ICSV14
Cairns • Australia
9-12 July, 2007

PRACTICAL EXPERIENCE IN ENGAGING THE PUBLIC THROUGH INTERACTIVE 3D TECHNOLOGY IN RETROFITTING BARRIER PROJECTS ON EXISTING ROADS

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Abstract

Public engagement is an important element that is critical to the planning and success in retrofitting barriers on existing roads. Residents living close to the area, where retrofit barriers are proposed to be installed, may have strong views as to whether barriers should be erected or not. To communicate effectively with the public and to enhance public involvement during the planning stage, it is essential that the noise information presented should be as simple and as easy to understand as possible. Traditional presentation approaches using tables and maps are often not easily understood by the public or even professionals such as environmental consultants and engineers, especially for a project in a complex high-rise city like Hong Kong. This paper describes the practical experience of the Environmental Protection Department (EPD) of the Government of the Hong Kong Special Administrative Region using three-dimensional (3D) visualization tool to engage the public for their views of retrofitting barrier projects in Hong Kong. The tool provides a 3D interactive virtual reality (VR) environment, for the public to walk and fly through the future 3D space to visualize the proposed retrofitting barriers and to grasp the predicted noise information attached with it. This helps the public, the local district councilors and the decision makers to make their choices. The tool is developed by using Geographic Information System (GIS), 3D digital model technology and large-scale noise model application for noise prediction and assessment. An application of web-based data dissemination is also discussed.

1. INTRODUCTION

According to investigation of EPD [1], over a million Hong Kong residents were exposed to high levels of road traffic noise (dwelling façade noise levels greater than 70dB(A)L_{10}). To address the noise impact from existing roads, the Government introduced in 2000 a policy to implement engineering solutions such as retrofitting barriers and enclosures, where practicable, at existing excessively noisy roads. Retrofitting noise barrier projects including their locations and forms can be more successful and acceptable with continuous public engagement and involvement in early planning and design stages.

Erecting a retrofitting noise barrier along an existing road to reduce the road traffic noise impact to the nearby resident is always controversial. Barriers would mitigate the road traffic noise on the one hand and would alter the environmental scenery from the nearby residential dwellings on the other. To avoid unnecessary disputes in the late construction stage, it is of vital importance to ensure that the public understands how the acoustic effectiveness of the proposed barriers will be, how the proposed barriers will look like and how the proposed barriers will benefit them, etc. Therefore, views from the public should be adequately considered during early stage of a noise barrier project.

The significance of effective public engagement process was illustrated by a case several years ago when only traditional approach of consultation was adopted. Information such as layout plans, location of noise sensitive receivers (NSRs) and predicted noise levels were presented by means of figures and tables to stakeholders and local district councilors. They supported the project in planning stage when section layout plans as well as photomontages were shown during consultation. However, when the stakeholders and local district councilors saw the barriers erected, they considered that the barriers were not built to what they had expected, and they therefore objected the barriers. It was later found that the public and local district councilors in fact could not imagine how the barriers would look like during the consultation. In fact, even professionals may sometimes find it difficult to grasp the information contained in the complicated figures and tables and not to say figuring out the future noise environment virtually.

In many European metropolises such as London, Birmingham, Paris and Berlin, two-dimensional (2D) noise maps were employed to present the environmental noise distribution in identifying noise problems. In 2006, a working group of European Commission had also published a good practice guide for noise-mapping [2] to assist the member states in producing noise maps. EPD had in fact started to explore and use 2D noise maps to identify road traffic noise problems [1] back in 2003. Figure 1 shows a typical noise map demonstrating the distribution of road traffic noise at 4m high level. Different colors of the grids represent different noise levels at different locations. This is a big step forward for which professionals start using more user-friendly tools to communicate with laymen.

