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ERCIM NEWS

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Special theme:

Computational Science/Scientific Computing

Simulation & Modelling for Research and Industry

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by Kostas Glinos

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Future Research Challenges in Software Evolution and Maintenance – Report from EC Expert Meeting

R&D and Technology Transfer:
IT Security: Risk-Based Prediction Tool and Method for Critical Infrastructures

only valid during trajectories of given lengths, which may be very short.

Our work in the Nonlinear Dynamics, Chaos and Complex Systems Group at the Universidad Rey Juan Carlos (URJC) in Madrid, is focused on analysing and plotting predictability charts for certain models. We get the shadowing times by computing the finite time Lyapunov exponent distributions. Each computational run is based on the integration of one initial condition with a well-known Runge-Kutta-Fehlberg integrator scheme. As the integration progresses, the distribution is calculated and the instability and hyperbolicity indexes are derived. This is repeated for several conditions and parameters, thus returning a complete description about the predictability of the used model.

Note that this strategy is very well suited for high-throughput (Grid) numerical schemas. A set of shell scripts feeds the integrator with the proper initial conditions and a grid engine (in our case, GridWay) and submits the process to the proper cluster in a user transparent way.

These techniques are general enough to be applied to different models with minor modifications. Our work focuses on galactic modelling, where the applied timescales are critical. Mathematically meaningful timescales cannot be physically acceptable here. A particle being shadowed during only a few crossing times (cycles) is a critical issue. Galaxies are evolutionary entities, from the point of view of both their gravitational potential and their constituents. For instance, in a Milky Way type model, the older stars will have orbited the galactic centre just sixty times before death. And the galaxy itself may evolve during this short period of time. Interpreting the dynamical system in a broad sense, given an initial condition, the stability refers to the location itself, not to the tracer particles. But considering what happens to the model in such short timescales, and for the sake of our discussion, the forecast of the numerical galactic model reliability is then of importance.

Link: http://www.fisica.escet.es

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Realistic Material Appearance Modelling

by Michal Haindl, Jiří Filip and Martin Hatka

Physically correct and realistic visual appearance rendering or analysis of material surface visual properties require complex descriptive models capable of modelling material dependence on variable illumination and viewing conditions. While recent advances in computer hardware and virtual modelling are finally allowing the view and illumination dependencies of natural surface materials to be taken into account, this occurs at the expense of an immense increase in the required number of material sample measurements. The introduction of fast compression, modelling and rendering methods for visual data measurements is therefore inevitable.

The established practice in computer vision, graphics and pattern recognition is to base inferences only on restricted information. Virtual reality applications typically use oversimplified models that cannot even remotely approximate the appearance of real scenes, meaning human observers can easily differentiate between real and virtual scenes. Fortunately, the recent swift development of computer technology has allowed models and tools that seemed theoretical only a decade ago to become feasible as a part of foreseeable future routine processes. Physically correct and accurate material appearance visualization is in high demand. It not only has a huge economic impact in visual safety simulations and virtual design in automotive industry and architecture, but also has large potential in visual scene analytical applications, including health care, security, defect detection and content-based image retrieval. However, many challenging problems still exist, such as efficient measurement of material optical properties, image compression, optimal mathematical representation, unsupervised segmentation and interpretation and many others.

We have developed several multidimensional probabilistic models based either on a set of underlying Markov random fields or probabilistic mixtures, which allow physically correct surface lossless representation and modelling, huge measurement space compression (so far unbeaten at up to 1:1 000 000), and even modelling of previously unseen surface data or their editing. These methods are parametric, so they do not require original measurements to be stored. However, such models are nontrivial and suffer from several challenging theoretical problems such as stability, parameter estimation and non-iterative synthesis, which must be circumvented.

Alternative approaches using physical reflectance models or sophisticated sampling were also investigated. Regardless of the traits of individual models, they all meet comprehensible requirements such as unlimited seamless surface image enlargement, high visual quality and compression, as well as some less obvious features like strict separation of the analytical and synthesis parts, possible parallelization and implementation in advanced graphics hardware. Unfortunately, there is no ideal universal visual surface mathematical model suitable for all applications or material types. Each of these aforementioned models have their advantages and drawbacks simultaneously, hence optimal measurement as well as modelling depends on both material and intended application, and must be automatically recognized. Surprisingly, the reliable assessment of visual quality is also a difficult task because no usable mathematical criterion exists and such verification requires costly and time-demanding psychophysical visual evaluation. On the other hand, we have successfully applied methods of visual psychophysics to the development of even more efficient material-dependent compression and measurement methods.

