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A NEW SYSTEM FOR THE SURVEILLANCE OF ANALOGUE PLAYBACK DEVICES

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Introduction

When large amounts of analogue sound carriers need to be digitised, a significant improvement of quality surveillance as well as time savings can be achieved by the use of modern technology, especially when collections are recorded in standard formats and if they are of mostly homogeneous technical quality. Mass digitisation very often relates to the unique media of our audiovisual heritage. Furthermore, for reasons of cost and effort, the transfer of these media can be done only once. That is why precise and efficient quality assurance actions are essential.

These actions can be classified into methods of quality assurance, which include securing the best possible signal path – such actions are taken before the actual recording — and methods for quality control which are taken during and after the recording process.

Detection of transfer-related errors is of high priority in mass digitisation, because where such errors occur, the technical quality of the archive file is reduced compared to the physical carrier. Of less importance is the detection of media errors (errors that are already present on the physical carrier), as such errors cannot be avoided during the digitisation process — they can only be logged.

The following will show how existing methods of quality assurance can be optimised by employing a new system which helps to ensure the integrity of the signal path by automatically evaluating reference recordings. When describing these methods and approaches, the focus is set on recurrent procedures. Obvious quality influences such as the qualification of employees, the definition of appropriate practices/the adherence to these practices, or simply the quality of the playback devices in use are not further described.

Quality assurance through optimising the recording path

Measures that are taken prior to an audio recording in order to improve its quality are generally related to quality assurance. One such measure is the optimisation and maintenance of the recording path.

The signal path consists of different single devices when digitising analogue sound carriers. In most cases the signal path is a series connection of the following components:

- analogue playback device
- analogue-to-digital converter
- audio interface
- recording software

Analogue playback devices are usually the most error-sensitive components in a digitisation system. It is therefore essential to regularly service and calibrate these devices. Additionally, the whole signal path should be controlled in regular intervals by using reference signals. Executing and evaluating such measurements is time-consuming and often involves a considerable technical outlay, plus it requires qualified personnel. For the determination of different relevant parameters it is usually necessary to carry out measurements with different test signals or media, and partially different measuring devices.

However, cleaning the tape path of reel-to-reel and cassette-tape machines can be undertaken by the operator. Depending on the quality of the archived tape material, cleaning should be done up to several times a day. As every practitioner knows, even playing back a single tape can leave remnants on the tape head, thus causing sound quality deteriorations for subsequent playback.

Cleaning or physical restoration of sound carriers — as is often necessary with records — can also be assigned to the category of quality assurance.

New system for surveillance of playback devices

In practice, the great effort inherent in quality assurance in the form of regular alignment of analogue playback devices is a big problem. Together with the need to exclusively employ experts for this task, the activity often leads to a drawn-out maintenance interval which makes it impossible to get safe statements about the condition of the devices.

This security gap can be bridged with the help of a new system which is based on the automatic analysis of a recorded reference signal. It is achieved by using a special test medium containing a defined sequence of different test tones. Depending on the playback device, these tones can be on tapes, compact-cassettes or records. Special software takes care of the recording as well as of the automatic analysis of the reference signal passing through the signal path. In this way, numerous variables characterising the condition of playback devices can be determined within a short period of time. Provided that reference media are of high quality, very precise measurements can be achieved. The system, called "Calibration-Inspector", is capable of measuring quantities such as, amongst other things, frequency response, speed deviation, wow & flutter, distortion, azimuth, stereo balance, cross talk and signal-to-noise ratio.

The option of parallel reference signal recording from multiple playback devices and the short analysis duration, which mainly depends on the approximately two minute reference signal, allow for checking analogue playback devices at short intervals — e.g. daily. The surveillance of reel-to-reel machines, cassette decks and turntables therefore becomes independent from alignment procedures which are completed at longer time intervals. In addition, this quasi-continuous monitoring does not only indicate when a calibration is necessary, but it also provides valuable information for the service technician in order to achieve an optimal alignment of the devices. By filling the gaps between the maintenance dates, it is possible to avoid recording audio material over a long time while using machines that do not meet the required quality criteria.

Figure 1 illustrates the security problem that occurs when maintenance is performed at large time intervals only. The security once attained after alignment decreases over time (front graph), so it is impossible to make any safe statements about the integrity of the recording path between maintenance dates. Even though the analysis during a device calibration allows for drawing conclusions about past recordings, the consequence of this information should possibly be a re-digitisation of the archive material recorded in the previous days or weeks. This would lead to enormous additional costs, and could be avoided with the new system by performing a preventive analysis of the signal path (rear graph) — the security gap would be closed.

