USER STORY

Philips Consumer Lifestyle (Philips) Develops One-Piece Surround Sound System with MathWorks™ Tools

For engineers at Philips Consumer Lifestyle Innovation Lab (iLab), surround sound audio technology is about more than sophisticated algorithms and electronics; it is also about evoking emotion in the listener. "We started thinking about how to embrace the listener with sound without a room full of wires and speakers," explains Georges Aerts, iLab Program Manager.

The result is the Ambisound Soundbar, a one-piece, integrated home theater system that uses advanced digital sound processing technology to deliver multichannel surround sound. iLab engineers used MathWorks™ tools to develop and test algorithms, run real-time simulations, and tune acoustic parameters for the Ambisound Soundbar.

"Simulink® is crucial for the creative aspect of our work," says Aerts. "With Simulink we do not have to worry about details of implementation while we are exploring design ideas. When we have an idea, we can simply model it in Simulink, simulate it, and listen to it in real time. For us, that is a tremendous benefit."

The Ambisound Soundbar integrated home theater system.

THE CHALLENGE

Aerts and his colleagues wanted to develop sound processing components that would produce a surround sound effect from a single device. In the past, iLab engineers designed audio components using analog circuitry or by hand-coding DSPs in Assembler or C code. These approaches made it difficult to test out new ideas and techniques. In addition, there was no way for acoustic engineers to evaluate a new approach without investing a significant amount of time and resources in building a hardware prototype.

The iLab team needed a development environment that would enable them to rapidly evaluate design ideas and optimize them to perform within hardware constraints such as available RAM, program space, and processing power. They also needed a way to enable Philips marketers and product development teams to evaluate the concepts in real time and hear the effect of various parameters on audio output.

THE SOLUTION

Working with Simulink, the engineers developed sound models and ran high level simulations that enabled them to quickly converge on the most promising algorithms. Using Signal Processing Toolbox™, they applied infinite impulse response (IIR) filters as well as low-pass, high-pass, peaking, and shelving filters to improve sound characteristics – including voice intelligibility and deep bass performance.

THE CHALLENGE

To develop a high quality surround sound system integrated in a single component

THE SOLUTION

Use MathWorks™ tools to develop and test acoustic algorithms, run real-time simulations, and fine-tune parameters

THE RESULTS

- New algorithms validated in days, not weeks
- Executable demonstrations ready in one day
- 80% of design reused in future projects

> *Our acoustical engineers are not expert programmers. With Simulink® they can quickly develop algorithms and test their ideas without writing any low-level DSP code. Only after identifying the best solution, sound algorithms are implemented on a DSP and committed to hardware.*
>
> **Georges Aerts, Philips Consumer Lifestyle**

The engineers used MATLAB® Compiler™ to create a standalone MATLAB® application with a graphical user interface (GUI) that enables other teams to adjust parameters in the Simulink model.

Using Real-Time Workshop®, they generated C code for the algorithms in the Simulink model and compiled a second stand-alone application. They distributed the MATLAB application and the compiled code to another Philips engineering group, who could run them even without having installed MATLAB. This team ran both applications on a standard PC with a sound card and used the GUI to fine-tune the design while listening to the effect of various parameters on any audio input in real time.

The iLab team then implemented the algorithms on a DSP, adjusting them to fit within the DSP's RAM or MIPS limitations. After testing the hardware implementation with the Ambisound Soundbar, the team returned to the Simulink model to further fine-tune parameters. The optimized parameters were extracted from the Simulink model using a MATLAB script and downloaded onto the DSP.

The Ambisound Soundbar, which won a European Imaging and Sound Association (EISA) award for best product – home theatre compact system and the CES 2007 CNET best of CES award, is currently available on the shelves, and is a commercial success.

THE RESULTS

- **New algorithms validated in days, not weeks.** "Without Simulink, it could take us two or three weeks to code a new algorithm and test it to see if it had the desired acoustical effect," says Jan Tielen, DSP engineer at iLab. "Using Simulink, we can very quickly test the basics of new ideas – sometimes in a couple of hours."

- **Executable demonstrations ready in one day.** "In the past we had no easy way to get feedback from the Philips product division for whom the audio concepts were being developed. It could take a month to develop and validate a prototype system," notes Tielen. "With MathWorks tools, in one day we can produce a real-time simulation that our colleagues can use to fine-tune the system and provide us with valuable feedback."

- **80% of design reused in future projects.** The iLab team is accelerating development of the next generation of the home theater system by reusing about 80 percent of the Simulink design for the Ambisound Soundbar.

To learn more about Philips products, visit *www.philips.com*

APPLICATION AREAS

- Consumer electronics
- Signal processing
- Application development and deployment
- Code generation

PRODUCTS USED

- MATLAB®
- Simulink®
- Signal Processing Toolbox™
- Signal Processing Blockset™
- Real-Time Workshop®
- MATLAB® Compiler™

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