School of
Computing and Engineering

David Moore (d.j.moore@hud.ac.uk)
Supervisor: Dr J P Wakefield (j.p.wakefield@hud.ac.uk)

University of HUDDERSFIELD

Improved Surround Sound Decoder Algorithms

Abstract

This poster summarizes research into the design of Ambisonic decoders for irregular loudspeakers arrays. The work so far has focused on improving the perception of source localisation through the development of improved surround sound decoder algorithms.

Introduction

❖A large number of domestic surround sound systems (e.g. 5.1) are set up in way which is convenient for the user rather than to a standard loudspeaker layout.

❖Most surround sound decoders developed for domestic use do not take this fact into account resulting in degraded localisation performance.

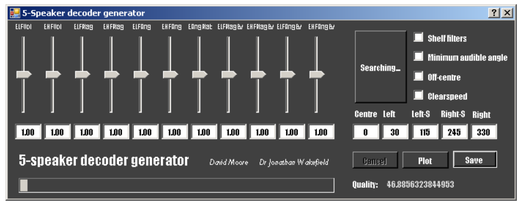
Method

❖ In this work the design of an Ambisonic decoder is formulated as a search problem.

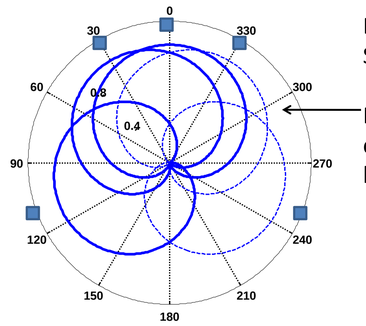
❖A heuristic search algorithm is used to find "good" decoder coefficients according to a developed fitness function.

❖Localisation performance of a decoder is measured in the fitness function using the velocity vector and energy vector.

❖This has been encapsulated in a software application which uses ClearSpeed's High Performance Computing technology.



ITU 5.0 Ambisonic Decoder Before Optimisation

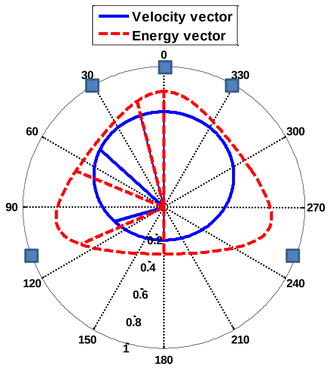


Default settings on the SoundField SP451 decoder

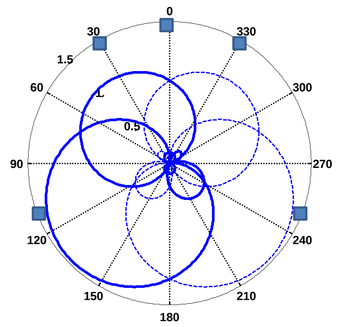
Note the cardioid gain response the decoder generates for each loudspeaker

This above gain response **is not** suited to an irregular 5-speaker layout. It results in a poor * velocity vector and energy vector response (see right).

*An ideal velocity vector and energy vector magnitude would be unit magnitude (equivalent to a real sound source). The vector angles should match 0, 30, 90, 150 and 180 degrees.



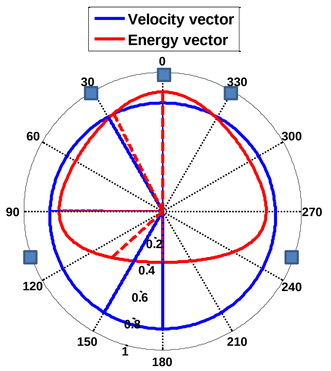
ITU 5.0 Ambisonic Decoder After Optimisation



Optimised Ambisonic 5.0 decoder

Note the decoder now exhibits a gain response which is different for the front side and rear side loudspeaker. The algorithm has also reduced the contribution from the centre.

This change results in velocity vector and energy vector magnitudes which are closer to an ideal value of 1 and vector angles which match more closely the intended directions (see angles at 0, 30, 90, 150 and 180 degrees).



Summary

❖Better localisation performance can be achieved over irregular loudspeaker layouts when formulating the design of Ambisonic decoders as a search problem (see demo).

❖Same optimisation concept can be used for higher order Ambisonic decoders. Higher order decoders are capable of producing a better response than those shown.

❖Recent research by the authors has shown it is possible to fine tune localisation performance by angle [1].

❖Future work will look into improving other aspects of surround sound reproduction such as envelopment and immersion.

[1] J.D. Moore, J,P Wakefield, "Exploiting Human Spatial Resolution in Surround Sound Decoder Design", 125th AES Convention, San Francisco

Audio Demo Information

Optimised Ambisonic 5.0 decoder coefficients

	Centre (0°)	Left (30°)	Left Surround (115°)
W	0.0000	0.2505	0.5134
X	0.0631	0.3130	0.3223
Y	-	0.2953	0.3213

Demo in Room T4/11 at 14:50

All Ambisonically encoded audio files used in the demonstration can be downloaded for free from:

http://www. ambisonia.com