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SYNTH CHALLENGE 2022
Sound and Musical Instrument Synthesis

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Abstract

In this report, I will describe this year's contest: Synth challenge 2022. I found out about this challenge through the course of 'Synthesis of Audio Signals' on Czech technical university in Prague. The tasks included the synthesis of sounds and music or musical instruments. One of the tasks was to make a sound for electric car Škoda and the other task was to synthesis a musical instrument for one of the following compositions using MIDI files. I personally chose the composer Jacques Offenbach and the composition "Barcarolle".

For the electric car part of the challenge, I wanted to create a sports car sound and for the second part, working with music, I wanted to include as many instruments as possible thus creating the sound of a large orchestra.

For the electric car, I came close to the sound I had imagined at the beginning, but for the second part I didn't managed to create "the orchestra". In the end, I just designed a lead instrument that, with some imagination, resembles the sound of a saxophone, an instrument that I wanted to imitate. The entire implementation of the project is described in more detail in the following chapters.

Both parts of the challenge were a big challenge for me as I'm not the most proficient in Matlab. But I had to do a lot of research while creating them and in that way, I learned a lot. At the end of this challenge, I am very satisfied, but I believe this is not the end and the challenge has only just begun.

Introduction

This year, within the course 'Synthesis of Audio Signals', we took part in the synth challenge 2022. The competition is designed for university students who can participate by submitting two tasks. The tasks include the synthesis of sounds and music or musical instruments.

The competition covers the following challenges.

the first part covers the synthesis of the sound of an electric car. The Škoda company has provided all the necessary data that the car records on the road. We had over 70 variables at our disposal that we could use for sound synthesis. However, we focused mostly on the variable speed and engine revolutions, with which we could most naturally define the final sound.

The second part of the challenge included Musical instrument synthesis of one of the following compositions using MIDI files. We were choosing between Jacques Offenbach's composition "*Barcarolle*" from 'The Tales of Hoffmann' and Leroy Anderson's "*Typewriter*".

I personally chose the composer Jacques Offenbach and the composition "Barcarolle"

When synthesizing the sound of an electric car, I wanted to get as close as possible to the sound of a sportier car. Personally, I think that I managed to get close to that. I will describe the method itself and how I approached the challenge in more detail in the method chapter.

Unfortunately, I didn't manage to do much when it came to synthesizing of the song. When reviewing the challenge, I made it my goal to include as many instruments as possible to get as close to the original composition as possible, which I find truly beautiful. I'm a musician myself, so the assignment really appealed to me. Unfortunately, despite a lot of effort, I was not able to achieve my goal. Right before the end, I had to abandon the goal and, in the desire to submit at least something, focus only on the simple synthesis of the sound that I liked the most. I will write a little more about the method I used in the next chapter.
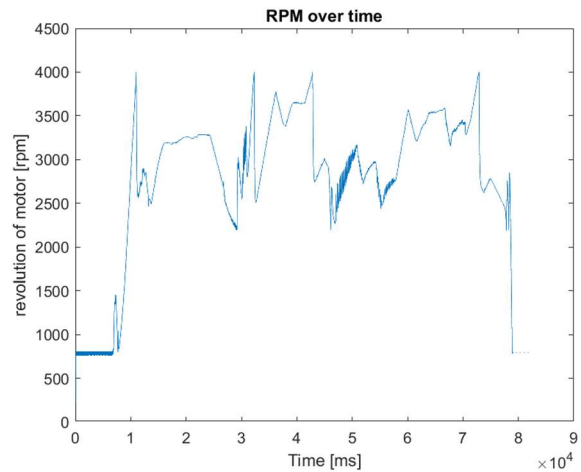
Method

Electric car sound synthesis

I performed the synthesis of the sound of the electric car using the MatLab software. First, I analyzed what data we had available. The key variables I ended up using were time and speed, and in addition the engine revolutions (rpm).

For an easier representation, I first graphically displayed the variables on a timeline. In that way I got an idea of the range of variables.
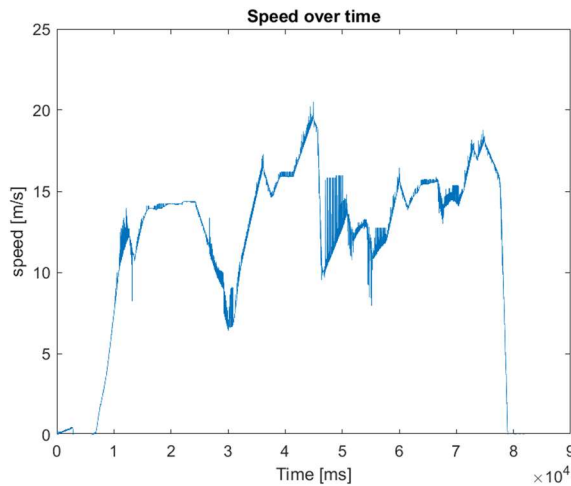
Picture 1: Speed over time   *Picture 2: Revolution of the motor*

This was followed by the synthesis of the sound of the car itself. First, I scaled the data and, in this way, gained control over the pitch of the sound we are used to when driving cars with internal combustion engines.

I then synthesized the sound with a simple sine wave that uses the velocity data as the phase variable. In order to beautify the sound a bit and add depth to it, I changed the sine signal and tried to create an attractive sound, but it seemed to me that a simple sine sound best recreated the sportier sound of the car, which I liked.

In the end, I saved the result in an audio file. The sound itself can be played already in MatLab with the audioplayer command at the bottom of the code.

Synthesizing of the song

As already written in the previous chapter, I did not manage to realize my main goal in synthesizing music. Since I already had the experience of creating sound with the help of sine wave in the first task, I also used a sine function for synthesis in the case of music, which I modified to fit my wishes. I wanted to get as close as possible to the sound of the saxophone. It's hard to say I succeeded, but in the end I'm happy with the synthesized sound given the last minute change in goal.

Results and conclusions

Electric car sound synthesis

I am not completely satisfied with the result I achieved in the first task of synthesizing the sound of an electric car. In general, I am a person who always wants to improve and upgrade things. But considering that I'm still not very proficient in MatLab, I'm still very pleased that in the end I managed to create at least some sound that could resemble an electric car. I want to upgrade and supplement my knowledge of Matlab and everything related to sound synthesis, and I am sure that I will return to this challenge.

I already have an idea exactly what I could do. Since we know that electric cars don't have a transmission, the sound of electric cars kind of sounds like they are always in first gear. Humans are not used to it, so this sound may sound a bit strange. We could change this to create a sound that simulates a gear shift, even though there isn't really a gear shifter.

Synthesizing of the song

Similarly, I encountered a lot of "challenges" in the second challenge. I'm not completely satisfied with the sound of the instrument and maybe some things could have been written more effectively, but I learned a lot here too. I would also like to come back to this challenge and make mistakes that I could not solve. The goal is to create a wonderful orchestra that would play wonderful music.

Overall, this competition has taught me a lot, for which I am grateful. And I will certainly participate in the competition next year as well.