Abstract

In this thesis we approached the stages of developing and implementing a software product that would improve the quality of certain types of audio recordings. The considered audio recordings are those whose storage format is the mechanical analog one, namely vinyl and shellac records. This paper presents the theoretical concepts used, from signal processing basics to machine learning, and also the practical experiments and results, which go from understanding the problem to trying different approaches in solving it.

Personal contribution to this work shows in many different ways. First, there's the studying and understanding the details behind the problem, which besides hours of listening to different records on various playback setups, also involved reading and putting together information from forums, microscopic images and audio waveforms and spectrograms. Then, there's the distortion repair procedure, for which we decided to use a two-step process: detection and reconstruction. For detection, the use of a neural network was decided based on results that compared it to other classification systems. The training data for the intelligent agents were also the results of our own work: monaural records were recorded with a stereo cartridge, so any significant difference between the two channels could be considered distortion. This way, big and accurate datasets were generated in a way easier and faster manner than manual classification. Finally, on the reconstruction step, we observed that only reconstructing the high frequencies gave much better results than reconstructing the signal as-it-is, but with a few exceptions.

This paper is structured into 6 chapters. The first one gives the reader a better understanding of what's happening at the groove level during playback and what causes the different types of damage. The second chapter presents the results obtained by other software programs that offer a solution to our problem. Third chapter provides the some basic signal processing notions that will further be required, especially in the practical part of the work: the application. These notions include the Fourier transforms and FIR and IIR signal filters, which when pieced together are used to change a signal's frequency response. The fourth chapter comprises two parts: damage detection and signal reconstruction. For damage detection, results of training a neural network with different data configurations are given, and for the signal reconstruction, linear prediction is explained, while also presenting refinements that make the signal repair give more ear pleasing results. The fifth chapter is all about the application: its architecture, structure and details about the implementation. It also includes how-to-use instructions and system requirements. This paper concludes with the sixth chapter, which is short summary of this thesis' contents and how it can be improved and continued, while also highlighting the personal contribution involved in this work.

This work is the result of my own activity. I have neither given nor received unauthorized assistance on this work.