Figure 1 Typical noise map shows the road traffic noise at 4m high level

Due to the unique compact environment in Hong Kong, with numerous high-rise residential buildings, road networks, complex terrains and elevated structures, the noise exposure distribution on the building facades are extremely complicated. 2D noise exposure maps at various heights may help to illustrate the complex situation. To achieve an efficient and effective public engagement process, information including the acoustic effectiveness of proposed barriers, their visual effects to drivers and residents in the vicinity, should be conveyed to the public in a way that they can easily understand and digest. A virtual 3D computer graphic model allowing the stakeholders to experience a proposed barrier project by walking, driving, flying over it, can more effectively stimulate the thinking of the stakeholders as compared with the traditional 2D drawings and plans.

While some studies used noise maps to formulate the noise mitigation plan, some used them to identify the quiet area for protection. This paper illustrates one of the practical applications of 3D road traffic noise modeling, and shares the experience of utilizing the GIS and VR technology to help stakeholders to understand the complex noise environment.

2. PRODUCTION OF INTERACTIVE VIRTUAL REALITY ENVIRONMENT WITH NOISE INFORMATION

A photorealistic 3D noise model is the fundamental element for the production of an interactive VR environment, which is the composition of three types of techniques, namely the GIS application, large scale noise modeling and 3D computer graphic techniques. Three different technologies are used to produce three different elements of the model, which are the basic 3D model, façade noise grids and the image textures. Figure 2 as below shows the integration of photorealistic 3D noise model.

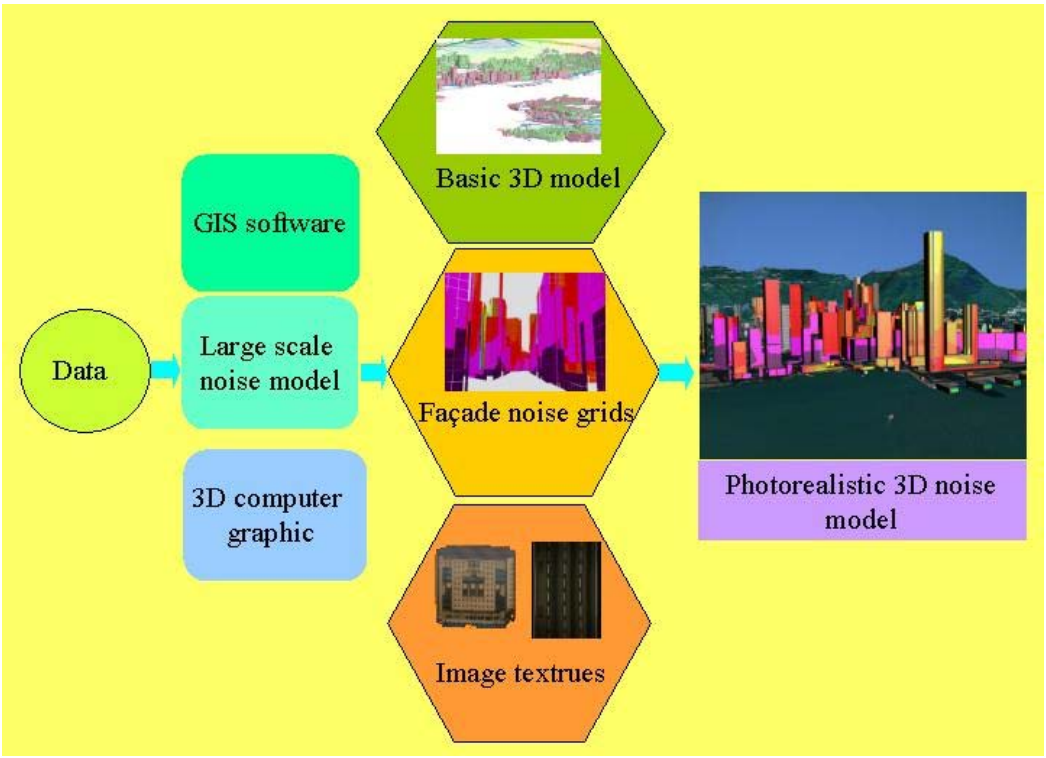


Figure 2. Integration of photorealistic 3D noise model

2.1 Basic 3D Model

The basic 3D model is developed by GIS data such as buildings, roads, terrains, podiums and barriers, …… etc., forming the skeleton of the database. Information such as traffic flow, traffic composition, speed of vehicles, ground surface types are also inserted as GIS data and prepared for the large scale noise modeling. Other GIS information such as the type of buildings, population distribution, district boundaries are also included and available for other computational data analysis.

