph only allowed the values -1 (no success) and 1 (full success).

With the results and a lot of research in the beginning we had gathered enough knowledge and experience to decide which concept we wanted to realize:

A game based on the simple and fun proven concept of a labyrinth in combination with traces of a sound rhythm game.

The most important fact why we chose the labyrinth was that the player had one specific goal in the game to reach. The task to find the exit caused excitement in the search and fun in the achievement. The workshops also showed us some other important problems we solved as followed:

Problem:

Corners and dead ends are fun killers for a labyrinth game where you do not see anything.

Solution:

All of our levels are organically shaped and do not have any dead ends.

Problem:

Having only one specific sound coming from the portal is rather annoying.

Solution:

We produced complete soundtracks for each level. The closer the player gets to the portal the more instruments he or she will hear. In addition this was a huge step into the direction of a sound rhythm game. The player now would be able to interactively change the music.

Problem

If you do not see anything you cannot decide whether the haptic device's workspace is at its limits or you have a virtual obstacle in front of you.

Solution

We gave the virtual obstacles a texture which differs clearly from just blocking the movement of the device. At this point we also realised that it is crucial that the player must not be in need of seeing anything even if he or she is not visually impaired. It is important to close your eyes while concentrating on your sense of touch. The effectiveness can be up to ten times higher than with opened eyes.

In order to complete the concept we developed a short but interesting story. See chapter „story“ for details.

7. Realisation of *sonus:portals*

After the workshops and their analysis was over we had our final game idea, a "rhythmic" labyrinth. We could now concentrate on the game-specific research. We had to decide on a variety of things in order to shape a realizable concept out of the idea. With the suggestions we gathered and the problems pointed out in the workshops in mind we made decisions on important game play aspects: Level size and shape, the sound atmosphere and range models as well as fun elements and many other things. Also the concepts for navigation and orientation had to be strongly improved. But we realized that this could not be worked out in theory only. We had to do another variety of prototypes to find the most suitable principles that were also as intuitive as possible.

In the meantime we also had to settle for a project and game title and get the product design done (although it was never planned as a commercial product our claim was to prepare it as a fictional one for the final presentation). We had a wide-spread variety of suggested names but decided for one of the simplest, *sonus*, which is latin for "tone" or just "sound". We found it suitable because that was just what the game concept was mainly based on. The reason we renamed *sonus* to *sonus:portals* lately can be read in the chapter about the future of the project later on.

When we began with the serious development of the game we had just about five weeks left. With three developers we started what was first planned as a framework. Before the project semester began we already worked out a concept that was about developing a framework that would help people in making games with haptic controllers and a collection of physics, sound and graphics modules. But that turned out to be not realistic enough in terms of time and overall team competence. So we settled for "just" realizing a game. The main parts were done in these five weeks. Documentation and a code revision in some parts were done the weeks and months after the project had already ended. The exact structure of modules and the functional principles can be read in the "Architecture" chapters. Finally we should not forget to mention the aspects of sound production which results led to a rich and enjoyable game experience. We wanted the sound to have a touch of fast electronic beats to provoke the players movement in favour of more adrenalin dischargement. The tracks for *sonus:portals* were all produced by one person, Roland Löblein. A semi-professional music enthusiast who put all his experience in music creation and production together to create the wonderful and exciting ambient tracks that make a whole lot of the game.

8. Preparation for the fmx/08

When we first heard we were in for the fmx/08 we were very excited. Soon we knew we had quite a few things to do until then: write this paper, make cards, design printed game information and leaflets, make a concept for our stand and realize it and work on the software itself.

In the beginning we planned to use four game stations at the fmx. We soon came to the conclusion that we would not need four stations and decided to make a stand with only two game and one replay station. We were sure this only would have advantages. On the one hand it would not look as if we had exaggerated expectations and on the other hand we managed to have a lot of people staying at our stand since they had a little waiting time.

The last time we used *sonus:portals* was at the final project presentation and so we had to do quite some work in development. First of all we eliminated bugs and errors and after that we implemented replays and made it possible to replay games over the network.