We believe that the combination of perceptually optimized measurement and effective mathematical representation of surface appearance is a key to the wide applied usage of realistic view- and illumination-dependent surface material optical measurements.

Links:
http://ro.utia.cas.cz/10cvpr_tutorial/
http://staff.utia.cas.cz/filip/projects/pertex

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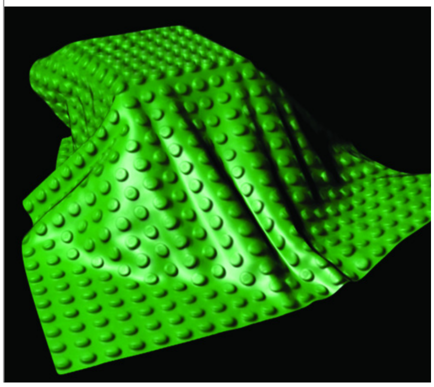
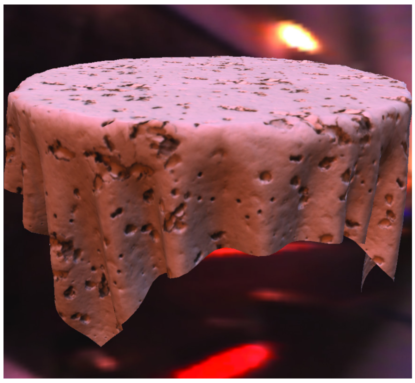
Figure 1: Examples of the realistic rendering of view- and illumination-dependent textures in a car interior, on virtual drapery and on an environmentally lit tablecloth.





Risk Assessment Study based of the 365AD Earthquake to Drive a Civil Protection Exercise

by Evangelia T. Flouri, Costas E. Synolakis, Nikos A. Kampanis and Catherine E. Chronaki

The simulation of the extreme destructive historical earthquake of 365 AD in the Aegean Sea will help to draw a realistic disaster scenario to test EU member state collaboration in the frame of the European Civil Protection Mechanism.

POSEIDON, a project co-funded by the European Commission, DG Environment, Civil Protection Unit, aims to design, organize and evaluate an operational civil protection exercise involving Greece, Cyprus and France, addressing the results of a hypothetical extreme disaster caused by an earthquake of considerable magnitude followed by a tsunami. This hypothetical disaster will devastate the island of Crete and will require the invocation of the European Civil Protection Mechanism to bring assistance from other areas in Greece, France and Cyprus. The aims of POSEIDON are: (a) to understand, verify and improve civil protection procedures for preparedness and response, particularly in relation to earthquake events followed by tsunamis, (b) to provide a learning opportunity for the actors involved in civil protection assistance interventions, (c) to test the coordination of EU civil protection assistance particularly through the Monitoring and Information Centre (MIC), and (d) to validate new applications for early warning and communications systems as well as procedures by which to inform the public of emergency measures to be undertaken.

FORTH-IACM, and specifically the Laboratory of Coastal Research & Applications is responsible for performing a risk assessment study that will provide the hypothetical disaster scenario from a large earthquake and the tsunami that follows, using advanced simulation techniques. The risk assessment study involves the production of tsunami inundation and seismic intensity maps to be used before the exercise by the emergency planners to prepare their response and then during the operational exercise when additional local scenarios will be added to overwhelm the local command and control and direct search and rescue operations.

We take as our starting point the historical earthquake of 365 AD that occurred in the sea west of the island of Crete and which was followed by a tsunami. Historical sources report that this particular earthquake caused extensive destruction, and this has been verified by contemporary seismological and geological research (Shaw B, Ambraseys NN, England PC, Eastern Mediterranean tectonics and tsunami hazard inferred from the AD 365 earthquake, Nature Geoscience 1, 268 - 276 (2008)). Apart from the destruction, the earthquake caused significant geological disturbances, particularly acute in the westward coast of the island.

The reconstruction of the earthquake characteristics from bibliographical

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