School of Electronic, Electrical and Systems Engineering

A Smart Monitoring Platform for Underwater Noise

Paul Barker, Paul Lepper; Loughborough University, UK

Loughborough University

Introduction

The long-term monitoring of underwater noise levels, whilst desirable, results in large volumes of raw acoustic data which must be analysed to give meaningful information. By performing such analysis onboard the device which captures the acoustic signal the cost of subsequent data storage and transmission can be vastly reduced. The ongoing development of an open platform for data capture and processing (the UDAQ), an analysis methodology and a software toolkit (TUNA) which will fulfil these goals is outlined in this poster.

UDAQ Platform

The UDAQ system has been developed as an open platform for research into the real-time monitoring and processing of underwater acoustic noise. It consists of off-the-shelf hardware components, a custom adaptor board and a bespoke Linux system image. It is capable of capturing an acoustic signal at a range of sampling frequencies between 36 kHz and 615 kHz, with a sample size of 24 bits and a dynamic range of at least 107 dB. This acoustic data is processed or recorded via the TUNA application detailed below, although it is straightforward to replace this with a different signal processing application if desired. A photograph of the signal acquisition and processing hardware within the UDAQ is shown in figure 1.

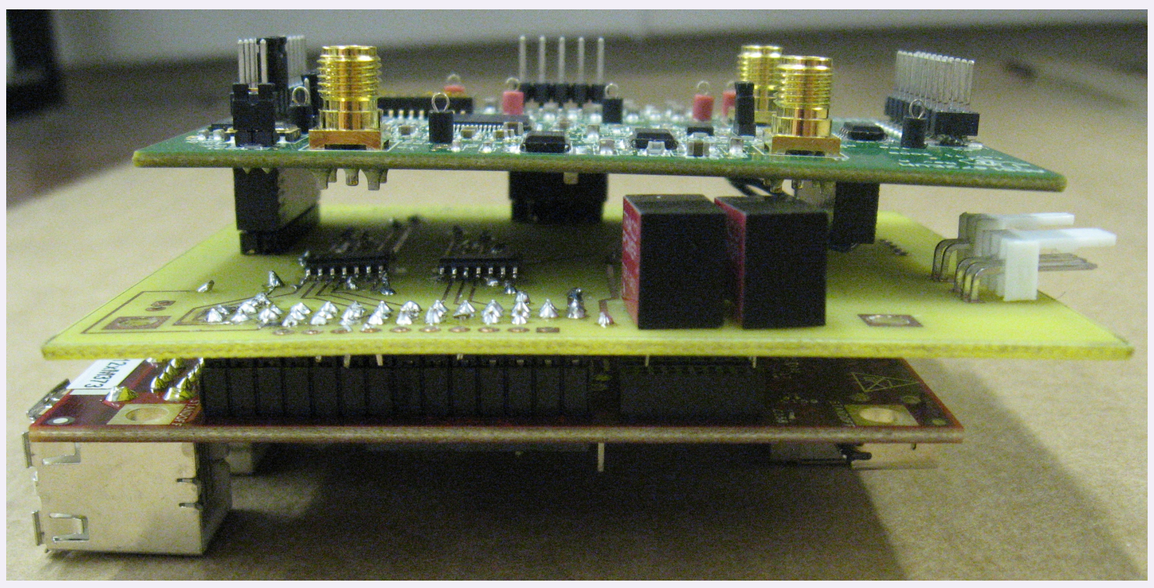

Figure 1: UDAQ Hardware

Toolkit for Underwater Noise Analysis (TUNA)

The analysis application is capable of processing data in real-time as it is captured or from pre-recorded WAVE files and can run on standard laptop or desktop PCs as well as on the Beagleboard xM used in the UDAQ. It is highly modular and is designed so that the input, processing and output stages can be customised or replaced easily. The IRP analysis methodology is implemented as a processing stage within this application.

This software is available at:

https://bitbucket.org/underwater-acoustics/tuna

Impact Relevant Parameters (IRPs)

A set of acoustic parameters indicated by recent research [1,2] to be relevant in estimating the impact of underwater noise on marine life were selected. These parameters are calculated once per 'time slice', where the default length of a time slice is 1 s.

