Lecture 1: History and future of audio signal processing

Introduction

The topic of this week's lecture was a historical overview of developments made in the area of audio signal processing from its origins in the 19th century all the way to the modern, so called digital era.
In this short essay I will try to go over the most important developments achieved in the area of audio signal processing past 150 years, but I will also make an attempt in predicting and discussing what the future development of this field potentially brings us while taking into consideration the most recent developments and the direction they're going in.

Origins of audio signal processing

We can say that audio signal processing as a field dates all the way back to the Bell's invention of the telephone in the 1876. Following this invention there are also several notable inventions in the 19th century such as phonograph - the first device that allowed us to perform sound recording. What is particularly interesting about it is the way it stored the sound waveforms which was purely mechanical, contrary to today's devices approach of storing the waveforms digitally which wasn't available at the time. A horn is attached to a diaphragm which vibrates when subjected to sound, the diaphragm is further connected to a stylus which moves when the diaphragm vibrates. This movement combined with the turning of the handle attached to a cylinder causes the stylus to leave a trace in the surface of the cylinder, which would be covered in wax or thin layer of tin foil, depending on the implementation.
Besides the telephone and phonograph, other notable inventions include De Forest's invention of the amplifier in the 1906 as well as Rice & Kellog's invention of the dynamic loudspeaker in the 1925.

Lastly, I'd like to mention the accidental invention of the theremin[1] which also reminded me of the Spencer's accidental invention of the microwave as a result of a chocolate bar melting in his pocket. However I digress, Leon Theremin was working on a machine that used radio waves to measure properties of gasses when he noticed that by moving his hands around, the apparatus emitted various sounds which could be shaped by his hand movement around the antennas. Realizing the potential of this due to his previous cello training, he went on to turn it into a playable instrument which is still in use to this date especially in the movie industry.

20th century overview

Audio signal processing saw rapid development during the 20th century, especially during the second half of it following the second world war. This was partially thanks to declassification of military inventions made during the war, but also due to significant advancements made both in computers, but also in electronic instruments.

1948 is considered as a birth year of signal processing with publishing of Shannon's *"A mathematical theory of communication"*, Hamming's invention of error-correcting codes and transistor invention by the Bell Telephone Lab. In the 50s we saw a first appearance of headphones (initially believed not to reach such success),

computer music experiments but it's also the time when Fender unveiled their first electric guitar nowadays known as Telecaster, formerly called Esquire which differed from the modern Telecasters in its pickup configuration - only one, single coil pickup in the bridge position instead of both in the neck and bridge positions.

In the 60s we saw the first DSP algorithms such as digital reverberation, analog music synthesizer (Moog) and probably most importantly FFT algorithm in the 1965. It was also the time when first 3-D sound experiences became available using the 2 loudspeaker technique. Throughout the 70s we saw further development of DSP, synthesizers and other related technologies such as appearance of first samplers, Synclavier in 1975 followed by a Fairlight CMI in 1978. At the time these were fairly rare and very expensive devices with Fairlight CMI costing a staggering 30, 000 USD. Despite the price, they found its usage both in film and pop music industry. It's graphical interface resembled today's DAWs or sequencers. 1980s were the time when audio DSP became mainstream and portable. This is thanks to the invention of the Sony's Walkman in the 1980 followed by the invention of the CD in the 1982 which set the standard for audio storing for the next 20+ years. It is also important to note that at this time MIDI first appeared which is still in use to this day as a standard mean of communication between MIDI instruments and various modern DAWs and other software.

Digital era development

The galloping development continued to this day as the invention of internet in the late 90s changed everything, including the audio field. Throughout the past two decades we saw significant advancements made in the way we store audio files, moving from CDs, SD-cards and other similar media to digital storing in various digital platforms or cloud services. Consequently, this also impacted the way we consume audio as nowadays most people have access to various streaming services and can access them within a few clicks on their smartphones or computers. Furthermore, devices we use such as mobile phones, headphones, laptops, etc. keep increasing their sound quality and amount of provided features while significantly reducing the form factor. Besides that, we also saw significant advancements in terms of augmented and virtual reality and the level of sound realism achieved there.

What to expect in the future?

The rapid development of audio signal processing and related fields, which we witnessed in the past, shows no signs of stopping anytime soon. Therefore, I believe that there are surely some important inventions coming in the future, surely some of which we cannot even imagine yet. However, considering the most recent developments I would imagine that the role of artificial intelligence in various applications is going to keep increasing (e.g. effect modelling, sound restoration, speech recognition, music transcription, music stemming, etc.) Besides that, I believe that significant advancements will be made in terms of virtual acoustics and virtual audio as the importance of VR/AR keeps growing. Other aspects that might change is how we consume audio, i.e. the devices for audio playback will most likely keep shrinking while maintaining or even improving the audio quality. All things considered, I believe that the future of the audio signal processing and audio fields in general is very bright with a lot of interesting and useful innovations to come.

References

[1] BBC - The theremin: The strangest instrument ever invented?

[2] Lecture Slides - History and future of audio signal processing