FORUM

RECORDING CONCERT HALL ACOUSTICS FOR POSTERITY

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Heyser [1] has asked if there is any way of incorporating into modern recordings information enabling a future technology to recover the original sound field from the recording. In the following we observe that it is possible to preserve useful information concerning concert hall acoustics, and that this may be used to "reverberate" recordings artificially with a given acoustic. Proposals are made for recording the acoustic itself (in a way independent of the music) for the purpose of studying architectural and musical acoustics.

Recent developments [2]–[4] in ambisonic recording and reproduction technology (i.e., the recording, storage, and recreation of the sound field pressure and three-dimensional velocity at a point; see also [5], [6]) have shown that it is possible both to transduce the lower order directional components of a sound field at a point with good accuracy up to frequencies around 7.5 kHz, and to create via four or more loudspeakers horizontally (or six or more for periphonic reproduction [7]) a reasonably faithful illusion of the original directional field, including the effect of sound source distance, whether closer or further than the loudspeaker distance used in reproduction.

The primary use of such a sound field microphone array [3] is to take down as accurately as possible the relative balances and directionalities of individual sound sources, early reflections, and the reverberant field. In this sense, such a recording using four channels[1] is in itself a "Rosetta stone" [1] for the sound of the original performance. The only "subjective" element of control by the recordist is the positioning of such a microphone, although he may also subsequently use the already recorded sound field as a basis for further processing to obtain a desired less natural effect.

In cases where a nonnatural recording is made (using close microphones and multitrack tape), it is clearly not possible to use this information plus further information about the hall acoustics (whatever the form in which the latter information may be stored) to recover an accurate recreation of the sound of the original performance. There are a number of reasons for this impossibility. First, the number of channels of information required to store all the sound field information over the audio frequency range even over a listening region of only 2-m diameter is around 400 000 by sampling theorem arguments, with the number of channels increasing proportionately to the listening area covered. Second, each of the recorded sound sources is a directional emitter of sound, and the excitation of the hall by this unknown frequency-dependent polar diagram is unpredictable, especially as the close microphone placement can only sample one part of the polar diagram. Third, even small movements or rotations of a performer will change the hall's response to his/her sound. Fourth, normal changes in the disposition of people and objects in a hall (and changes in temperature and humidity) will change the hall response in an unpredictable fashion during the performance.

Also, the layout of performers during a multimicrophone recording session is usually quite different to the optimum performance layout in order to give improved microphone separation. The increased spacing of performers gives acoustic time delays (often in excess of 0.1 s) that affect the timing of cues heard by the musicians, and hence the musical interpretation. It is thus not evident that a recreation of the "studio" performance in the original hall acoustics would be satisfactory in musical terms, even if technically possible. It must also be observed that the empty halls often used for recording sessions rarely have an optimum acoustic. Adding to a recording an acoustic different from that heard by the performers is likely to make those aspects of the original performance depending on the use of the original hall acoustic seem to be musically ill-judged.

Nevertheless, it is perfectly feasible to record the acoustic of concert halls for posterity subject to the above-stated limitations. The procedure is essentially a well-known one. An accurate impulse (e.g., a spark discharge) is launched into the hall from a position A_i and picked up by

[1] This 'tetraphonic' use of four channels to represent components of the sound field is, of course, quite distinct from the use of four audio channels to convey speaker-feed signals for a square loudspeaker layout.