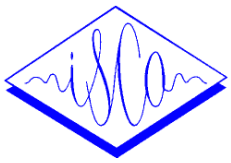

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RECONSTRUCTION, SIGNAL ENHANCEMENT AND STORAGE OF OLD SOUND MATERIAL

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ABSTRACT

In recent years, a growing interest has been shown in the reproduction of sound from old sound carriers and the storage of this material in data bases. Special techniques have been developed for the purpose of sound reproduction, using the reflection and refraction of laser beams. In this contribution, a review of current research in these fields will be given.

1. INTRODUCTION

We want to report on the possibilities of retrieving the acoustic material from wax cylinders and other old recordings by using modern techniques of signal detection and analysis. We pay special attention to the laser-beam reflection method, developed at the Research Institute of Applied Electricity, Hokkaido University, Japan (Asakura et al., 1986). This method has been applied to the reconstruction of speech and songs of the Ainu population in Sakhalin and can also be used in other projects for the restoration of old sound recordings.

Many European institutes, also in the Netherlands, have collections of old wax cylinders, which were used in phonetic and ethnographic research at the beginning of this century. At present, the sound of many of these recordings is not available, because of the absence of the right equipment and the risks of damaging the sound carriers.

2. THE USE OF THE PHONOGRAPH

The principle of the original phonograph, which was introduced by Edison in 1877, is simple: A metal horn focuses the energy of the sound waves onto a thin diaphragm, which supports a small needle in its centre. When the diaphragm vibrates in response to the energy of the focused sound waves, the needle, too, vibrates as it is drawn across the revolving surface of a wax cylinder, cutting a groove consisting of microscopic gouges in the soft cylinder surface. In this way, a recording of the pattern of sound waves is made. To play back the recording, the fitting with diaphragm and needle is replaced over the gouges made during the registration. The attached diaphragm vibrates, creating sound waves duplicating

those which had originally been recorded. From the early use of the phonograph until the coming of portable disc-recording equipment in the early 1930s, the cylinder phonograph was the only mechanical means of recording ethnographic data acoustically. Ethnographers in the late 1880s were intrigued by the possibilities of using the new cylinder phonograph for field work and it was used for the first time around 1890 for the recording of American Indian songs and stories. Since that time many other cylinders have been produced for a similar purpose and such recordings on wax cylinders are still being kept in many places in the world. It would be of great interest to regain the sound material they contain, and to improve its quality by using modern registration techniques and signal analysis.

3. THE REPRODUCTION SYSTEM

Using the original Edison-type phonograph for the reconstruction of the sound material involves a risk of damaging the wax cylinders. This method cannot be applied to broken wax cylinders which have been repaired. Therefore, at the Institute of Applied Electricity of Hokkaido University, a non-destructive, non-contacting method has been developed on the basis of laser-optics technology (Asakura et al., 1986).
A Gaussian laser beam is focused by an objective lense. The wax cylinder, which is translated during rotation, is illuminated by this beam of which the spot diameter on the cylinder can be adjusted to the width of the grooves. The detecting plane for the reflected beam is set perpendicular to the optical axis. The wax cylinder is rotated and the intersection position of the reflected ray on the detecting plane moves in time on this plane. The time variation of the intersection position is detected by a 1-D position-sensitive device and it corresponds to the time-differentiated sound signal. The properties of the sounds reproduced in this way depend on the width of the illuminating laser beam. In addition, there is the obstructive noise in the reproduced sounds, caused by using a coherent laser beam for illumination, and there is the tracking error resulting from improper contact with the grooves. These problems have been investigated experimentally by Asakura et al.(1986). Since the laser-beam reflection method is non-contacting and non-destructive, it is a powerful tool for retrieving sounds from old wax cylinders without damaging them.

A similar method has been developed for the non-destructive non-contacting reproduction of the sound from old disk-type records. In this method the diffraction properties of the laser beam are used in order to get an optical signal where the direction represents the horizontal (lateral) deviation of the groves. In these records lateral variation of the groove represents the acoustic signal (Uozumi & Asakura, 1988).

4. RESULTS OF SOUND RESTORATION PROJECTS

The Japanese project has provided the possibility to study the Ainu language from Sakhalin as it was spoken at the beginning of

this century (Murasaki, Kirikae & Fujimura, 1985). The Ainu people lived in the Northern part of Japan, on Sakhalin and the Kurilian Islands. Due to historical developments, their number has decreased dramatically and the language is at present only spoken by a few old people living on Hokkaido. Some of them were consulted when the material from the Pilsudski wax cylinders was played to them. In several cases, they recognized the Ainu dialect and the voices from the past.

In this way, the last stages of a dying language have been safely recorded and the restoration of sound material with this method is therefore of great importance. The material can be studied by linguists and ethnologists in order to obtain information on the Ainu people. The wax cylinders and their contents can thus be considered to be part of a very important cultural heritage, because they contain valuable sound data of spoken language and songs of the Ainu people that were lost long ago.

4. SOUND ARCHIVES

In Europe, in particular in the Netherlands, this and similar methods could be used to study the dialect material that was recorded more than 60 years ago by the first phoneticians at the Amsterdam Institute of Phonetic Sciences and elsewhere. In this way, we shall be able to get information about the spoken language of that time and to compare that language use with the present situation.

The material can be added to the data base of Dutch dialects which is stored in the Sound Archives of the Department of Dialectology at the P.J.Meertens-Institute in Amsterdam. A collection of 1200 sound tapes is kept there on analogue tape, for part of which a transcription has been made. This collection has been used for various projects in the study of the Dutch language and its dialects. In the future, new techniques for the restoration of old spoken language material will provide a useful further contribution to this collection.

5. SIGNAL ENHANCEMENT

The sound reproduced from old recordings is usually of poor quality. This may be caused by the original recording techniques (e.g. resonances in the horn), by the damage of the sound carrier which has occurred over the years (clicks at burst positions) and by the reconstruction technique. In order to improve the sound quality, several methods have been developed which can also be applied to speech enhancement in general.

In Japan, the old Ainu recordings have been processed by the Speech Processing System by use of the Auto Correlation Function (SPAC), described by Suzuki(1985) and applied at the Communications Research Laboratory in Tokyo. In the case of the Ainu tapes, the result of the processed sounds was not always satisfactory: in several cases the listeners preferred the original unprocessed

sounds, even if there was noise on the tape. This was due to the fact that after processing the noise level is reduced, but certain bad-quality-features are still there and become more prominent. The recorded and processed Ainu data are stored at the Research Institute of Applied Electricity, Hokkaido University.
Another digital signal processing method has been developed by Deutsch (1988) at the Austrian Academy of Science as an integrated work station for Music, Acoustics, Speech and Signal Processing. In this system, the signal is improved by eliminating random impulsive noise distortions due to damage, and by reducing background noise and unnatural sounds caused by resonances in the original recording equipment. It is found that the acceptibility and intelligibility of the resulting speech sound does not increase when more and more of the background noise is removed. There is a certain noise level at which an optimal situation is reached: there the defects of the original recordings are still sufficiently masked by the remaining noise. These psychoacousic aspects of the restoration of these old sound recordings have to be investigated further (Deutsch, 1988).

CONCLUDING REMARKS

In a research proposal of the Groningen Institute of Phonetic Sciences, in collaboration with the Groningen Laboratory of Technical Physics, we have suggested using techniques similar to those of the Japanese groups in order to investigate the old sound material stored in many places in Europe. This could provide important material for further research in the fields of linguistics, dialectology and ethnography.

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