

Die Technologie der Langzeitspeicherung von Audioinformation

Technology for long-term storage of audio information

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Zusammenfassung:

Es sind Resultate der Untersuchungen an Verwahrung der rariteten Audioaufzeichnungen dargestellt.

Abstract:

The results of researches on preserving rarity audio records are presented.

1. Introduction

The preservation of the cultural heritage is one of the foreground task in the modern world. The task consists not only in keeping physically manuscripts, soundtracks, videos, etc. but also to provide for to them an access of the broad circle of researchers. Now the unified general approach to the solution of this problem was formed: the digitization of rarity editions and the organization to them of the on-line access. In realization of this approach to preservation of concrete collections there are many common engineering solutions: maintenance of long-term storage of digital copies, use of standard data presentation. However, in some cases it is necessary to develop special hardware for digitizing initial materials. The process of preparation of the audio information which has been recorded on phonographic cylinders, to transferring in a digital form on carriers for long-term storage, is presented in the given communication.

2. The tasks of research

Principles of recording the earliest audio signals, realized in Edison wax cylinders, turned out to be very successful. This provided safety of audio records for the whole century. Modern systems of reading audio signals from wax cylinders can provide even a higher quality of sounding than those used at the instant of information recording on them. It naturally concerns the cylinders that were not damaged during long storage. The principal causes of damages are scratches and pits from chips on the surface, destructions produced by activity of microorganisms, contamination by dust particles. The only real way of keeping the unique audio collections stored on wax cylinders is their translation into a digital form and transfer onto other types of carriers. The translation into the digital form will allow not only to keep audio heritage for a long period, but also to make the soundtracks free of noise by using digital filtration methods and organize on-line access to these soundtracks.

The reproduction of audio information with sufficiently high quality from phonographic cylinders is possible only on the modern specially developed equipment. Attempts to carry out reproduction of a sound on original devices results in irreversible changes in structure of sound tracks. Repeated attempts of reading information by mechanical sound pickups result in significant reduction of frequency band of reproduced signals and increase of the noise level.

To make the rarity records reproduced from phonographic cylinders accessible for a wide range of researchers is possible only after careful multistage clearing the soundtracks. The experience in preparation for the edition of the soundtracks reproduced using phonographic cylinders from the M. Beregovsky collection (it is the collection of Jewish ethnic music related to the first half of the 20th century) and Osip Rozdolsky collection (i.e., the collection of Ukrainian ethnic music dated by the same period) has shown the necessity to represent phonorecords with various levels of signal processing (the instrumental records that are of interest for a narrow circle of experts and edited to a maximal degree, with a low noise level - for those who are interested in ethnic music). The obligatory requirement is the presence of the contextual information: about performers, conditions of soundtrack recording, music notations, *etc.* As a consequence, the short audio records (sounding 1 to 4 minutes) with the limited frequency band (4...8 kHz) require the memory capacity of tens Mbytes. It means that recording multimedia information representing results of ethnographic expeditions requires the carriers with the capacity equal to several hundreds of Mbytes and a high speed of reproduction from them.

3. The process of preparation of audio materials to issuing

The principal distinctive feature of the developed method is that from the cylinder in a digital form the profile of a sound track is taken off and registered in a computer rather than its first derivative (speed, i.e. a sound) as it occurs in case of application of a sound pickup. Thus reproduction of a profile is carried out at the speed 20-30 time lower than that of a sound recording at the value of static loading on the stylus of 0,5-0,8 g.

The method and the equipment allow to reproduce a sound without appreciable nonlinear distortions in the frequency band from 0 up to 16 kHz to reduce substantially the noise level caused by the presence of the dust, microcracks, surface cylinder damages by microorganisms.

The technological process of soundtrack processing consists of the following operations:

- recording the data on information track profile onto Winchester, approximation (correction) of the damaged areas (as the first stage of clearing);
- differentiation of signals corresponding to the surface profile, for reception of audio signals;
- usage of a software and hardware for clearing the sound;

At this stage classification, separation by duration and frequency of distortions present in a soundtrack is made first of all. Then the regeneration and the reconstruction of a signal is carried out. During this process the digital processing of soundtracks is performed in the following sequence:

- Removal of pulse interference (clicks);
- Removal of low-frequency pulse interference (crackling in a signal);
- Filtration of low-frequency noise (rumble);
- Suppression of broadband surface noise.

The process of clearing soundtracks, depending on the physical condition of the cylinder surface, and consequently both on quantity and type of interference and distortions of a sound signal, can take from 30 minutes to 3-4 hours. Such a significant time spread is connected with that many operations on clearing and regeneration of a signal record is necessary for carrying out "manually", for each concrete sound material is necessary to arrange the nonlinear filter monitoring speed of change of a signal, to update the algorithm of detection, regeneration and correction of a signal from clicks and other pulse interference of various frequency.

- creation of the multimedia supplement by using the earlier digitized additional graphic materials;
- recording on CD-R (DVD-R) or CD-RAM (DVD-RW).

4. The organization of the recorded long-term information storage

The recorded compact disk should provide long-term storage of the multimedia information located on it. However, it is difficult to hope that it will preserve the information so much time as the wax cylinders from which it was read out. This restriction is bound up with several reasons:

- the limited period of information storage on CD-R (CD-RW) disks;
- physical and moral aging of CD players;
- appearance of new software products.

Since the problem of the limited service life of compact disks is related to changes of polycarbonate properties and characteristics of thin-film reflecting layers with time, we offer to solve it by using glass compact disks. The relief structure created on the surface of a glass substrate precisely corresponds to representation of information in the form of pits with various lengths on a plastic substrate of a standard compact disk. The metal reflecting layer is expedient to be made from corrosion-proof materials with the high adhesion to glass (chromium, nickel, platinum, *etc*). Such carriers can be read out using standard CD players. The use of high-quality glass substrates with minimal optical inhomogeneities (first of all, with essentially lower birefringence) and beating will facilitate the process of information reading. Since new CD players are developed and produced in view of the requirement of backward compatibility and data recording is carried out in unified ISO 9660 format, there are all grounds to consider that high-reliability optical disks with rarity records will be more long-living than phonographic cylinders. It is also noteworthy that the chosen form of data presentation on compact disks allows to read out the information from them not only by the focused optical radiation but also by methods of scanning tunnel or electron microscopy.