

Generic Compression and Recall of Signals with Application to Dolphin Whistles

by

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Abstract

The efficient compression of a lengthy signal in order to allow quick detection of repeated elements, even though the repetitions are separated by large amounts of time, is investigated using a dolphin whistle database. Work is done in three levels. Level I does silence removal as well as conditioning of the data for further analysis. Typical compression for this level is about a factor of 12. In level II, data is further compressed by converting it into single frequency-vs.-time trace. Assuming there is no desire to reverse the level II compression, the compression factor is typically increased an additional factor of 257 relative to level I.

The final level, III, involves irreversible compression and by itself achieves a compression factor of about 1. Reconstruction of the original signal is not possible using Level III output, although detection of repetitions is possible. In this level, each of the 1169 whistles in the database is converted into a single point in a 16-D coding space. Techniques for the creation of adequate coding spaces are presented. To find a whistle in the database, the coding space needs to be searched. Two methods, the *k-d* tree and the expanding bucket, are implemented and evaluated for the search problem. Although the *k-d* tree requires that a larger fraction of the database be searched to find a match, it is faster than the expanding bucket. However, the best speeds for both methods (obtained with a 6-D coding space) are comparable (35 ms to 53 ms on a SparcStation 2). Under certain budget constraints, the expanding bucket can give superior performance.

Using the coding space of level III, the maximum potential whistle vocabulary the space can hold was estimated. Single animals reproduce their own signature whistles precisely, and the associated "single" potential vocabulary was found to be over one billion unique whistles. When the possibility of copying "errors" are introduced, the "shared" potential vocabulary was just a few hundred whistles; based on very limited copying data.