



**FACULTY OF ELECTRICAL ENGINEERING  
AND INFORMATION SCIENCE**



**INFORMATION TECHNOLOGY AND  
ELECTRICAL ENGINEERING -  
DEVICES AND SYSTEMS,  
MATERIALS AND TECHNOLOGIES  
FOR THE FUTURE**

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D. de Vries

## **Multi-Actuator Panel (MAP) loudspeaker arrays for Wave Field Synthesis**

### **WAVE FIELD SYNTHESIS**

Wave Field Synthesis (WFS) has been introduced in 1988 by Berkhout [1], at the time the head of the Acoustics group at TU Delft, as a sound reproduction format providing natural sound field properties in time and space without 'sweet spot' restrictions. The concept goes back to the Huygens principle, and is realized by the application of loudspeaker array technology. In the following years, WFS has been further developed, first in Delft [2], and later on an international scale in the framework of the EU-IST project 'Carrouso' coordinated by Fraunhofer IDMT in Ilmenau [3]. Since then, WFS is being applied for various purposes worldwide; research is going on at several places to further extend the applicability, flexibility and reproduction quality of WFS systems.

### **MULTI-ACTUATOR PANEL LOUDSPEAKERS**

Arrays of traditional loudspeakers have the disadvantage that they often disturb the esthetics of the room where they are applied. Therefore, during the 'Carrouso' project, the idea came up to use arrays based on flat panel loudspeaker technology. Promising experiments were done with white-coloured sandwich panels (130cm wide, 70 cm high) driven by 8 actuators (hence the name Multi-Actuator Panel, MAP), thus forming an alternative for an array module with 8 traditional speakers. They can easily be integrated in a room interior, having the additional advantage that they can simultaneously be used as projection screens in multimedia applications. Also, they better behave as the theoretically required plane sound radiator than a line source-like array of traditional loudspeakers. However, it became clear that the audio quality of the MAPs was significantly lower than that of traditional speakers. Therefore, the TU Delft Acoustics group decided to explore, as part of its research program, all possibilities to improve the sound quality to a level acceptable for the critical listener.

## MAP RESEARCH

In order to understand the propagation of dispersive bending waves in MAPs – being the basic mechanism of the sound generation – fundamental research was started in close cooperation with Fraunhofer IDMT [4] which is now continued as a project of the Dutch foundation for technical sciences NOW/STW. In cooperation with IRCAM, another ‘Carrouso’ partner, a method was developed to equalize the frequency characteristics of a MAP array configuration. Also, filters were developed to eliminate the unwanted reflections that MAPs in an array generate from each others signals [5]. Computation algorithms were developed and optimized in speed and efficiency, in order to enable real-time WFS performance.

## STATE-OF-THE-ART

In January 2006, in the semi-anechoic WFS studio of TU Delft already housing an array configuration of cone loudspeakers, a 14-module rectangular (5.3m x 4.0m) MAP loudspeaker array (112 actuators) has been installed, applying all results of the above research. Experiments are done to compare the performance of both array systems. Also, using audio-visual material of several formats, the possibilities of MAP arrays for multimedia application is further explored. Recent results will be reported and discussed in the paper.

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