Module INM378 — Digital Signal Processing and Audio Programming
2019/20 Period 2
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Coursework

Enhancing a game with sound and real-time effects / Signal filtering and analysis

The topic of this coursework is to implement frequency or time domain DSP functions for real-time processing and for data analysis.

TASKS
This coursework has a **games** stream and a **data** stream, which have some **common** and some **specific** tasks.
For the **common task**, implement a filter either in FMOD with C++ or C# (games stream) or in Python (data stream).
For the **data** part, apply prediction and classification on a given dataset using Fourier analysis, filtering and correlation. For the **games** part, implement the sound and music elements listed below in your coursework for INM379 or INM376 with C++ or in a new demo using the template provided.

1. **Common DSP:** Program a controllable FIR filter, i.e. a filter that changes its characteristics over time in response to a control signal. To change in the characteristics of the filter, you need to change the filter coefficients.
   If you do the **games** track, implement the **filter for real time use** with a **circular buffer** in an FMOD custom DSP and implement a **trigger** in the demo that **changes the filter**. If you do the **data** track, you can implement the **filter** by implementing the convolution with the coefficients **in a loop** over the samples (you can't use the ready-made convolution function, because they don't allow changing coefficients). If you do the data track, implement the function to be used **offline** with the **filter modulated by a sine function** at 2Hz. **(40%)**

2.
   a. **Games:**
      ***3D Sound*:** Place a sound source in a 3D world where it can be moved around using the mouse and/or keyboard. Make sure that the sound in the 3D world is adapted with distance roll-off including filtering, and Doppler effect. **(30%)**
      Implement **dynamic filter control** for an object of your choice (using a custom DSP you created), e.g. for the engine of a car, to sound differently based on the speed. **(20%)**
   b. **Data:**
      ***Digit recognition*:** Program a character classifier using 2d-correlation to classify digits. (**25%**)
      ***Time series prediction*:** Use Fourier analysis for implementing a time series predictor on financial data. (**25%**)
      A Google Colab template containing the datasets and specific instructions is available on Moodle.
   c. **Games (for pairs):**
      3D Occlusion: Implement a 3D objects in your game/demo, that you register with the FMOD framework to achieve an occlusion effect. (**25%**)
      ***Flanger*:** Implement a Flanger effect (time-varying delay) as an FMOD custom DSP effect, that apply to a sound source in your game. (**25%**)
   d. **Data (for pairs):**
      ***Frequency domain filtering*:** Implement the filter from task 1 in the frequency domain. Use the STFT and compare the results with task 1. Explain what the advantages and disadvantages of processing in the frequency and the time domain are. (**50%**)
3. **Report:** Write a short report that explains how you solved the tasks, where to find the solutions in your submitted code and any specific points you would like me to pay attention to (no more than 1500 words) (10%).

I recommend you do this coursework in pairs. If you do so, you have to do two tasks out of 2 a, b, c, d (the weight of tasks will be scaled proportionally to add up to 100).

Background Information and Support
For every step of the coursework, relevant information, examples and data will be provided in the lectures

and tutorials.

Coding Style and Comments

- Every method in your code must be commented w.r.t. its purpose, its parameters and its return values.
- Use meaningful variable names and explain their use in comments, if you are not using Python make sure your code is properly indented.
- Comments and style will be marked together with the code.

You can ask questions about the coursework on Moodle or email me (johan.pauwels@city.ac.uk). I may publish your emailed questions together with my answer on Moodle if they are relevant to all.

Submission

The submission deadline for this coursework is 29/3/2020. Please submit your program online on Moodle, stating your name and City user ID in the headings.