Group Project: Acoustic Phased Arrays and 'Phase Advancing'

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An optical grating can produce a diffraction pattern if the slit separation and associated light source frequency have appropriate values.

A phased array is an extension of this basic system. In this case, a series of transmitters are all supplied with a signal that radiates away from them. However, if each signal source can be supplied with a phase shifter, it is possible to form a beam through careful selection of the phase shift for each transmitter. This is because each radiating transmitter provides constructive/destructive interference that forces the radiated beam to have a specific direction and acoustic profile. In addition, it is possible to steer the beam by changing the signal phases supplied to each transmitter.

In this project, the group will produce an acoustic phased array. This will build on the work conducted by Edward Szoka and Tom Jackson of Cornell University.

http://people.ece.cornell.edu/land/courses/ece4760/FinalProjects/s2012/tcj26_ecs227/tcj26_ecs227/index.html#intro

The initial stages of the project will be to reproduce their system but with the ability to change the separation of the transmitting elements. It will be important to have circuit boards printed and populated with components early in the project. Bernard Bristoll in Lab 3 will be able to advise on how to achieve this.

A requirement of the programme will be to demonstrate that beam steering can be achieved for transmitters and transmitter separations that are appropriate for a given frequency. A way will need to be found to characterise the beam shape, in one plane, using a sensor. It is expected that the measurements will take place in the Fresnel Region.

The second objective (far more interesting and innovative) will be to investigate whether it is possible to 'phase advance' signals (to give a phase signal that has the normal phased-array phase-shift plus an extra phase-shift) for transmitters that have unfavourable frequencies/transmitter separations.

This may require modification to the theoretical treatment conducted by Szoka and Jackson on the mathematics underpinning phased arrays.

References

Diffraction Theory and Antennas, R.H. Clarke and J Brown, Ellis Horwood, Chichester, 1980 (copy helped by PAB in Lab 1).