Visualising acoustic surface properties, using colours

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The OpenGL™ rendering engine, which comes with the Windows PC operating system, allows display of room geometries, which have been modeled for room acoustics prediction purposes. Viewing a 3D geometry as a surface geometry rather than as a wire frame, allows easy detection of geometrical errors like holes and missing surfaces. However with an appropriate surface colouration it is also possible to view material properties. This paper suggests that the acoustic reflectance of acoustic materials is converted directly into a visual representation, where red represents low frequency, green represents middle frequency and blue represents high frequency reflectance. In this way total absorbing surfaces appear black whereas total reflecting surfaces appear white and indeed surface colours, which display acoustic reflectance appears in a visually plausible way and it is very easy to read the acoustics properties of the surfaces in a room model.

OPEN GL FOR VISUALISATION

Today's computer configurations allow rendering of surface geometries using the OpenGL rendering engine, which comes with the Windows operating system. OpenGL is usually used for geometry rendering in computer games, but may indeed also be used visualisation of geometries in scientific programs – in fact Silicon Graphics™ originally created OpenGL for this purpose.

Acoustic properties to visualize

In room acoustics prediction programs based on geometrical assumptions, a number of surface properties may be applied to the surfaces in the room geometry. The properties are absorption coefficients, scattering coefficients and for some prediction programs transparency coefficients as well.

Transparency coefficients

In some room acoustics programs it is possible to assign a frequency independent transparency coefficients in order to model surfaces, which have a degree of transparency or to model an area covered by many small surfaces in an easy way, just modeling one large surface with a transparency coefficient. Examples of such surfaces are banisters, rails, installations bridges etc. In OpenGL it is possible to assign a visual transparency coefficient to each surface, so using this option is an obvious way to visualize a frequency independent transparency coefficient.

Scattering coefficients

Most room acoustics programs use scattering coefficients, which are assigned to each surface in the room geometries in order to describe to what degree reflected sound is scattered by a surface. In OpenGL it is also possible to assign a kind of scattering coefficient to surfaces, which determines the amount of shininess (white specular highlights) the surface will have.

Absorption Coefficients

The main material properties in a room acoustics modelling are the absorption properties. In a room acoustic program like ODEON, absorption coefficients, one for each frequency band, are assigned to each surface. In OpenGL, it is possible to assign the surface colours in terms of Red, Green and Blue intensities (the human eye is capable to distinguishing three different frequency bands of *light* because of different tap-cells in the eye, which are sensitive to each frequency range). To convert the acoustic absorption coefficients into a visual RGB intensity, an average absorption coefficient is calculated for the lower, the middle and the upper frequency range of the material. The average absorption coefficients are then converted into acoustic reflectance ($r = 1 - \alpha$), which are then used for the specification of colour intensities, one

intensity for each of the colours red, green and blue of the surfaces in the visual OpenGL representation.

Using the rendered room geometries

A visual 3D representation of the room geometry with the surfaces coloured in the acoustics colours as suggested above, allows a very efficient check on the assigned materials e.g. where are the absorbing or hard materials, have some of the surfaces been assigned a wrong material etc. As a bonus the colours usually looks quite natural, thus offers a nice way of presenting the room geometries built for acoustic prediction without having to spend time on preparing a sensible visual representation. The colour mapping is as follows:

- Low frequency reflectance is mapped into Red (which is low frequency light)

- Middle frequency reflectance is mapped into Green (which is middle frequency light)

- High frequency reflectance is mapped into Blue (which is high frequency light)

Some examples on the visual representation of different acoustics materials:

- White; total reflecting at all frequencies

- Black; total absorbing at all frequencies

- Grey scale; equal absorption at all frequencies

- Strong colour; strong colouration of the sound
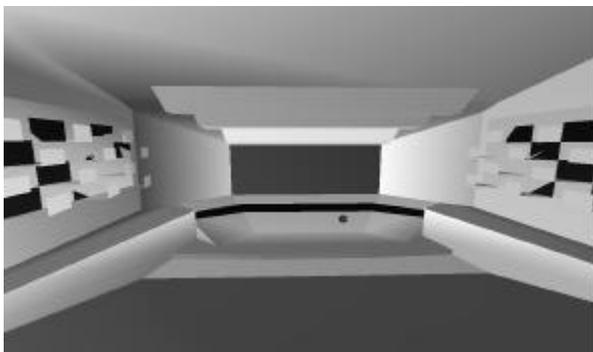
Examples on rendered rooms

FIGURE 1. Visualisation of a computer model of the Royal Festival Hall, London.

The examples displayed here are in black and white even so with intensity based colour mapping of acoustic materials, one gets a reasonable impression of the material properties (dark surfaces reflecting less sound than white ones). If the pictures were reproduced in colours one would also get some information on the acoustic colours of the materials.
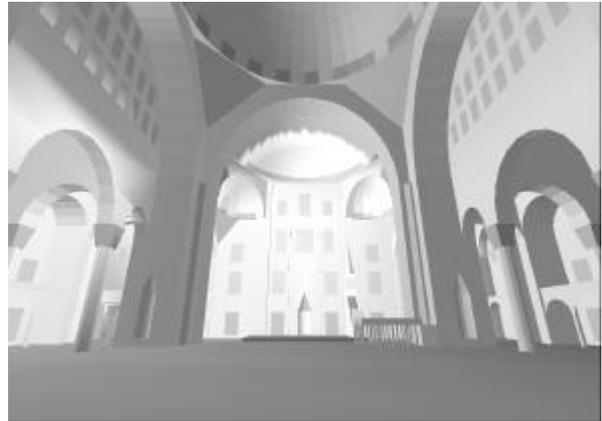

FIGURE 2, Interior of a mosque, the acoustic colour of the carpet appear in a redish colour while windows appear blue.

CONCLUSION

OpenGL offers an easy yet very powerful way of providing information to users of a room acoustic prediction programs. In particular if a comprehensive colours scheme is chosen, it is very easy to read the material properties of a room.

REFERENCES

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