2.2 Façade Noise Grids

The GIS data mentioned in the basic 3D model provided by various government authorities in Hong Kong is used to calculate the noise levels at the building facades. Employing the procedures in the ‘Calculation of Road Traffic Noise (CRTN)’ [3] and a large scale noise

mapping software, having considered the traffic composition, flow, speed, the noise propagation as well as road surface texture, the source model can be built. Having identified the noise assessment points at one metre from the building façade, having considered the noise propagation parameters such as distance, reflection, screening, ……etc. and having followed the ray tracing algorithm, a 3D noise model can been generated in 3m by 3m noise grids. This façade noise grids can be overlaid on the basic 3D model and photorealistic model, generating the models of different scenarios. The colour grids are categorized according to the range of noise levels calculated, indicating the various degree of noise impact at the façade of buildings. Through this 3D noise model, people can understand the location of the most and least affected areas at a glance.

2.3 Image Textures

By mapping the aerial photos on the terrains, the building texture images on the perimeters of buildings and, the road texture images on the road surface, a simple photorealistic 3D model can be generated. Some photos of the buildings are mapped onto some selected landmark buildings to better produce a "photorealistic" feel.

To help the industry and consultants to transform the traditional common noise models to a simple 3D noise model, two transformation software tools have been uploaded in the EPD website for public use. One can transform the most common noise models to standard exchange protocol file (text), and the other can transform the standard exchange protocol to 3D model in virtual reality modelling language (VRML) [4] format.

3. APPLICATIONS IN RETROFITTING BARRIER PROJECTS

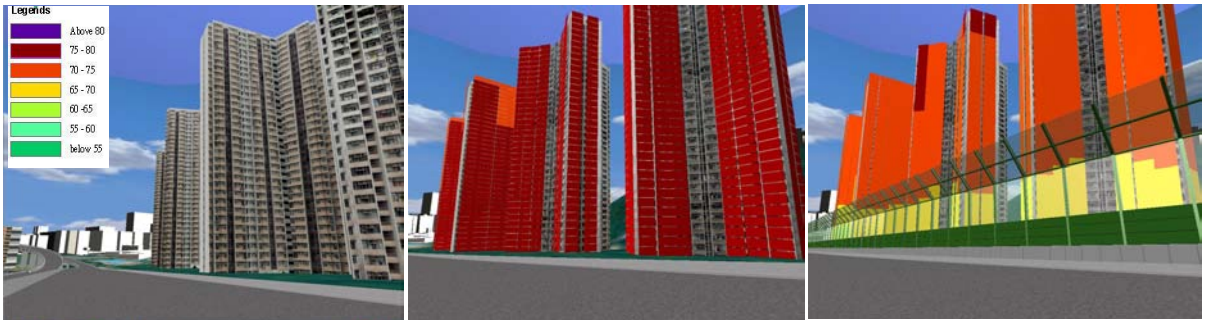
3.1 Tseung Kwun O (TKO) Road

TKO Road is one of the busiest major and trunk roads in Kwun Tong district, Hong Kong. A photo and a photorealistic 3D model of the area are shown in Figures 3(a) and 3(b). Figures 4(a) to 4(e) show the photorealistic 3D models of a retrofitting barrier project on this road, the façade noise grids in the unmitigated and mitigated scenarios, and from residents' and drivers' views. As most of the elements in the model such as building, roads and barriers are located based on the true coordinates in GIS, users can identify the predicted noise level at a particular flat and location and observe the changes in noise level at different heights with different scenarios. By presenting the noise information, proposed noise mitigation measures incorporating with the realistic 3D model, the noise environment and different views can be easily appreciated by the stakeholders or non-professionals.

