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IMAGE PRESERVATION IN SOUND REINFORCEMENT SYSTEMS

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1. INTRODUCTION

The downfall of most stereophonic reinforcement systems today with two or three speaker clusters on or near the stage is the seat-dependent distorted level and stereo image. This paper describes briefly a new multi-channel reinforcement system based on appropriately delayed speakers distributed throughout the listening area and further means to recreate the true perspective on stage both, in direction and depth.

2. THEORETICAL BACKGROUND

Since the basic principle of the "Delta Stereophony System" - in short "DSS" has been published a number of times [1, 2, 3, 4, 5], a summary should suffice here.

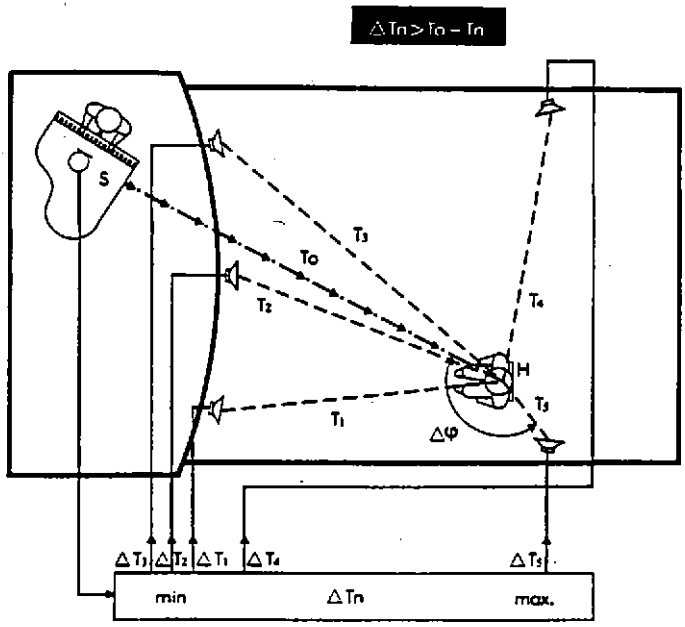
For precise localization of the sound source, the "DSS" applies the law of the first wave front. A high degree of correlation between the optical and the acoustical perception is achieved by the special application of digital delay techniques in connection with a decentralized speaker system.

2.1 The Objectives of this System are:
-> congruent acoustic and visual perceptions, i.e. to hear the sound from where it is being produced on stage
-> well-balanced sound, even if the performers move about
-> excellent intelligibility of vocals even at low sound levels
-> improved sense of space (direction and depth) also in open air venues
-> reproduction of special sound effects, like surround sound or similar

2.2 The System is based on:
-> fundamental laws of sound source localization
-> a method of ensuring for each listener's location that the first wavefront from a sound source (or its simulation) arrives first
-> the use of advanced sound system technology, specifically electronic (digital) delay lines and processors
-> scientifically proven computer-aided design methods.

IMAGE PRESERVATION

Fig. 1 illustrates a simplified situation in a hall where measures are taken, that the sound wave from the original source on stage (S) will arrive with the propagation delay time of the sound wave (To) first at the listener's position (H). After that, the sound from the loudspeaker nearest to the connecting line between the sound source (S) and the listener (H) should arrive next at the listener's position. All other loudspeaker signals should follow according to the same rule.



Δφ	..... Angle between visual and acoustic stimulus (without delay devices)
To	..... Acoustic delay of direct sound waves (unamplified)
Tn	..... Acoustic delays (T_1, T_2, T_3, ...)
ΔTn	..... Electrical delay times (ΔT_1, ΔT_2, ΔT_3, ...)
S	..... Sound source
H	..... Listener location

2.3 Maybe it should be explained here now, where the designation "Delta Stereophony System" has been derived from. Apparently, there exists still some confusion with regard to the term "stereophony", despite of the clear definition contained in CCIR, OIRT, IEC and other documents.

"Stereophony" designates in general a multi-channel method for the recording and transmission of sound events to realize the additional reproduction of direction and of room information from where the recording was made.

For replay systems of records and broadcast transmission systems into the homes, room-related two-channel intensity stereophony via loudspeakers is commonly used.

But two-channel stereophony-despite all advantages - exhibits the deficiency, that there exists a strong location (seat)-dependent perception and consequently this technique should only be used for smaller listening rooms.

