Review of Bachelor's Thesis

Student: Kálazi Adrián
Title: Lossless Encoding of Signals from Microphone Array (id 24799)
Reviewer: Malenovský Vladimír, Ing., Ph.D., DCGM FIT BUT

1. Assignment complexity   **more demanding assignment**

The difficulty level for this work is above average in my view. The student is requested to address several sub-tasks in his work and especially (3) "Suggest a technique for lossless coding of a multi-channel audio signal for a microphone array and implement it." is quite challenging.

2. Completeness of assignment requirements   **assignment fulfilled**

The student has successfully addressed all sub-tasks in his work.

3. Length of technical report   **in usual extent**

The thesis fullfills all the requirements.

4. Presentation level of technical report   **97 p. (A)**

The thesis is written in English. The structure of the thesis is clear and easy to follow. The chapters are arranged logically with appropriate content. The author analyzes some existing lossless codecs (including FLAC) and describes some of their key parameters and design characteristics. The motivation for the proposed improvements is always clearly explained along with the expectations. There are some minor technical issues in the paper. The most important problem is the frequent usage of undefined symbols in equations or in the text. When describing algorithms with descriptive text instead of equations it is often not straightforward to understand (and reproduce) the intended behavior.

5. Formal aspects of technical report   **93 p. (A)**

The thesis is well written. There are only minor, rather insignificant, flaws in the thesis such as using programmatical terms in algorithmical descriptions. The thesis would probably benefit one more round of proofreading to correct some unclear statements.

6. Literature usage   **87 p. (B)**

The list of references is not very exhaustive. For example, I'm missing links to some well-known existing decorrelation techniques, e.g. active multi-channel downmixing techniques or beamformers. Also, the author did not list any literature sources dealing with array signal processing techniques. This could explain why, in the thesis, there is no mentioning of e.g. DoA (direction of arrival), ITD (inter-channel time difference), ILD, inter-channel coherence, etc.

7. Implementation results   **98 p. (A)**

The programmatical part of the work is provided in the form of a Python library, accessible through github. The library is a standalone module that can be easily launched and tested. The interface is intuitive and easy to understand. The parameters are fully described in the documentation. The application is flawless, producing expected results.

8. Utilizability of results

All ideas proposed in the thesis are new and original based solely on the knowledge that the author has acquired during the experimentation with the FLAC codec. The developed library tools can be re-used, if requested, and they can be improved in the future. The work provides a solid basis for understanding of multi-channel lossless audio compression technology.

9. Questions for defence

1) What happens to the passive downmix (d_MID in eq. 4.9) if the two input channels, s_L and s_R, have opposite phase, i.e. effectively cancelling each other? How do you deal with this problem in your codec?
3) On page 23 you state that the entropy rises when the input signals are re-scaled to the same energy level. Can you explain how is it possible? I'd expect the exact opposite, i.e. lower energy of the residual signal and, consequently, also lower entropy.

2) In Fig. 4.14 the "m" parameter seems toggling. Would smoothing or interpolation help?

10. Total assessment   **95 p. excellent (A)**

This is a solid work and a solid thesis. The author has clearly demonstrated that he could analyze a complex problem of multi-channel lossless audio compression. The author has successfully implemented several innovative ideas to the proposed codec and tested them on the provided dataset. Although the compression ratio

achieved with the proposed codec is only slightly better than that of the reference codec (FLAC) the added features provide a valuable extension to an exsting framework. This could be re-used, extended or applied in a different framework.

In Brno 26 May 2022

 Malenovský Vladimír, Ing., Ph.D.
reviewer