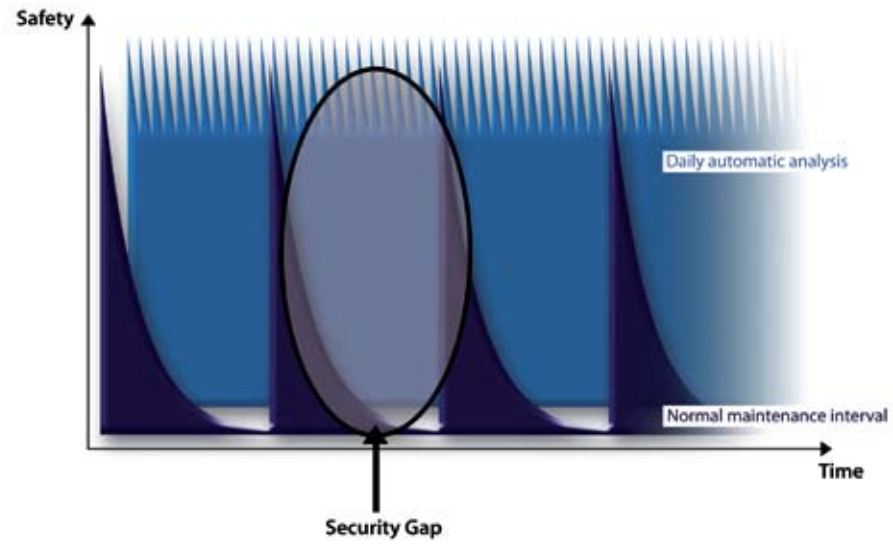

Figure 1. Security gap when maintenance is performed in large time intervals (front graph) and prevention of this problem through the use of a system for automatic, reference-based condition analysis (rear graph).

Suitable professional playback machines have not been produced for a long time. In the case of reel-to-reel machines, most of these machines are between 20 and 40 years old. In a mass digitisation project they are operated for up to 12 hours per day. So monitoring the condition of these machines should be taken for granted. Until now, there have not been any adequate solutions to close this dangerous quality management gap in a satisfactory way.

The system presented also allows for automatic examination of compliance with a defined quality standard. The user can set two tolerance values with different priorities for all available parameters — or only for those of interest — within a tolerance scheme. After analysis, the present measurements are compared to the values that were defined in the tolerance scheme in an evaluation process and are displayed on a unified percentage scale. The additional application of a traffic light style visualisation helps with maintaining an overview of the compliance with the tolerances.

Figure 2. Principle of an automatic, reference-based condition monitoring of playback devices.

Figure 2 schematically illustrates the principle of function of the "Calibration-Inspector" system. Both the measurement values determined during the analysis and the results of the evaluation are saved in a report file.

Another interesting feature of this system is the possibility of long-term evaluation and documentation of the results. By graphically displaying the measurement results over a longer period of time, subtle effects as well as creeping deterioration become visible and the comparison of different machines is made possible. Statistical evaluation of long-term data may provide insight into coherences which otherwise would not have become obvious.

As an example, Figure 3 shows the speed deviation measured for six different reel-to-reel machines in percent over a time period of six weeks. The applied tolerances are displayed as different coloured areas in the background of the diagram. The user can see at a glance if the chosen tolerances have been fulfilled.

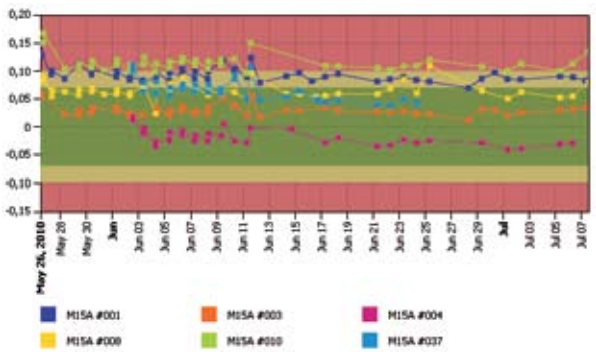

Figure 3. Speed deviation in percent, measured for six reel-to-reel machines over a time period of six weeks.

The advantages and disadvantages of the system for automatic, reference-based condition analysis of analogue playback devices are summarised as follows:

Advantages:

- efficiency: the controlling process does not require specialised personnel; time effort is reduced to the length of recording the few minutes reference signal
- precise measurement of different technical quantities
- automatic monitoring of adherence to self-defined tolerances
- indicates the need for maintenance
- provides valuable information for alignment procedure of playback devices
- automatic condition documentation of playback devices

Disadvantages:

- test media only available in common standard formats
- lifetime of test medium is limited
- quality of test medium has impact on the final result
- when dealing with strongly inhomogeneous archive material, most of the parameters are not of great interest, because individual adjustment of the playback devices is necessary for each variable.

Certification of digitisation services

Based on the presented measurement procedure, a certification service was developed. This service allows for the continuous monitoring of measurement parameters of analogue playback devices. The service can on the one hand be used for internal quality management. On the other hand it can also become part of contracts between sound carrier owners who are striving for mass digitisation through outsourcing and service providers that offer this digitisation service, and then be used as a means for quality surveillance.