As explained before, the "DSS" uses delay time differences rather than intensity differences for localization cues. The method of delay time stacking was chosen as an essential element for the term "Delta Stereophony" and so this particular new sound system was introduced under the trade name "Delta Stereophony System".

3. PRESENTLY USED REINFORCEMENT SYSTEMS

The majority of electro-acoustical reinforcement systems for medium and larger sized halls or theatres are still monophonic systems, relying on central loudspeaker clusters for more or less balanced level distribution throughout the hall.

Two-channel intensity stereophonic systems are also being operated frequently with two loudspeaker "towers" placed far too wide apart. The operators completely ignore the fact, that this method was delevoped for smaller rooms only. Consequently, the directional impression intended by the sound mixer will be noticed only in a very limited area in the centre of the auditorium or near the mixing desk.

Nowadays, single or multi-channel systems with electronic delays for speaker elements closer to the audience are also used. These systems avoid effectively disturbing echoes created by multiple speaker signals arriving at the listener's position with time intervals larger than 30 to 50 ms.

4. THE FUTURE OF SOUND REINFORCEMENT

The latest step in the direction of realistic perception of reinforced sound with emphasis on the real meaning of the term "reinforcement", i.e. enhancing the natural sound source in loudness level and clarity but avoiding all other colourations" of directionality, spatiality, and the like is the "Delta Stereophony System".

It is only a matter of time that this new level of demands will be asked from a sound system by all parties involved, like sound designers, show producers, theatre management, artists and - last not least - the audience.

5. SYSTEM REQUIREMENTS

This new system requires:
-> a suitable distributed loudspeaker system
-> the DELTA STEREO PROCESSOR - DSP 610 connected between a usually existing multibus sound mixer and the power amplifiers for the loudspeaker groups.

5.1 The realization of the "Delta Stereophony System" with descrete delay units and connection matrix requires a substantial investment in hardware and installation work. It will also miss important features and possibilities of a perfect "Delta Stereophony System".

AKG has developed a compact Delta Stereo Processor to fulfil all requirements asked from such a system and match it with fairly simple operational features. Due to its compact size, but last not least because of the operational aspect, the Delta Stereo Processor DSP 610 is well suited for small and medium sized theatres and halls. The DSP 610 may be also expanded for larger venues providing a system with similar operational features. The DSP 610 is also ideally suited for mobile reinforcement systems often required at open-air festivals and similar temporary occasions.

The Delta Stereo Processor contains a digital matrix with six inputs, each with its own delay network and possible connection to one or more of the ten output channels. The delay signal channels may also be attenuated, if required.

IMAGE PRESERVATION

5.2 The Features of the DSP 610:
-> Digital matrix routing 6 delayed inputs to 10 outputs
-> 4 additional non-delayed (auxiliary) inputs
-> Adjustable delay times and attenuation (optional) for each input/output matrix connection
-> Each matrix connection and each input or output channel may be individually switched off
-> Computer control of delay times for moving sound sources, e.g. wireless microphones
-> Level indication for each input and output channel
-> Adjustable gain control for each output channel
-> Transformer balanced inputs and outputs
-> Storage facilities for delay time settings, attenuation and level values
-> All signals are digitally processed to support wide dynamic range and top grade sound quality
-> Means for establishing emergency circuits in case of temporary malfunction
-> The DSP 610 is controlled by an IBM-AT or 100 % compatible computer system via a standard RS 232 interface.

5.3 The Computer Software
All parameters within the DSP 610 are software controlled by an MS-DOS computer (IBM-AT or compatible) via a serial interface.

The most important functions of the software are:

-> Calculation of the individual delay times and attenuation levels using a pre-programmed algorithm
-> Transfer of the delay times and attenuation data to the microprocessor of the DSP 610
-> Control of the delay time values according to the moving sound source position which may be simulated on the monitor screen by a cursor moved with a computer mouse
-> Storage and recall of complete data sets to adapt to changed or alternate system/stage layouts
-> Display of all input and output levels
-> Switching one or more matrix connections or individual input or output channels on or off

6. REFERENCES

[1] Steinke G.: "A Sound Delay System for a Large 5000-Seat Multipurpose Hall", presented Febr., 1980 at the 65th AES-Convention in London. Preprint No. 1599

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