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AN EXPERIMENT OF ACTIVE NOISE ATTENUATION IN THREE-DIMENSIONAL SPACE

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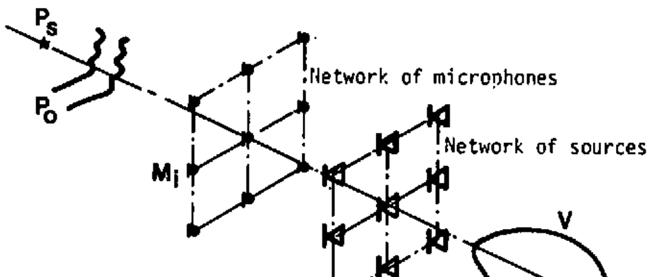
This paper is a continuation of a paper presented at INER-NOISE 80 (2) which proposed a theoretical model for active noise attenuation in three-dimensional space. Let PS be a primary source generating an acoustical field p_0, M_i (i = 1,...,I) a network of microphones detecting the field p_0, SS_j (j = 1,...J) a network of secondary sources and V a volume in which the superposition of the fields minimizes the acoustical energy. Our aim is to describe a system of active attenuation according to the theoretical model.



- Figure 1 -

INTRODUCTION

The practical problem of active attenuation may be defined by three points :
1. The detection and mathematical representation of the primary field p_0 ;

2. An efficient modelling of the acoustical field generated by the secondary sources ;
3. An algorithm of minimisation of the acoustical energy in the volume V.

This paper is limited to the case of a primary source with a well-known radiation diagram (for example spherical). Furthermore, we suppose that the information on the M_i can be deduced from the electrical signal, x(t), feeding PS. Then, we can avoid the first point. Numerical techniques seem to be most appropriate for this problem. The signal x(t) has to be converted from analog to digital and the $y_i(t)$ from digital to analog. Moreover the numeric performance exigencies of our system depends on :
1. The number of outputs (provisionally, j = 1,2, using the symmetry of the PS and SS_j in Fig. 2) ;
2. The spectrum complexity of x(t) (here x(t) is sinusoidal at 340Hz).

In the sinusoidal case, the numerical treatment consists of sampling x(t) and restoring it with precise phase (±0.2 degree) and correct amplitude (±0.5%)

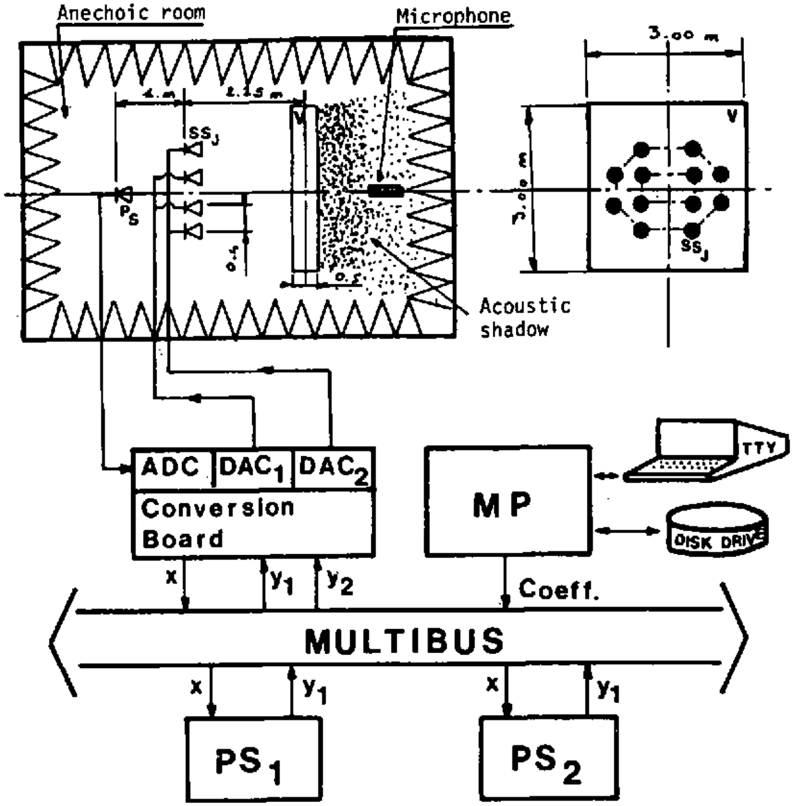
DESIGN OF OUR FIRST EXPERIMENT

It fulfils the following requirements :
1. An easy extension of the number of channels for the SS_J and M_i.
2. The components of the system should be modular so that each of them can be modified without changing the others.
3. Possibility of real-time digital filtering
4. Programming of the numerical algorithms with high-level languages.

All these exigences lead to a multiprocessing system.
The whole system has the following configuation (Figure 2).
It should be noted that each processor (MP,PS1,PS2) has the same design, so that all the programs developped on MP (in high-level language) are executable on the PS_i.MP has to compute directly the coefficients for the filters.

CONCLUSION

The experiment took place in an anechoic room within a range of 250 to 350 Hz. Before experimenting, we had constructed a set of programs for all the computations and simulations. Each subprogram is written with a modular structure so that it is possible to modify each component individually (source, geometry, etc.).
It is interesting to note the good fit between the theoretical part, the numerical simulations and the experimental results : in volume V the attenuation is between 18 and 23 dB and between 12 and 15 dB behind V (acoustical shadow).
In the future we will treat the asymmetrical case with 16 independant channels, introduce slow variations of temperature or frequency and perhaps repeat the experiments in an ordinary room.



Anechoic room
Microphone
3.00 m
V
SS_J
P_S
Acoustic
shadow
ADC
DAC1
DAC2
Conversion
Board
MP
TTY
DISK DRIVE
x
y1
y2
Coeff.
MULTIBUS
x
y1
x
y1
PS1
PS2

- Figure 2 -

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