Martin Möhwald and Alexander Lawrence worked quite a lot on the software while Roland Lösslein did all the conception and layout for the printed material as well as motion graphics which turned out to be very helpful and attractive as visual aids and giveaways.

9. Cleanup and documentation

After a successful time at the fmx/08 we came home with about 200 questionnaires and a few new contacts. Since everyone had to do lots of other stuff we did not develop further on *sonus*.

In August we decided to bring the project to a final status. We implemented an application structure with a menu to manage replays and the game itself, processed the questionnaire data and documented the whole code.

6. Exhibition

1. 28th of January 2008: Final project presentation ("Multimedia Presentation" – Abraxas, Augsburg)

On the 28th of January 2008 we finalized the project with a presentation and conclusion of the work we did in the project semester. With three other projects that were made by fellow students we were able to book the Abraxas Augsburg for one day to organize the showcase and to make our projects finally available to the public. With the help of our sponsors we realized a stand for *sonus:portals* where the 400 attendants could get information about the project and even play the game. The formal presentation was performed by one of our project leaders, Alexander Lawrence and Raphael Estrada, both members of the development team. The whole presentation and especially our project gained much respect and appreciation and was widely recognized by attendants as well as local radio stations and newspapers.

2. 5th/6th of April 2008: Munich Gaming 2008

With *Munich Gaming* being the first real gaming event in Munich we got the

chance to present *sonus:portals* there. At the 5th and 6th of April 2008 we had a separate place with one station to play at the desk of MedienCampus Bayern e.V. The special thing about this event was the fact that these two days had the purpose of introducing games to non-gamers, parents and a lot of other interested people. To our surprise nearly every visitor could identify with the game as it is not the typical gamer you would expect. The fact that you do not sit in front of a computer display and do not need a mouse and a keyboard is a great possibility to show the people that gaming can be more than that. Overall the visitors were excited by the game and everyone who played *sonus:portals* reached at least one portal.
<http://munich-gaming.com/>

3. May 05–08 2008: fmx/08 artek

In February we had been invited to [fmx/artek](#), a newly created slot at *fmx* for experimental developments with an artistic touch. The *fmx* is a very well known digital media conference for 2d/3d animation, visual effects and games in Stuttgart, taking place every year since 2000. From the 5th of May through the 8th we had a self-made stand right at the entrance area of the "Haus der Wirtschaft" where all *artek* projects were exhibited.

Our stand mainly consisted of two playing stations equipped with haptic devices and headphones and one 37" LCD screen where we presented a newly created how-to-play tutorial and replays. As we experienced at various exhibitions (like *Girls Day*, a small event at the University itself, or *Munich Gaming*) one important and very interesting thing for the players was to watch how they did after they finished or aborted the game. So we integrated a mechanism to replay the movement of the players if they wanted to see it exclusively for the show at *fmx/artek*. Unfortunately we did not have the time to implement live play over network but there were very few requests for it.

We were well prepared with a lot of information material like flyers, concepts and even business cards. But the most important thing were our questionnaires. Although packed with many questions (we had tough times making it fit on A4 sheets) we were very surprised to see that nearly every player took the time and answered everything meticulously. We now have a pack of about 200 questionnaires and replays to be analyzed. The summary will help us to improve the game play of *sonus:portals* and future episodes. The feedback we got was overwhelmingly positive and rich in requests. We also gave different interviews and are looking forward to be mentioned in some journals and online magazines soon. We will publish the links in the news section.

It was a great pleasure and honour to be there. All of us who had been at *fmx* enjoyed it and gained lots of experience.

Definitely looking forward to [fmx/09!](#)

7. Last development team

When the project semester was over four of us decided to go on developing *sonus*. The development slowed down after the *fmx/08* which was of great success for us. At the moment and in the future it is more likely that we are working on other projects but we would be very happy to see someone using or extending *sonus*. The development team consists of:

Alexander Lawrence

Developer for Haptics and Graphics
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Martin Möhwald

Game Designer and Developer for Audio
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Raphael Estrada

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Roland Lösslein

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