Simulering av ljudvågor med tillämpning inom datorspel

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Dagens datorspel erbjuder inte sällan en hög nivå av realism. En viktig källa till detta är att simuleringen av grafiken har förbättras enormt sedan introduktionen av 3D grafikacceleratorer, eller GPU (Graphical Processing Unit). En stor utmaning för framtida generationer av datorspel är att simulera realistisk ljudutbredning i realtid. Målet med detta projekt är att uppnå en ljudsimulering som är både beräkningsmässigt effektiv och ger en ökad upplevd realism. Metoden går ut på att adaptivt approximera en given geometri i rektanglar, varefter den akustiska vågekvationen löses i dessa med en effektiv spektral metod. Metoden lämpar sig väl för implementering på en grafikprocessor där sådana metoder har en hög effektivitet. Tiden för att hantera ljudsimuleringen kan på så sätt reduceras väsentligt. I metoden så är rektanglarnas kanter randvillkor till vågekvationen, vilket ställer krav på realistiska beteenden såsom reflektion och absorption. Metoden testas genom ett flertal numeriska experiment. Dels ett absorptionsexperiment där vågens energi betraktas. Det fysikaliskt korrekta sambandet att energin är proportionell mot amplituden i kvadrat observeras. I två andra numeriska experiment i 2D genomförs simuleringar som illustrerar diffraktion och dopplereffekt. Diffraktion är ett frekvensberoende fenomen som beskriver huruvida ett ljud fortplantar sig runt hörn. Dopplereffekten, som är en förskjutning i tonhöjden hos ljudet, uppstår när ljudkälla och mottagare rör sig i förhållande mot varandra.
En diskussion med exempel följer om de begränsningar som finns med att simulera ljud med den linjära akustiska vågekvationen. Även de absorberande randvillkorens fysikaliska riktighet i 2D tas upp i diskussionen. I verkligheten sker reflektion och absorption vid alla infallsvinklar. De absorberande randvillkoren i modellen simulerar absorption väldigt bra vid normal infallsvinkel men ju längre man avviker från detta desto sämre blir simuleringen. Vissa materials dispersion är frekvensberoende och detta beroende kommer påverka absorption av ljud.

Timescales for diffusion in the cytoplasm

By

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Supervisor was Michael Hanke

Abstract

In experiments carried out by a group at *Karolinska Institutet* in Stockholm, the diffusion process of carcinogenic substrates in mammalian cells has been studied. The purpose of this paper is to understand and approximate the timescales of this diffusion process in small compartments of the cytoplasm in these cells. This was carried out by calculating the eigenvalues of a corresponding diffusion equation with physical parameters describing the biological experiment. The largest time scale of diffusion through one membrane layer in the cytoplasm turned out to be approximately 10 μs, which is also a measurement of the time it takes for the system to reach equilibrium. Transfer Conditions imposed at inner boundaries between membranes makes it difficult to solve the problem with a standard method, such as the finite difference or finite element method. However, using the so-called Prüfer Transform, a mathematical transform based on a change of variables in the phase-plane, it is possible to solve the problem using only a standard solver for initial value problems with high reliability. The general approach of this project has been to implement the Prüfer Transform in MATLAB and test it on several eigenvalue problems with known solutions, in order to have a reliable computational tool before solving the biological problem. Furthermore, a method designed to solve any one-dimensional time-dependent transfer problem is presented, including a simple algorithm to compute Fourier Coefficients.

Probabilistic Tracking of Multiple Rodent Whiskers in Monocular Video Sequences

Jim Holmström Emil Lundberg

April 2012

Bachelor's Thesis at CSC, KTH
Supervisor: Örjan Ekeberg

Abstract

The interest in studying rodent whiskers has recently seen a significant increase, particularly in the field of neurophysiology. As a result, there is a need for automatic tracking of whisker movements. Currently available commercial solutions either are extremely expensive, restrict the experiment setup, or fail when whiskers cross or overlap. A cheap, reliable solution to the tracking problem is needed.

This thesis proposes a proof-of-concept implementation of a probabilistic tracking system. This solution uses a technique known as the *Particle Filter* to propagate a whisker model between frames of high speed video. In each frame, the next state of the model is predicted by searching a pre-trained database, and filtering the results through the Particle Filter. The implementation is written in Python using NumPy and an SQLite3 database.

There are two main strengths of the proposed solution. First, it successfully tracks multiple whiskers at once, even when they cross or overlap. Second, being a standalone program operating on pre-recorded video, it does not notably restrict the experiment.

Abstract

Group Members

Johan Torell, Joakim Jalap.

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Description

In this project an interface was constructed so as to let the Learner Based Testing Framework developed by Meinke and Sindhu connect to and communicate with an actual, separate, system. Also two different user interfaces were written, one graphical and one commandline deriven. To achieve this the original code was modified and several new components were added. The new framework was created using the MVC model. The report begins with a brief survey of the field of study, to introduce the preliminaries needed to understand the report. A case study was made to demonstrate the correctness of the model, and to provide a short demonstration of how to use the framework. Future implementations of this framework were also discussed.

Evolutionära algoritmer tillämpat på tetris

Christopher Nagy, Jesper Lundin, Sam Lööf

Sammanfattning

Många beräkningsproblem har en stor sökrymd. När ett beräkningsproblem är så komplext att en genomsökning av hela sökrymden inte är rimlig krävs approximativa sökmetoder. En grupp av approximativa sökmetoder är evolutionära algoritmer (EA) som immiterar de urvalsprocesser och mekanismer som sker i evolutionen i naturen. Syftet med detta examensarbete är att undersöka evolutionära algoritmer och demonstrera hur de kan användas, vilket görs genom att med EA utveckla och optimera en tetrisspelande algoritm. Rapporten börjar en med övergripande teoridel och därefter följer en detaljerad beskrivning av den evolutionära algoritm som implementerades.

KEX

High Frequency Waves in a Confined Circular Domain with Diffuse Reflection

Kandidatexamensarbete, SA104X, Spring 2012
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Abstract

When a source of energy in a convex domain radiates, the energy will reach the domain's boundary, and reflect. Models for specular and diffuse reflections in such domains were implemented and tested in Matlab®. Further, to increase the resolution of our results, parallel programming was implemented for efficiency.

The reflections were modelled with a ray tracing method, where the energy from the source is accumulated along the boundary of the domain and then used to create an energy map of the domain's interior part. Different cases were evaluated by varying source, discretization, and diffusion parameters. These tests were in large part performed on the high performance computer *Ferlin* at the *Royal Institute of Technology*, Stockholm.

In the end of the present thesis, post-processings of energy maps and their convergence rates for various cases are presented. Similarities and differences between specular and diffuse reflection are discussed. For future expansion, the programs written are suitable for calculations in any 2D convex domain.