Subject: Computer Simulation of Room Acoustics
Posted by Wayne Parham on Tue, 21 Mar 2006 19:39:33 GMT
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I recently purchased a software package for modeling room acoustics. On initial inspection, it's pretty impressive. I am setting up a study of several speaker setups in various rooms, sort of duplicating the Welti study but adding a few more configurations and room types. I also wanted a graphic representation of the room energy, which is an option that the CARA program is capable of doing.

Part of what prompted this is I wanted to test Dr. Geddes suggestion of asymmetrical random subwoofer placement. Welti published a study a few years ago that indicated there were symmetrical placements that worked better than random placement of the same number of subwoofers. Geddes maintains that Welti was wrong, and that he failed to try Geddes specific configuration, so I wanted to test Geddes suggestion for myself. To be specific, Geddes suggests the following conditions: Subwoofers should be placed asymmetrically, one should be in the apex of a room corner, one should be above mid-height of the room and at least one more should be placed in a random position in the room.

Geddes preferred implementation requires at least three woofers. Welti suggests four, one at each room midpoint or one in each corner. He also found that a pair of subs at opposing wall midpoints worked pretty well. But the point is that you can arrange four subwoofers in either a Welti or Geddes arrangement, so it isn't a matter of cost, only of placement. Other considerations may also apply, such as compatibility with room decor and integration with mains, but we're basically talking about where to place the same number of speakers to get the best results.

I could accept either conclusion, whatever the facts indicate. But to be honest, I was skeptical of Geddes conclusion mostly because I thought that Welti had already considered it and thrown it out. But to be fair, Welti did not test Geddes exact placement, so I thought it was worth seeing for myself.

Dr. Geddes and I have discussed this offline, and he proposed a wager. If I would bet him $500.00 that Welti was right, he'd prove me wrong. I immediately jumped at this, because to get the expertise of a man so accomplished for just five hundred bucks is a real bargain, either way it works out. I told him I'd even be willing to run some of the sims. He proposes a series of MathCAD simulations, which is the natural choice for a study of this sort. So we're still talking about the particulars, and what would be required to run the tests.

In the meantime, I suggest to each of you interested in room acoustics to purchase a modeling tool like CARA. Setup a room and see for yourself how it acts. I think once you see the room energy distribution graphically, this whole exercise becomes self-explainitory. Look at the low frequency room modes, and how the pockets of energy form at various bass and lower midrange frequencies. Then look at how reflections cause interactions at higher frequencies too. And even odd-shaped rooms and furniture can be simulated, so the study doesn't have to be limited to simplified rooms.
Computer Simulation of Room Acoustics

Subject: Re: Computer Simulation of Room Acoustics
Posted by Earl Geddes on Tue, 21 Mar 2006 20:23:58 GMT
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CARA is a ray tracing program. It will not be able to do the LF modal study. Ray tracing methods do not retain phase and as such do not correctly predict standing waves. They only work above the modal region, not below it.

Subject: Re: Computer Simulation of Room Acoustics
Posted by Wayne Parham on Wed, 22 Mar 2006 00:00:01 GMT
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CARA documentation indicates that it calculates using the phase part of the complex sound pressure amplitude and that it uses a grid of several thousand points, evaluating the sound field modal structure as a steady-state sound pressure distribution. This implied to me that it was calculating LF standing waves as pressure nodes using a finite element mesh of some sort. I would assume it uses a ray-tracing algorithm for frequencies above the modal range. But I'm not sure what algorithms they've used, so I think it's better to allow them to address your post. I've written an E-Mail to the folks that authored CARA, so we'll see how they respond.

Subject: Re: Computer Simulation of Room Acoustics
Posted by Ulrich Franz Thomanek on Sat, 25 Mar 2006 09:30:54 GMT
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Dear Mr. Parham and Dr. Geddes,As the chief developer of CARA (Computer Aided Room Acoustics) I want to clarify the mathematics implemented in CARA.Dr. Geddes states:"CARA is a ray tracing program. It will not be able to do the LF modal study. Ray tracingmethods do not retain phase and as such do not correctly predict standing waves.They only work above the modal region, not below it. "CARA is not a ray tracing program! If CARA was a ray tracing program then Dr Geddes would be right. But CARA is based on a model using sound source images and therefore calculates the total sound field (direct and diffuse) with complex numbers (magnitude and phase).I ask Dr. Geddes and all others interested in this subject to try the "CARA Walkthrough" on www.cara.de .CARA correctly predicts the modal structure of the room sound fields. CARA focuses on the room acoustics of small rooms and we pay very particular attention to correctly calculating the room modes because these are relevant for all frequencies up to several hundred Hz.Best Regards,Dr. U. Franz ThomanekELAC Technische Software GmbHRendsburger Landstr. 215D- 24113 KIELDeutschland/GermanyTel +49 (0)431 680779Fax +49 (0)431 682101E-Mail tho@cara.deInternet www.cara.de

