

# SYNTH CHALLENGE 2019

A Report About Used Techniques

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# 1 Introduction

In this paper, I will shortly describe all the techniques I used in SYNTH CHALLENGE 2019. This competition consists of 3 parts:

1. synthesis of musical instruments of obligatory composition,
2. creation of major scale with synthesized instruments
3. and any own synthesis.

## 2 Obligatory Composition

This part of competition is based on synthesis of specific composition, while the MIDI file of this composition is provided. MIDI toolbox, which contains all functions to work with MIDI file in MATLAB, is also provided, so the only task is to synthesize the musical instruments.

There was an option to choose between two compositions. I decided for one called *Tři oříšky pro Popelku* by Karel Svoboda. Following musical instruments are used in this composition: piano, flute, violin, viol, violoncello and bassoon. Moreover all the three string instruments are used not just with fiddlestick but also as pizzicato.

### 2.1 Piano

Piano is the most used musical instrument in this composition, so it is very important to create good synthesis of it.

I decided to base this synthesis on physical modeling, more specifically on Karplus-Strong algorithm with output filtering. It models vibrations of the string via feedback filter and delay. The sound is then multiplied by specific envelope and finally filtered with low-pass filter to adjust the timbre.

### 2.2 Flute

For the synthesis of flute, I used the additive synthesis. It is based on the knowledge of the spectrum of the specific instrument. I found the amplitudes of the most important harmonics in spectrum and then used them to synthesize the sound by summation of the harmonics. ADSR envelope is used for flute, as the typical envelope for this type of instrument.

### 2.3 Violin and Viol

For both violin and viol I used the wavetable synthesis. It is based on real musical instrument sample. I cut one period from the whole sample and used it for wavetable synthesis. The code is taken from the `tybsynth.m` MATLAB function by prof. Ing. Roman Čmejla, CSc. (see Resources)

I also used ADSR envelope for both of the instruments. Moreover I decided to use short echo for viol to make it sound more impressive.

## 2.4 Violoncello

Even though violoncello is, according to its principles, very similar musical instrument to viol, I decided to use another method for it - formant synthesis.

Sawtooth is used as an excitation because it simulates the friction of the fiddlestick well. Formant frequencies and bandwidths for violoncello were chosen according to 6. lecture of the subject Synthesis of Audio Signals (see Resources). Then I calculated the coefficients of formant filters, made the filtration, used ADSR envelope and also enhanced the sound a little bit by using short echo.

## 2.5 Bassoon

For bassoon I used wavetable synthesis once more, because its result was pretty good. The procedure is the same as described above for violin and viol.

## 2.6 Pizzicato

For pizzicato sounds I used the additive synthesis. Unlike for fiddlestick use, I did not distinguish between violin, viol and violoncello here. The difference from flute is the usage of exponential envelope instead of ADSR and different amplitude spectrum values, of course.

# 3 Major Scale

There are many ways of creating this part. I decided to make my own MIDI file for each instrument in the specific range it is used in the composition. As a result I could use MIDI toolbox to create the output files.

# 4 Own Synthesis

For the third part I decided to synthesize the Harry Potter Prologue melody also with the use of MIDI file. I found suitable one on [freemidi.org](http://freemidi.org) website (see Resources).

This composition consists of the following musical instruments: piano, pizzicato strings, tremolo strings, violin, french horn, oboe, clarinet and flute. I synthesized some of the instruments in the obligatory part, but I edited some of them here and created the rest.

## 4.1 Violin

Violin definitely needed a change since the first part. The sound here was too sharp, so I used reverberation modeling via Schroeder algorithm. After this filtering, the sound is very pleasant and does not tend to be disturbing.

## 4.2 Clarinet, French Horn and Oboe

Since these instruments are quite similar to each other, I used wavetable synthesis for all three. It works surprisingly good for them, so the result seems satisfactory to me.

### 4.3 Tremolo Strings

For tremolo strings I used formant synthesis to generate strings and tremolo effect afterwards.

As an excitation sawtooth is ideal for strings. I chose the values of formant frequencies and bandwidths just like for violoncello, because suggested values for violin or viol produced less authentic sound. The tremolo effect is done by periodic changes in amplitude of the sound via envelope.

## 5 Resources

Most of the materials I studied and then used in this work are from lectures of the subject Synthesis of Audio Signals taught by prof. Ing. Roman Čmejla, CSc. on FEE CTU, Prague.

Materials and the `tybsynth.m` function mentioned above can be found on

<http://sami.fel.cvut.cz/syn/>.

MIDI file used in own synthesis was downloaded from

<https://freemidi.org/download3-22664-harry-potter-prologue-harry-potter>.