If, for example, an archive is planning to outsource the digitisation of a large tape collection, it is now possible for the first time, through the use of the above mentioned system for automatic, reference-based analysis, to explicitly define the expected quality of the digitisation within the respective service level agreement (SLA). In contrast to general regulations which, for example, regulate the use of certain playback machines or the frequency of maintenance, additional objective aims or tolerances for the measurable audio quality parameters can be defined and efficiently controlled throughout the digitisation project.

Defining tolerances for a minimal acceptable signal-to-noise ratio or the maximum possible wow & flutter values for reel-to-reel machines ensures a monitoring of parameters which is not possible when using conventional methods.

Controlling whether the service provider adheres to the predefined guidelines can be realised through a respective online service. It is necessary, however, to ensure an automatic and safe transfer of the quality measurement data from the service provider to the online service platform. After evaluating the measurement data by reference to the tolerances defined in the service level agreement, a quality certificate for the ingest of recordings within a defined time period is awarded. The frequency of analysis is defined in the service level agreement. As a standard, the measurement has to be completed once a day. In order to simplify the SLA draft, universally applicable descriptions of the service level quality guidelines are available and can be used within the scope of, for example, tenders for digitisation outsourcing.

Both the archive and the service provider are given an insight into the measurement data of the playback machines in use. By means of a web-based quality management system (QMS) provided by the system, both parties can participate in the controlling process and are able to view detailed reports.

Figure 4 shows a schematic of the interactions between the outsourcing archive and the digitisation service provider.

Figure 4. Quality control when digitising analogue media with the help of an online quality certification service.

The employment of such an online certification service provides benefits for both parties: archives obtain a quality assurance instrument for the recording of their media. In the past, sound carrier owners had to implement quality control by means of a cost-intensive strategy: multiple recording of a single sound medium and time-consuming comparative analysis. The availability of objective measurement results allows for a drastically simplified quality monitoring.

For companies or organisations dealing with the process of mass migration of analogue media, long-term evaluation is an important tool for supporting the continuous internal improvement process. For example, slow deterioration over time can be made visible. Besides the cost savings due to precise situation assessment, there is another advantage for service providers: when using playback devices of different quality, it may have been difficult to argue the higher costs for recording with high-quality machines to their clients. With the help of the automatic, reference-based analysis, quality differences between average and high-class playback devices become easily measurable. By documenting the measurement results, the client can easily see the quality difference between different machines. The SLA guidelines can therefore offer different service levels, thus enabling a quality based pricing system. The adherence to the agreed service level can be proven to the client with the online service. For quality-conscious service providers this opens up new opportunities to set themselves apart from competitors that operate with a less than convincing quality management system.

Summary

The use of a system for the automatic and reference-based quality surveillance of analogue playback devices represents an efficient means of quality assurance when digitising audio media. The method therefore contributes to the preservation of our acoustical heritage.

The quality of digitisation can be markedly improved by this newly obtained control option, provided that a sufficient homogeneity of archive material is given. With extensive automation of the measurement procedure, the ratio of achievable quality to cost or duration of the migration project is improved significantly.

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VIDEO DIGITIZATION AT THE AUSTRIAN MEDIATHEK

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In September 2009 the Austrian Mediathek started a project called "Österreich am Wort". Its goal is to digitize and publish via the web about 10,000 full-length recordings within three years. The misfortune for me personally was that in the proposal for this project someone had claimed 2,000 of these to be video recordings. This meant I had to start what we so far successfully had postponed: Video digitization.

Requirements

As a first step, we outlined the requirements we thought important for a digitization schema that best supported long-term preservation. Unlike audio digitization there is still no widely accepted archive format for video.

- **Lossless format**
  The most important requirement for the archive format is that it is absolutely lossless. It is clear that if the content is expected to last forever, it must undergo endless instances of conversion into future formats. Therefore each loss in quality, even if it is minimal, would lead to a total loss of content at the end of the migration chain.

- **Non-proprietary codec**
  The codec must not be proprietary. It must be capable of being used by any programmer for implementation in any program that is intended to deal with it.

- **Hardware independency**
  Video playback shouldn't depend on dedicated hardware. This would limit the use of programs to those that can deal with the dedicated hardware, which in many cases would be proprietary software.

- **Reduced data**
  Calculations have shown that video digitization produces a huge amount of data. Although the prices for storage decrease steadily, the costs are still very high. Calculating in these dimensions, the chance to cut them in half it becomes an important argument.

- **Metadata**
  Documenting the whole process of digitization including metadata of all tools used and their configuration is important for later research.

- **Affordable system**
  Only a small portion of the budget could be spent on video digitization at the Austrian Mediathek. There was only a limited funding for the project "Österreich am Wort". Therefore, the system to be installed for the video digitization had to be cost-effective.

As a last requirement we tried to follow the basic strategy that simplicity makes life easier.

9 The author wants to thank Peter Bubestinger, who did all the scripting for this project, and made the concept of this project grow from the simple idea of a script to a complete system. I also want to gratefully mention Christopher Maines, who helped to prevent me from accidentally writing nonsense because of my ignorance of the English language.