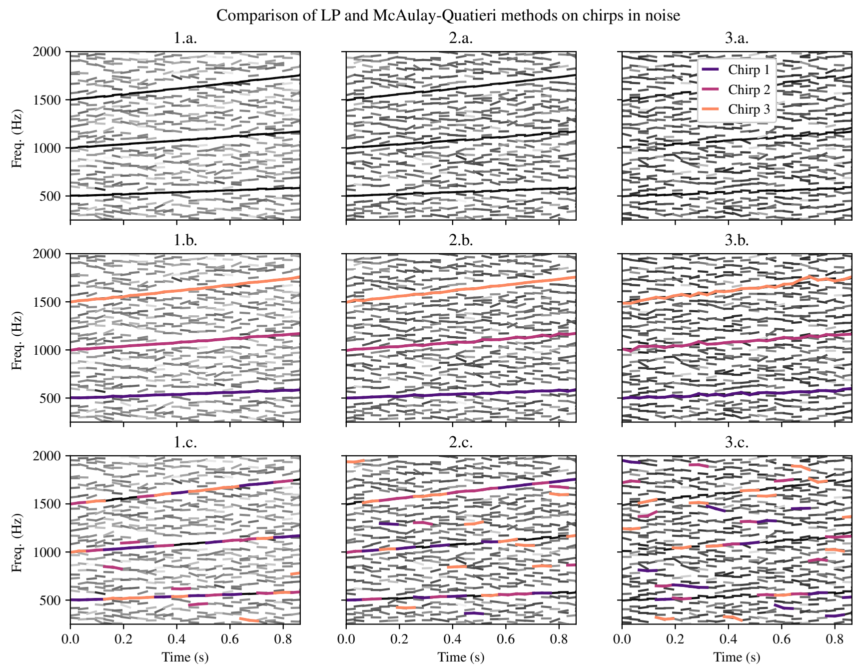

Figure 1. Line-segments representing the frequency and frequency-slope at local spectrogram maxima. The power of each atom is represented by shades of grey: black atoms have the highest power and white the lowest. The coloured segments correspond to connected paths returned by the search algorithms. Plots 1–3.a. show the atomic decomposition of the signal before partial tracking for SNRs of 0, -6 and -12 dB, respectively. Plots 1–3.b. show the partial paths discovered by the LP method and plots 1–3.c. show the paths discovered by the McAulay-Quatieri method. See Table 1 for the chirp parameters.

7. CONCLUSION

In this paper we reformulated the classical partial tracking technique of McAulay and Quatieri and showed that it can be seen as a greedy algorithm for finding the L shortest paths in a lattice. An algorithm was then proposed minimizing the sum of the L paths, using a linear programming approach. The complexity of the new algorithm was shown to be generally less than the Viterbi-based methods and the McAulay-Quatieri algorithm for large K. It was shown on synthetic signals that the new approach finds plausible paths in lattices with a large number of spurious nodes.

The proposed approach has some drawbacks. There are situations where it is undesirable to have paths extend throughout the entire lattice. Acoustic signals produced by striking media, such as strings or bars, exhibit a spectrum where the upper partials decay more quickly than the lower ones; it would be desirable in these situations to have shorter paths for these partials. This could be addressed as in [2] where the signal is divided into overlapping sequences of frames and partial paths are connected between sequences.

In its current form, the path search may choose undesirable paths if a convenient node is missing from the following frame. An extension could consider nodes some number of frames ahead.

The proposed algorithm, while asymptotically faster than other partial tracking algorithms, is still not fast. In situations where computational resources are limited, a McAulay-Quatieri method search over many sets of small K works sufficiently well. However in high amounts of noise the algorithm proposed here is robust while still of tractable complexity.

It may be possible to improve the performance of the algorithm by the use of different cost functions and regularization. The cost function (13) could be extended to encourage similarity between frequency slopes or amplitude information. Each metric should be scaled according to its desired contribution to the cost.

There may also be a way to extract individual paths through the use of auxiliary variables in (11). If so, path specific costs such as overall smoothness or fit to a particular model could be incorporated.

In any case, it would be interesting to further investigate programming relaxations encouraging underlying discrete structures plausible for audio in the framework of regularized approximation. These structures are closer to ground-truth structures for speech (text) and music (the musical score).

8. REFERENCES

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