Technology Strategy Board
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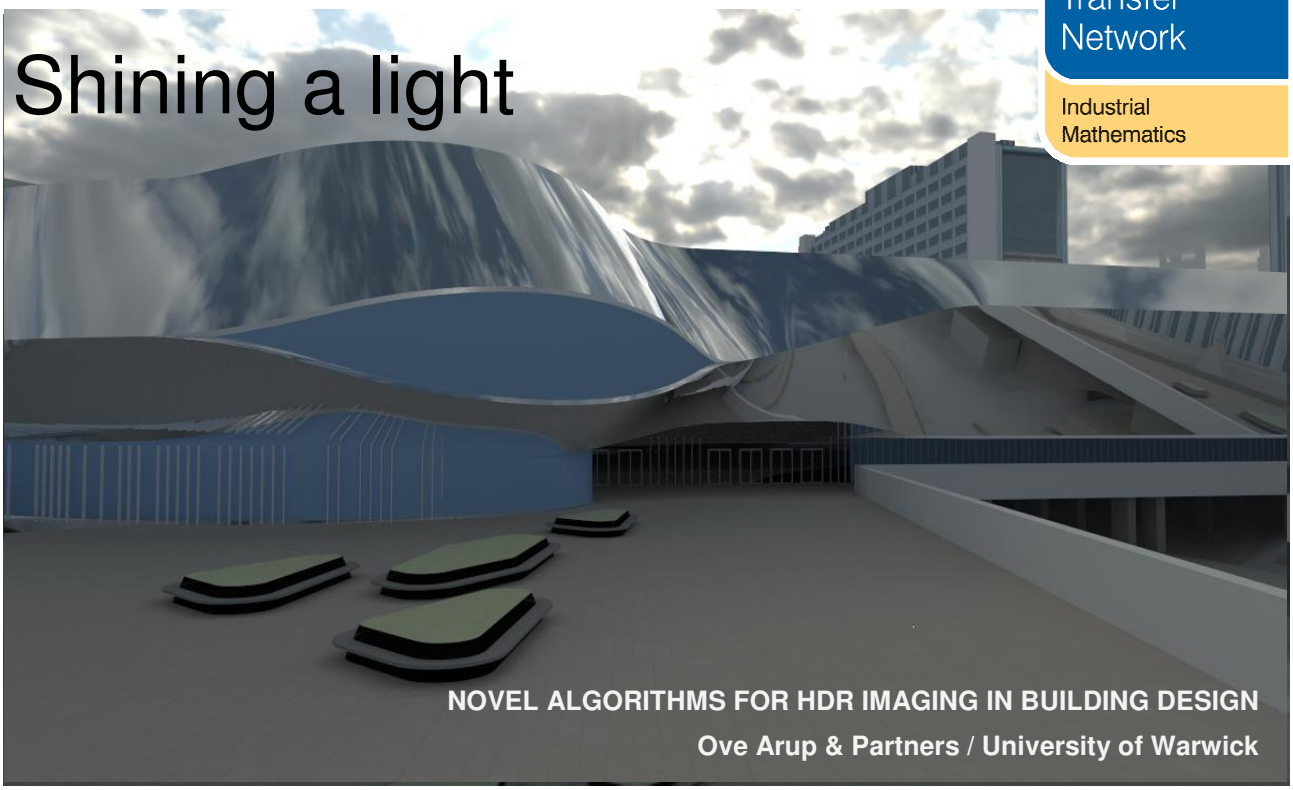
Knowledge Transfer Network
Industrial Mathematics

Shining a light



NOVEL ALGORITHMS FOR HDR IMAGING IN BUILDING DESIGN

Ove Arup & Partners / University of Warwick

The need

High quality visualisations play a growing role in the evaluation of designs created by engineering design firms and architecture practices.

High Dynamic Range (HDR) images can represent a much larger range of intensities than regular photographs. HDR imagery enables the capture of real world lighting which can be used to create more authentic visualisations.

We expect video or even interactive walkthrough digital models to become a mainstream practice during the next five years. The technology and algorithms for the use of HDR imagery in combination with these videos and walkthroughs are still in their infancy. This project addressed some of the further enhancements necessary before HDR can become commercially viable.

The outcomes

The aim of this project was to explore the use of novel and advanced imaging, photographic and rendering techniques and to chart the extensive changes which are currently happening at Birmingham New Street Station. There were two main themes:

1. Producing HDR video without expensive equipment by using software to exploit commercially available photography equipment.
2. A new mathematical method for rendering videos using HDR imagery to incorporate real world lighting.

These techniques have allowed the industrial partner to showcase the high quality videos of the Birmingham New Street Station development, which is not due to finish construction until 2015. Furthermore the realism introduced by the HDR video enables more analysis of the designs, such as glare and reflected solar heat analysis.

The associate has developed new mathematical algorithms, verified that they will work within industry and gained a deeper insight into the nature of industrial research and development. He now has first-hand experience of the constraints that are typical in industry, which are not commonly considered in academic environments, and will be able to take these factors into consideration in future research.

"We gained a great deal of insight into mathematical methods and their application and are pleased with the progress made in the project, we look forward to further opportunities to work with the University of Warwick in this and other fields."

Steve Walker, Ove Arup & Partners

Technical summary

High Dynamic Range (HDR) Video Capture

In this project we explored two techniques to make it possible to capture HDR video using commercially available equipment.

The first technique used a single HDR image to map the values of a Low Dynamic Range (LDR) video into HDR. This requires one or more HDR still captures that represent the range of luminance found in the scene being captured. A mapping between the HDR and LDR values is found and is applied to enhance the LDR video into HDR using a straightforward piece of software.

The second technique used a modified camera BIOS for specific digital SLR cameras. This makes the camera alternate between long and short exposures for each frame; each pair of frames with long and short exposures is subsequently combined into one HDR image in post processing, producing an HDR video.

New Mathematical Method

Using HDR images, such as the one on the left, as light sources in high quality visualisations is a common technique for creating results that look authentic. However adapting standard rendering methods used for still captures for HDR video is not sufficient as it can result in flickering in the resulting video and/or inefficient rendering performance.

For this project we developed a new mathematical method specifically for creating high quality rendered HDR videos. This method adapts the Population Monte Carlo sampling for use in an iterative algorithm that learns from each iteration, becoming more accurate at each step. This method is particularly effective when used with video as the information learnt from each frame can be applied to the next frame.

"This project has given me the opportunity to see how my research applies to real-world problems, including some that I had not considered before, for example, simulating glare reflected off buildings."

Sam Staton, University of Warwick

"It was a great pleasure to work with our colleagues at Arup, it gave us novel insights on how our methods and algorithms can be adjusted to work within industrial scenarios. It will enable us to design novel algorithms for rendering to meet industrial criteria and benefit from commercial opportunities."

Kurt Debattista, University of Warwick

This project was part of the programme of industrial mathematics shorter KTPs managed by the Knowledge Transfer Network (KTN) for Industrial Mathematics. The KTN works to exploit mathematics as an engine for innovation. It is supported by the Technology Strategy Board, in its role as the UK's national innovation agency, and the Engineering and Physical Sciences Research Council, in its role as the main UK government agency for funding research and training in engineering and the physical sciences.

EPSRC
Engineering and Physical Sciences Research Council

Project Details

Partners
Ove Arup & Partners
University of Warwick

Project investment
£13,000

Intern
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