inter.noise 2000
The 29th International Congress and Exhibition on Noise Control Engineering
27-30 August 2000, Nice, FRANCE

I-INCE Classification: 7.2

A NEW SURROUND SOUND RECORDING SYSTEM DEVELOPED AT NRC

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Keywords:
SURROUND, SOUND, RECORDING, MICROPHONES

ABSTRACT
A new surround sound recording system has been developed and built at the Institute for National Measurement Standards, National Research Council, Canada. The system consists of seven microphones housed in an ellipsoid that can be hand held for wireless recording or non-wireless studio recording applications. The system has very good directivity characteristics.

1 - INTRODUCTION

The microphones of the surround sound recording system are labelled according to industry standard: FRONT, LEFT, RIGHT, LEFT SURROUND, and RIGHT SURROUND. Exceeding the standard requirement, there are two extra microphones: TOP, and a LOW FREQUENCY microphone mounted inside the ellipsoid. The microphone system enables the recording of acoustical environment in real-time without phase shifts, time delays or signal encoding. On playback, the seven channel recordings can satisfy existing industry standards of 5.1 channels. The TOP channel can supply signal to an independent loudspeaker placed at the ceiling of the listening area, or the TOP channel signal can be added to the other channels to create a top-channel effect. Demonstration models of both the wireless and non-wireless version were designed and built at the Institute for National Measurement Standards, in collaboration with Rising Sun Productions Ltd., Toronto.

2 - SYSTEM DESCRIPTION

A rack mountable preamplifier control module that is part of the system accepts seven channels of audio signals. Special arrangement was made to enable adding the top channel signal via a ten-turn potentiometer (0 to 100 %) to the remaining six channels. The preamplifier module has seven independent analog outputs together with headphone monitor selection for each channel to facilitate a studio engineer to perform further signal mixing if necessary. Seven LEDs arranged physically similar to the deployment position of the microphones provide indication of the sound level of each microphone. The brightness of the LED gives an indication of the loudness of the sound arriving at a microphone. For the wireless system, the microphones are connected to UHF transmitters, and for the non-wireless system, signals from the microphones are fed to a preamplifier unit that has seven 10 m long audio cables connected to the above preamplifier module for recording studio usage. Both the wireless and the non-wireless systems have similar technical specifications.

The schematic view of the ellipsoid that housed the microphones is shown in Fig. 1. The fiberglass ellipsoid body is mounted on vibration isolated pivot-joints with dimensions of approximately 19 cm by 15 cm. The microphone holders were designed such that the position of the microphones can be adjusted for protrusion from the ellipsoid. For the wireless configuration, the microphones (Sennheiser MKE2-5, 20 Hz to 20 kHz, $\pm$ 3 dB) are connected to seven UHF wireless transmitters (Sennheiser SK 1063) that can be mounted on a belt worn by a person holding the ellipsoid during recording (Fig. 2). The receivers (Sennheiser EM 3032, UHF band 430-960 MHz), not shown, can be located typically up to 150 m from the transmitters.

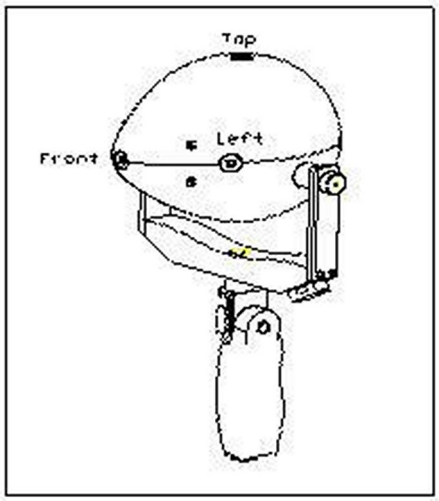


Figure 1: Schematic diagram of the surround sound recording microphone arrangement, showing only the FRONT, LEFT and TOP microphones; the LOW FREQUENCY microphone is located inside the ellipsoid; the handle may be replaced by a rod during directivity measurement.

3 - MEASUREMENTS AND EVALUATION

The electrical frequency response of the above systems is shown in Fig. 3. The small rise in response at the low frequency region is designed to compensate for the low frequency attenuation of the transmitter (Transmitter audio frequency response:
80 Hz to 20 kHz, +1/-3 dB) that has also been modified to enhance the signal transmission at the low frequency region. The LOW FREQUENCY microphone is embedded inside the ellipsoid, and that channel is enhanced to have peak response at 30 Hz, with − 7 dB and − 16 dB attenuation at 10 Hz and 300 Hz, respectively. The directivity response was measured in the NRC GLK Anechoic Chamber by rotating the ellipsoid about the vertical axis (see Fig. 1) at ten degrees intervals. Fig. 4 shows the 16 kHz directivity patterns of five microphones, with directivity response front-to-back separation of approximately 17-dB. The directivity pattern of the TOP microphone (not shown) is circular as expected. For lower frequencies, the directivity separation is less pronounced with approximately 5-dB separation at 400 Hz. During evaluation, it was necessary to have the microphone front surfaces mounted flush with the surface of the ellipsoid (Fig. 1) in order to achieve good directivity response separation. The directivity separation deteriorates rapidly as the microphone mounts protrude from the ellipsoid. It should be pointed out that on playback with a multi-track recorder (such as the TASCAM DA-38), the system does not require signal time-delay and phase-shifts to achieve surround sound effect. The listeners can move around within the confine of the deployment of loudspeakers that are arranged in the current industry standard configurations (FRONT, RIGHT, LEFT, etc) without degradation of the surround effects.
The system, commercially known as the Holophone, has been used to record the Boston Classical Orchestra at Faneuil Hall, Boston; musical instruments such as Guitar, piano, drums and percussion groups, etc. On playback the "hi-fi experts" gave very complimentary reviews [2]. The above multi-channel recording system is being commercialized.