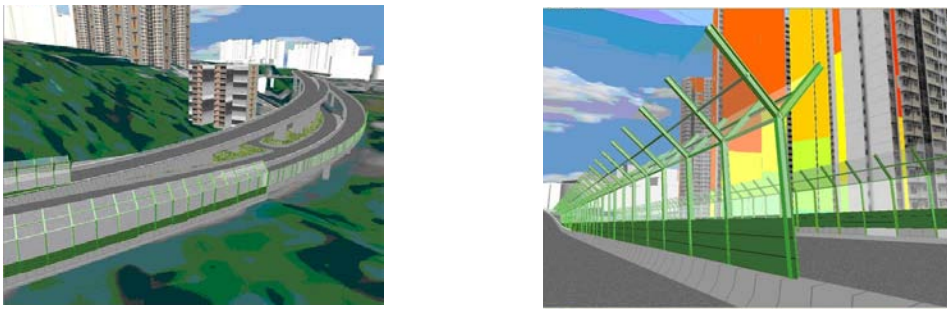
These 3D visualization tool was employed to present the performance of the proposed barriers to be retrofitted on TKO Road to the Kwun Tong District Council as part of the consultation process. The Councilors were well impressed by the works. The consultation went on smoothly and the project was accepted by the Council.

(a) Photo (b) Photorealistic 3D model

Figure 3 TKO Road and nearby high-rise residential building



(a) Current situation (b) Unmitigated scenario (c) Mitigated scenario



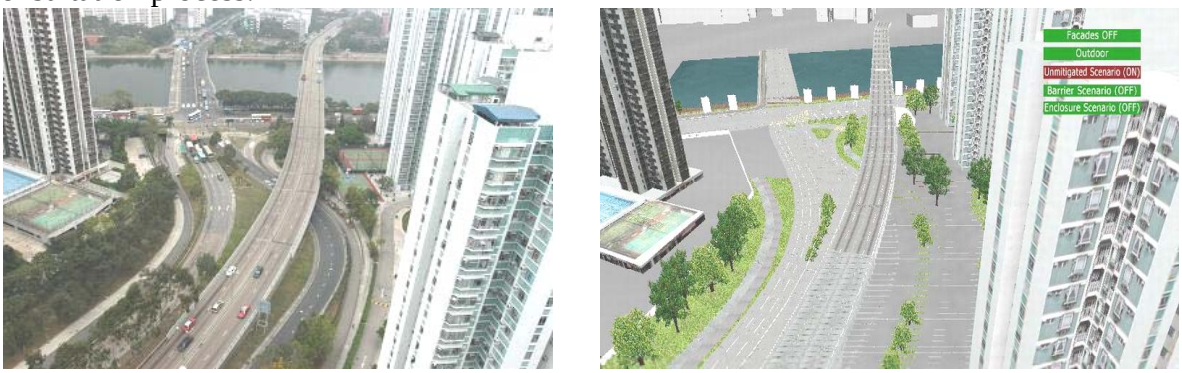
(d) Residents' view on proposed barriers (e) Drivers' view on proposed barriers

Figure 4 Photorealistic 3D models of different scenarios and views at TKO Road

3.2 Shatin Road

Shatin Road is another very noisy expressway close to high-rise residential buildings with dense population, as shown in Figure 5. The proposed retrofitting barriers project at Shatin Road is another good example demonstrating the importance of public engagement process. Consultation was conducted employing the 3D models demonstrating the current, the unmitigated, the barrier and the semi-enclosure scenarios, as shown in Figures 6(a) to 6(d), and at different angle of views, as shown in Figures 6 and 7. During the consultation meeting, the noise reduction effects due to different noise mitigation schemes together with different visual effects was presented to the stakeholders. The audio effect of road traffic noise was also simulated so that the stakeholders could see and hear the predicted noise levels with different

mitigation schemes in place. Different effects of the noise mitigation measures could also been tested and heard by the stakeholders. They could also control themselves the viewing angles and locations during the consultation. Figures 8 and 9 show the equipment set up and the photo during the consultation meeting. Two groups of stakeholders with different opinions in the mitigation schemes existed in the district. Through the utilization of the interactive photorealistic 3D noise model, excellent and interactive responses were received from the stakeholders and a very slightly modified noise mitigation scheme was concluded after the consultation process.

