REPORT ON SYNTH CHALLENGE 2018

A2B31SMS

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CTU FEE

TASKS

1. Synthesis of musical instruments in *Jim Parker*'s central melody from the series "*Midsomer Murders*", using the midsomer.mid MIDI file, which uses five instruments (whistle, piano, bass clarinet, cello and contrabass). In the original track, the Theremin electronic instrument is used as the main instrument instead of the whistle.

2. Three octaves of a major musical scale, in which the created musical instruments are alternated, possibly followed by percussion sounds.

3. Any own realization of audio synthesis in MATLAB (possibility of non-musical sounds).In realization, you can create any sound, including the synthesis of purely synthetic instruments (such as Theremin, Hammond's organ, FM synthesizer sounds, etc.) and everyday sounds. Various effects such as reverb, echo, chorus, stereo, and more can be used to highlight tracks.

SOLUTION PROCEDURE

TASK 1

1. I started with an analysis of the given midi file and found out MIDI numbers of instruments that should be generated (see Table 1).
2. For the generation of instrument sound additive synthesis was chosen. In order to obtain amplitudes of the needed instruments audio samples from the folder *instruments*[1] were analysed with *analyzer* function from analyzer.m . The following values were received:

Instrument	MIDI inst. №	Amplitude
Whistle	79	[0.00055 0.00262 0.00631 0.01756 0.03956 0.06535 0.07466 0.284 0.04829 0.02159 0.07606 0.01188 0.001748 0.000835 0.000806]
Piano	1	[0.01338 0.09013 0.03877 0.06265 0.0122 0.02873 0.012265 0.003076 0.009967 0.01656 0.01241 0.003983 0.006569 0.00783 0.0138 0.0007383 0.002431 0.008944 0.002712 0.01133]
Bass clarinet	72	[0.2048 0.2055 0.1152 0.00648 0.05934 0.03454 0.06453 0.0007843 0.03545 0.01827 0.03723 0.02296 0.016965 0.0155 0.01777 0.0109 0.01472 0.003637 0.0109 0.009268]
Cello	43	[0.2251 0.1455 0.1434 0.01996 0.005688 0.05813 0.005108 0.01004 0.01496 0.02528 0.03058 0.004631 0.01055 0.00164 0.002453 0.001904 0.004007 0.008808 0.002781 0.003831]
Contrabass	44	[0.05102 0.3038 0.05929 0.0293 0.05234 0.03874 0.02012 0.003505 0.03048 0.01294 0.05235 0.01677 0.004721 0.008769 0.007932 0.004198 0.001711 0.006383 0.006074 0.0119]
Violin	41	[0.004855 0.05492 0.08643 0.08519 0.07527 0.05998 0.03407 0.0187 0.008112 0.008108 0.01828 0.02081 0.02009 0.01683 0.01207 0.007146 0.003984 0.003498]

Table 1. Data to generate instruments

3. In separated files functions for each musical instrument were created and included into synth.m (see Fig.1)

```
if channel~=10
    if synthtype ==1
        y=piano(Fs,dur,amp,freq);
    elseif synthtype==41
        y=violin(Fs,dur,amp,freq);
    elseif synthtype==43
        y=cello(Fs,dur,amp,freq);
    elseif synthtype==44
        y=contrabass(Fs,dur,amp,freq);
    elseif synthtype==72
        y=bassclarinet(Fs,dur,amp,freq);
    elseif synthtype==79
        y=whistle(Fs,dur,amp,freq);
    elseif synthtype<64
        tau = 0.1;  % doznivani
        y = amp.*exp(-t/tau).*sin(2*pi*freq*t);
    else
        y = amp.*square(2*pi*freq*t);
    end
end
```

Figure 1. Capture of the switch in synth.m

TASK 2

In music theory scale is series of musical notes ordered by different pitches. There are three main type of Major scales: Natural, Harmonic, and Melodic Major scales. In order to accomplish this task, an F# harmonic major scale was chosen. By looking at the intervals, we find a pattern to build all the harmonic major scales: T-T-ST-T-ST-T+ST-ST (Tone (T) = Whole step, Semitone (ST) = Half step). [2]

A code snippet on Fig.2 represent a solution of this task. A row vector key contain a sequence of a numbers which correspond to midi note number and also to a serial number of a key on the piano keyboard. A for-loop call function of the musical instrument which generate a corresponding pitch for each member of the vector and concatenate it to an array x. Then output signal normalized and saved to scale_f_sharp.m4a file.

3 octaves of F# harmonic major scale

```
x = [];
fs = 48000;
amp = 1;
key = [30 32 34 35 37 38 41 42 44 46 47 49 50 53 54 56 58 59 61 62 65 66];
duration = 0.5*ones(1,length(key));
for k = 1:length(key)
    f = 440 * 2 .^ ((key(k)-49)/12);
    if(k<6)
        pitch = piano(fs,duration(k), amp, f);
        x = [x pitch];
    elseif (k>5 && k<11)
        pitch = cello(fs,duration(k), amp, f);
        x = [x pitch];
    elseif (k>10 && k<16)
        pitch = contrabass(fs,duration(k), amp, f);
        x = [x pitch];
    elseif (k>15 && k<21)
        pitch = bassclarinet(fs,duration(k), amp, f);
        x = [x pitch];
    elseif (k>20)
        pitch = whistle(fs,duration(k), amp, f);
        x = [x pitch];
    end
end

x=x./max(abs(x));
cd result
audiowrite('scale_f_sharp.m4a',x,fs);
```

Figure 2. Code snippet for task 2

TASK 3

Generated during task 1 instruments* were applied on midi file with composition "Experience" by Ludovico Einaudi[3].

*violin is not included into "*Midsomer Murders*" melody, but was created in advance especially for task 3.

RESULT GENERATION

Task 1&3: To generate a fresh output enter to MATLAB command line:

synthchallenge(name)

*(name = name of the midi file from *midi* folder as string)

Task 2: Simply run the script scale.m

REFERENCES

[1] https://freewavesamples.com/

[2] https://visihow.com/Build_Major_Scales_(Natural,_Harmonic,_Melodic)

[3] https://musescore.com/user/24692866/scores/4794914