Plan of Approach

Audio digital signal processor

BeCreative Minor

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Chapter 1: Background

Chapter 2: Project result

The goal of this project is to research how to make an audio-DSP. This raises the main research question: **"How to design an audio-DSP?"**. In the process of researching this an actual audio-DSP will be developed. From the main research question the following sub-research questions are derived:

- What is the best method for creating digital filters?
- What is the best method for creating digital effects?
- What is the most suitable anti-aliasing filter?
- What is the optimal needed roll-off for the anti-aliasing filter for a given bandwidth such that the noise can be negligible?
- What is the minimum sample frequency needed to capture the desired frequency spectrum?
- What is the minimum frequency range to be sampled to achieve sufficient detailed audio?
- What is the lowest allowable noise for decent audio?
- What ADC resolution is needed such that the quantization error and noise level are on par?
- What ADC and DAC architecture is most suitable for this application?
- What kind of processor is most suitable for this application?
- What is the permittable jitter for accurate audio?
- What is the maximum allowable ripple on the reference voltage for the ADC and DAC?
- How much RAM does the system need?
- How much flash does the system need?

The project is conducted during the minor BeCreative at Fontys. This minor takes 20 weeks and allows the students to have a budget of €300,-. Thus after 20 weeks starting from 6-2-2023 an audio-DSP will be delivered within a budget of €300,-. The audio system has some requirements to specify the final result. These requirements are derived with the "MoSCoW" method. It must be noted that the following requirements will be confirmed by the research that will be conducted.

2.1 Must have (to be confirmed by research)

- Two RCA audio inputs which work on a line level of 4 dBu (±1,74 V).
- Two 6,35 mm TRS plug audio inputs which work on a line level of 4 dBu (±1,74 V).
- Two XLR audio inputs which work on a line level of 22 dBu (±9,75 V).
- USB type B audio input
- Two RCA audio outputs which work on a line level of 4 dBu (±1,74 V).
- Two 6,35 mm TRS plug audio outputs which work on a line level of 4 dBu (±1,74 V).
- Four XLR signal outputs work on a line level of 22 dBu (±9,75 V).

- The system has a bandwidth (±3 dB) of at least 20 Hz up and till 20 kHz without any filters applied.
- The system has an audio sample rate of at least 44.1 kHz.
- The ADC resolution should be at least 16-bit.
- The DAC resolution should be at least 16-bit.
- propagation time delay of less than 100 ms without any filters applied.
- User can select what input will be used via an user interface
- User can select up to 4 effects to be active in one channel at the same time
- User can configure each effects
- The system must work stand alone and be configurable via a basic graphical user interface.
- Effects configurable per output channel at least four different sound effects should be able to be applied to each signal output signal at the same time:
  - Distortion
  - Reverb
  - Gain
  - Equalizer
  - Delay of 10 ms

2.2 Should have (to be confirmed by research)

- The system should have a bandwidth (±1 dB) of at least 20 Hz up and till 20 kHz without any filters applied.
- Audio sample rate of at least 96 kHz
- The ADC resolution should be at least 24-bit.
- The DAC resolution should be at least 24-bit.
- Six XLR signal outputs work on a line level of 22 dBu (±9,75 V).
- User can select up to 10 effects to be active in one channel at the same time.
- Low enough jitter to not influence the audio quality to much.
- Filters:
  - Tremelo
  - Flanger
  - Fuzz
  - Overdrive
  - Chorus
  - Compressor
  - Wah
  - Looper
  - Overdrive
  - Wow and flutter
  - Modulator
  - Echo
  - Fade in

2.3 Could have (to be confirmed by research)

- Audio sample rate of at least 192 kHz
- Touch screen user interface.

2.4 Won't have (to be confirmed by research)

- Self-made mains power supply.

Chapter 3: Project activities

3.1 Planning

3.2 Execute planning

3.3 Research

3.4 Testing

3.5 Finalize

3.6 Report

Chapter 4: Project boundaries

Chapter 5: Milestones

Chapter 6: Quality assurance

Chapter 7: Project organisation

Chapter 8: Planning

Chapter 9: Cost-benefit overview

Chapter 10: Risk Analysis

There are many risks and reasons why a project might fail or go bad, A change in organizational priorities is the most common reason. A change in project objectives is also common as poor communication and unclear risk definition.

- Unclear or shifting goals.
- lack of planning.
- lack of follow up.
- timing issues
- Lack of risk management.
- Unsuitable tools.
- Too many unsuitable tools

For these reasons and many more, we've created an overall table with ratings which rate the opportunity/effect and risk.

Scale

Ratings that can be seen below are from 1 to 9. Where 1 is low risk and 9 is high risk.

Risk	Opportunity	Effects	Risk	Measure to prevent / remedy it	Chance after	Consequences afterwards	Ultimate risk
A group member lacks in work /failed deadlines	4	2	8	Code of conduct created and signed by everyone	3	3	4
Clear file locations and easy to map.	3	3	6	Weekly document tracking and documentation is taken.	2	3	3
Behind schedule for lack of knowledge or confusion	4	3	7	Ask for help in time from fellow group members or teachers.	1	2	2
Running low on budget	1	6	5	Budget is documented	1	3	1
There is insufficient communication in the group.	2	3	6	meetings scheduled 2-3 times a week, Minutes and notes are taken and uploaded up to date.	1	3	3
Clear results are missing.	4	6	9	The strip planning clearly states which part you need to complete to be on schedule with your project component.	2	3	6
Shortage in components	2	9	3	A delay in ordering or receiving parts	6	6	9
The planning of Fontys teaching material is incorrect	4	5	9	Read documents carefully	4	7	7

Figure 10.1: Table with risk rating

Appendix A: Appendix A