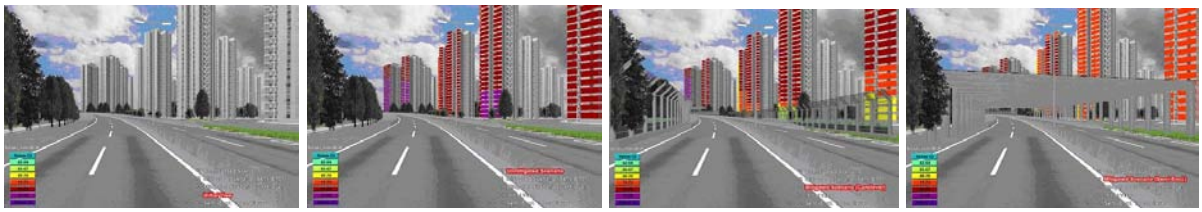


(a) Photo (b) Photorealistic 3D model

Figure 5 Shatin Road and nearby buildings

(a) Current situation (b) Unmitigated scenario (c) Barrier scenario (d) Semi-enclosure scenario

Figure 6 Resident's view to Shatin Road of different scenarios



(a) Current situation (b) Unmitigated scenario (c) Barrier scenario (d) Semi-enclosure scenario

Figure 7 Driver's view to Shatin Road of different scenarios

Figure 8 Screen and audio set up

Figure 9 Consultation meeting

3.3 Che Kung Miu Road

Che Kung Miu Road is one of the busy primary distributors close to high-rise residential buildings. The current situation can be seen and easily understood in the photorealistic 3D model as in Figure 8(a). Other 3D models such as the unmitigated, cantilever barrier and partial enclosure scenarios are illustrated in Figures 10(b) to 10(d) respectively. Other than for demonstration purpose in public consultations, the VRML format model had also been tested to disseminate the information via an Internet streaming technology. This is a technology similar to television broadcasting on demand, facilitating the stakeholders to obtain the model through Internet, so that they can study the model at different places and at different time. As shown Figure 10, animated objects inside the model and different scenarios can also be disseminated. This technology do not only avoid a waste of time in downloading huge amount of data before viewing, it is also beneficial in data security due to copyright or commercial issues.

(a) Current scenario (b) Unmitigated scenario

(c) Cantilever barrier scenario (d) Partial enclosure scenario

Figure 10 Photorealistic 3D model of Che Kung Miu Road using streaming technology

Other than the above VRML streaming technology, EPD is also investigating other technologies to disseminate the data, such as utilizing the Worldwind engine from National Aeronautics and Space Administration (NASA) or “real time rendering” (RTRE) data format from a commercial software supplier.

Through the recent dissemination of noise information in different scenarios and more effective communication, public engagement for the consultation of retrofitting noise barrier projects was enhanced, the decision makers would know more and deeper about the views from the stakeholders.

4. CONCLUSIONS

It is useful to integrate 3D GIS and photoreaslistic noise model to help the public, be them professionals or laymen, to quickly appreciate the noise level distribution and the visual effects of a barrier project in the compact and complex metropolitan and urban settings. With the development of photorealistic 3D noise models and the adoption of simple VR tools, noise environment can be illustrated in 3D format, even general public and non-professionals can understand easily the current and future noise environment. It provides the public with a better comprehension of the complex noise environment, an easier method for identifying noise impact at certain receivers, a better mean to understand the noise distribution in different scenarios of a barrier project, and to visualize acoustic effectiveness of barriers and hence, beneficial to the enhancement of continuous public involvement in those civil projects.

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