OBNZip — Intelligent Seismic Data Compressor for OBNs

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1. Overview

Intelligent Seismic Data Compressor for OBNs (OBNZip) is a joint effort of LISHA, LVA, LaSin and Petrobras to investigate the possibility of applying **Artificial Intelligence (AI)** techniques within the paradigm of the **Internet of Things (IoT)** to compress seismic data produced by **Ocean Bottom Node**s (OBNs). The project will also investigate techniques to efficiently manage the energy budget of such nodes, as well as alternative for them to communicate among themselves and with underwater vehicles and surface vessels.

2. Seismic Data Compressor

OBNZip main goal is to develop a system for compressing underwater seismic data in OBNs using artificial intelligence techniques and carry out exploratory studies on submarine wireless communication and energy management in OBNs. The compressor will support efficient communication and the respective AI models will increase the energy efficiency of the OBNs by selecting optimized operating modes of the OBNs.

2.1. Architecture

The architecture of the compressor developed is shown in Figure 1, where it possible to observe the differente stages concerninig differents blocks of data compression.

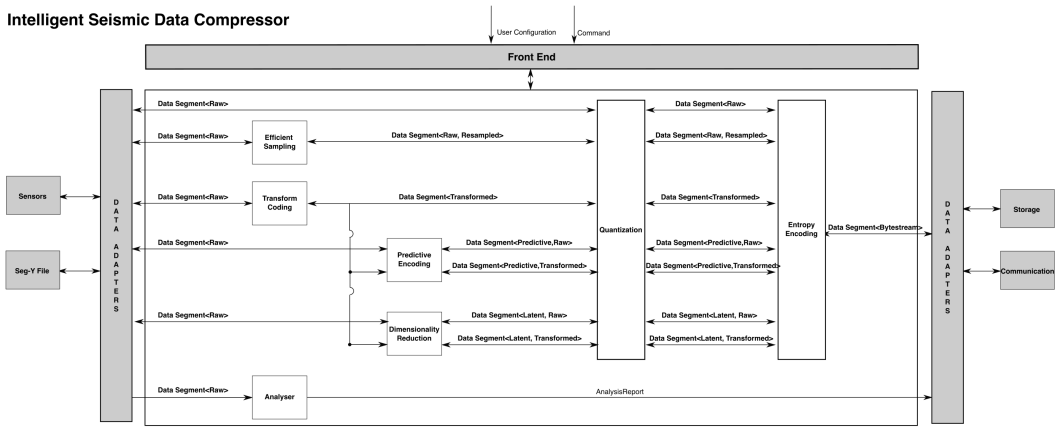

Figure 1: Compressor topview architecture.

2.2. Results

Tabel 1 shows a comparison of some results obtained with the OBNZip compressor in terms of compression rate and normalized residue energy global and in some frequency ranges. In addition,

results are shown for passive and active data as well as for different compresison techniques.

Table 1: Comparison of some results obtained with the OBNZip compressor in terms of CR (compression rate) and NRE (normalized residue energy) for different compression methods and seismic data, being DCT the discrete cosine transform, DWT the discrete wavelet transform and LZW the Lempel–Ziv–Welch compression.

Data type	Method	Parameters	CR	NRE	NRE (0-20 Hz)	NRE (15-65 Hz)	NRE (60-100 Hz)	NRE (105-250 Hz)
Passive	DCT + LZW + Quantization	Energy Threshold=1% Quantization=1%	4.0369:1	0.0304	0.0023	0.0061	0.0055	0.0186
Passive	DCT + LZW + Quantization	Energy Threshold=10% Quantization=10%	15.7746:1	0.3243	0.0244	0.1272	0.1240	0.0693
Active	2D DWT + LZW + Quantization	Energy Threshold=1% Quantization=1% Spatial Dimension=10	2.4320:1	0.0111	0.0009	0.0019	0.0018	0.0071
Active	2D DWT + LZW + Quantization	Energy Threshold=10% Quantization=10% Spatial Dimension=10	5.7863:1	0.2134	0.0929	0.0631	0.0244	0.0457

Figure 2 shows the OBNZip compressor performance in terms of time of execution for two implementations of the compression (Python and C++). In addition, the external time represents the whole execution time while the internal time represents only the time taken in the compression/decompression procession, not taking into account the compression setup. libraries import and etc.

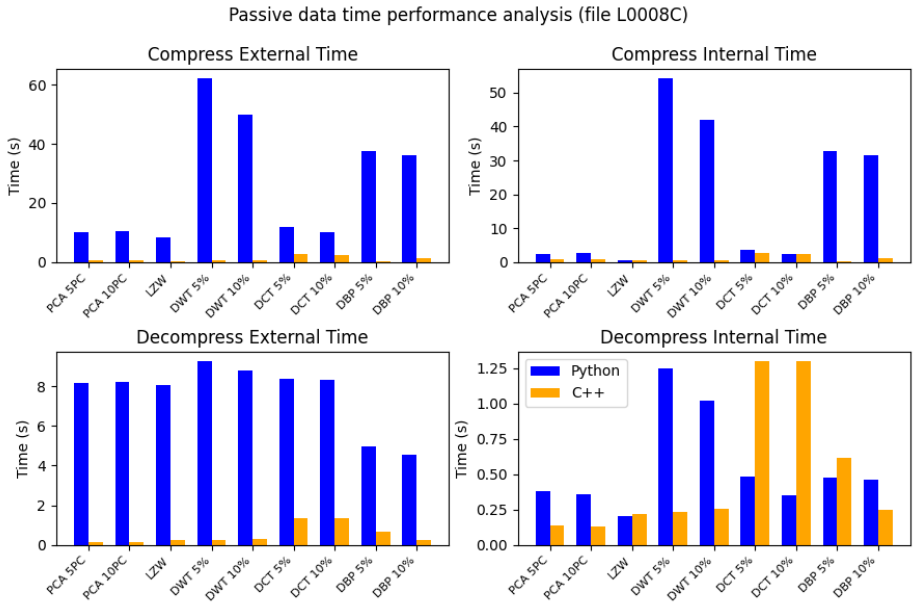

Figure 2: Passive seismic data time performance analysis.

3. Exploratory Studies

OBNZip project also aims to corry out exploratory studies on submarine wireless communication and energy management in OBNs, as briefly described below.

3.1. Energy Management

This objective will conduct an exploratory study on energy management in OBNs, including monitoring the energy available in the storage system, the orchestration of the operating modes of the various components of the OBN in terms of energy and recharging of storage systems. Resource scaling techniques, such as acoustic and thermal electric energy harvesting and a seawatter battery, are under development.

3.2. Underwater Communication

This exploratory study aims investigate about underwater wireless communication to determine the boundary conditions for application of the main technologies available in scenarios of interest to Petrobras, that is, deep marine waters. Two technologies are under investigation and tests: optical and acoustical communication. Experimental test have been carried out in water tanks and low cost prototypes are under development.

4. Publications

https://lisha.ufsc.br/pub/index.php?key=OBNZip