Subject: Re: Computer Simulation of Room Acoustics
Posted by Earl Geddes on Mon, 27 Mar 2006 14:56:33 GMT
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Dr. U. Franz Thomanek Mathematically the ray tracing and image source methods are the same, except in one instance. If the image sources are such that a series can be established that has a known answer then this is equivalent to the modal summation method. This can really only occur in rectangular rooms or some cylindrical ones.But, if the images are not so arranged, i.e. the room is not rectangular, then the image method will converge very slowly at low frequencies and it would take a very large number of images to get an accurate answer.I would suggest a test case where I use the modal method, which we would have to agree is the accepted standard answer, and you can run CARA. I would be most interested in this comparison.

Subject: Re: Computer Simulation of Room Acoustics
Posted by Ulrich Franz Thomanek on Tue, 28 Mar 2006 06:46:48 GMT
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Dr. Earl Geddes,All discussions of this matter are very old and are no longer reallyrelevant. Of course all simulation methods have a certain limit inaccuracy. As I told before, please visit www.cara.de and bring up themenu item "Products/CARA/Walkthrough" and then select chapter II(Calculations) and subchapter 6 (Comparison: CARA and Measurements).From this one may judge the accuracy of cara simulations. Comment regarding rectangular rooms: - any room with a rectangularoutline in the floor plan is no longer a rectangular room when severalpieces of furniture are introduced.Proposal of a test case:If you visit www.cara.de you will find our online service "CARA-Quick"which uses a modal method like you propose (series of eigenvaluefunctions). You may be sure that we checked very carefully themethods used in CARA and in CARA-Quick by comparing their results.

Subject: Re: Computer Simulation of Room Acoustics
Posted by Earl Geddes on Tue, 28 Mar 2006 13:14:45 GMT
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"All discussions of this matter are very old and are no longer really relevant."Perhaps so, but they are not old to the person who is interested in using CARA, which is not me.

Subject: Re: Computer Simulation of Room Acoustics
Posted by Wayne Parham on Tue, 28 Mar 2006 15:55:21 GMT
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Earl, if you are saying that you are not interested in using this program, I can accept that. You don't have to use it. But if what you are saying is that you are not interested in hearing Dr. Thomanek's explanation of how it works, as a reply to your arguments that it might not, I cannot accept that. You are the one that challenged its accuracy, so you are the one that should defend your accusations.It looks like CARA may be a very useful program for people interested in finding the best placement for speakers in their homes. If you are interested in educating people on where to place speakers for best sound, don't you think it would be good for them to be able to see for themselves?

Subject: Re: Computer Simulation of Room Acoustics
Posted by Earl Geddes on Tue, 28 Mar 2006 16:27:48 GMT
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"Earl, if you are saying that you are not interested in using this program, I can accept that. You don't have to use it. But if what you are saying is that you are not interested in hearing Dr. Thomanek's explanation of how it works, as a reply to your arguments that it might not, I cannot accept that."I am interested, it was he who said that this was an old discussion and not worth having. I am interested in discussing this further but I don't think that he is. His comment that he can use eigenmodes for LF is satisfactory for the problem at hand, I just dispute the use of image/ray tracing methods below the Schroeder frequency.But no, I am not interested in using CARA, but it appears to be a competent piece of software. I have already solved the problem in question so I don't see the need to do it again.

Subject: Re: Computer Simulation of Room Acoustics
Posted by Wayne Parham on Tue, 28 Mar 2006 16:45:29 GMT
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Well, sure. Modal analysis is completely different than ray tracing or image source methods. But it was already stated that CARA uses a hybrid approach, using both image source and modal methods.So it sounds to me like you are happy with Dr. Thomanek's explanation and you have concluded that CARA is a competent piece of software.