4 - CONCLUSIONS

A new surround sound recording system is described. On playback, the realism of the surround effect of the seven-microphone recording arrangement is superb. This new system may pave the way as the standard for future surround sound recording.

REFERENCES

1. **M. Godfrey**, U.S. Patent No. 5778083, *7 July 1998*

2. **Rising Sund Productions Ltd**, Internet Web site, *http://theholophone.com*

Figure 2: On the left the ellipsoid was under test in the INMS GLK anechoic chamber; on the right, the seven transmitters are mounted on a belt worn by a studio engineer.

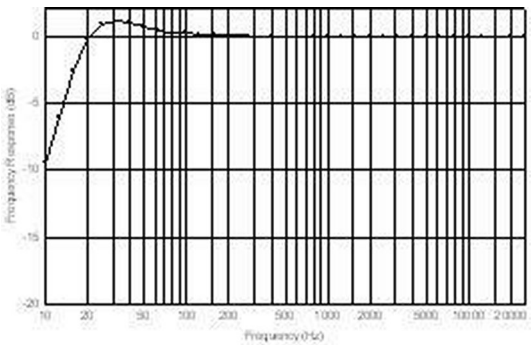
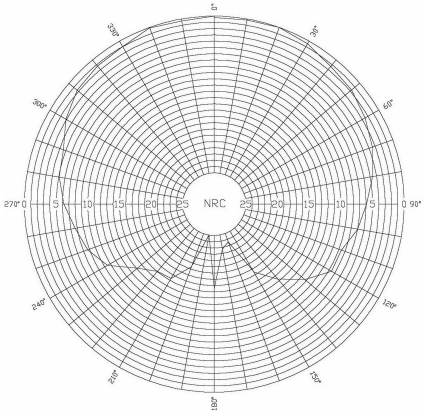
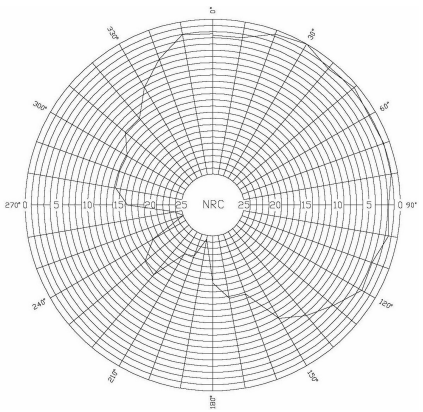


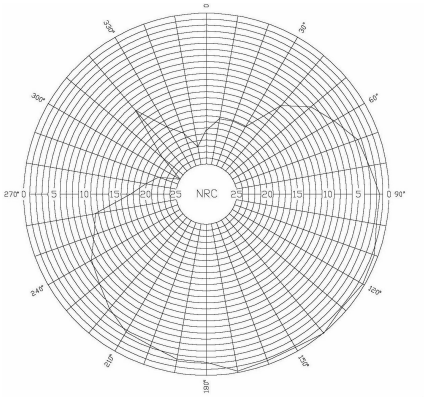
Figure 3: Electrical frequency response of the surround sound recording system; the small rise in response in the low frequency region is designed to compensate for the low frequency attenuation of the transmitter.



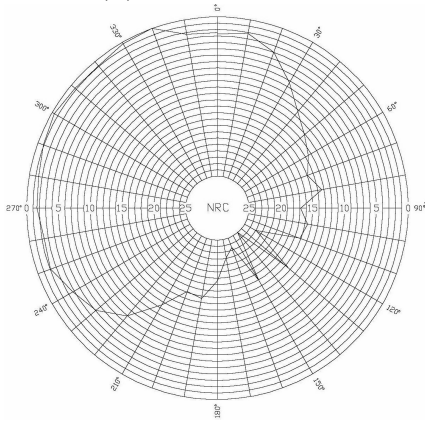
(a): Front: 16 kHz.



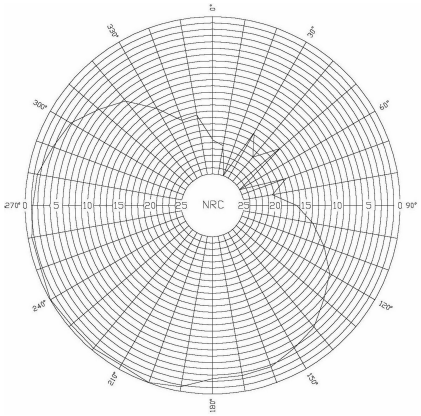
(b): Right: 16 kHz.



(c): R. Surround: 16 kHZ.



(d): Left: 16 kHz.



(e): L. Surround: 16 kHz.

Figure 4: Directivity of the Holophone system measured at 16 kHz; similar measurements at lower frequencies indicate that the directivity is less pronounced and with approx. 5 dB rear separation at 400 Hz.