As currently implemented it is possible for this analysis methodology to discard parameters important for the impact assessment of impulsive noise. Therefore, methods of detecting the onset of impulsive noise and other acoustic events of interest are currently being investigated. After an appropriate method has been selected, IRPs will be calculated for each detected acoustic event as well as per time slice, increasing the data rate but preserving considerably more information from the original acoustic signal.

The calculated IRPs are:

- Third-octave levels, with centre frequencies from 10 Hz to 160 kHz (43 values)
- Positive and negative peak levels with offsets of each (4 values)
- Intermediate values for kurtosis calculation (3 values; per time slice only)
- Rise time, fall time and total duration (3 values, per pulse only)

This methodology and the resulting data rates and equivalent compression ratios are shown in figure 2.

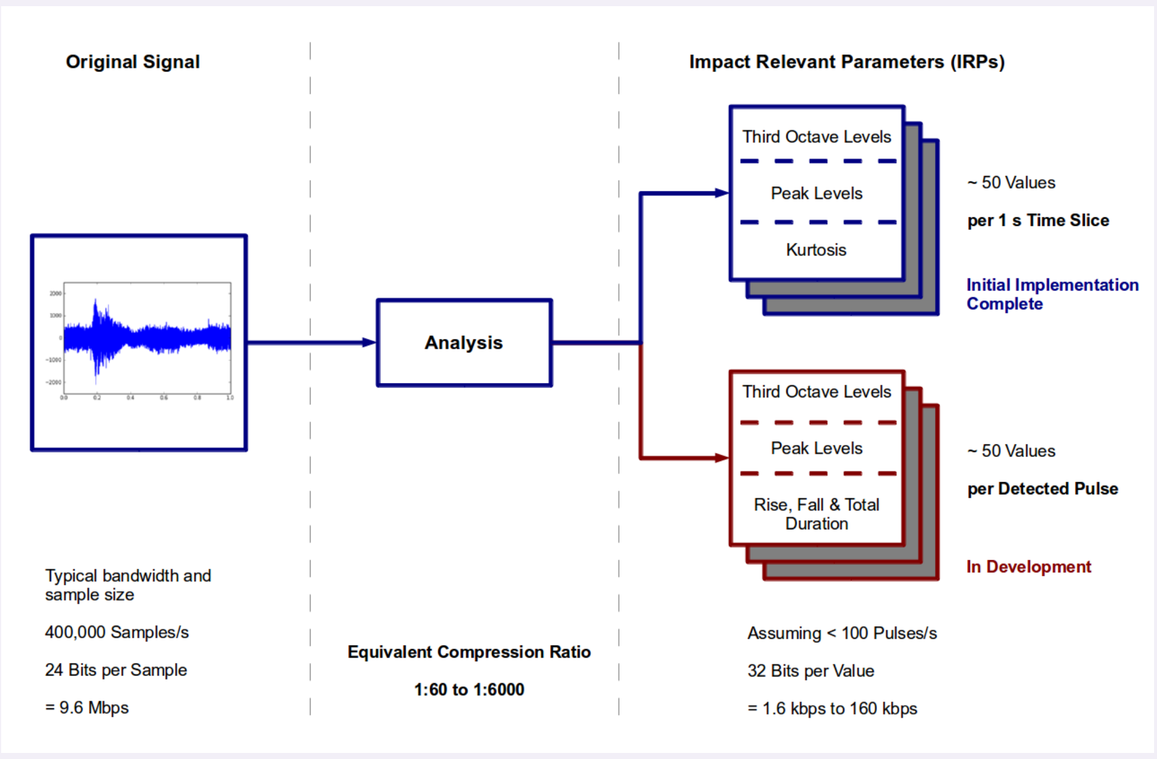

Figure 2: IRP Analysis Methodology

Conclusions and Future Work

The hardware, software and analysis methodology described in this poster allow underwater acoustic data to be analysed at the point of capture reducing both the data rate and the cost of further processing. It also provides an open platform for the development of additional real-time processing methods by other researchers.

Further work will focus on benchmarking and performance testing of the system and adding new features such as the detection of impulsive noise as outlined above.

REFERENCES

1. B. L. Southall, A. E. Bowles, W. T. Ellison, J. J. Finneran, R. L. Gentry, C. R. Greene Jr, D. Kastak, D. R. Ketten, J. H. Miller, P. E. Nachtigall, W. J. Richardson, J. A. Thomas, and P. L. Tyack, “Marine mammal noise exposure criteria: Initial scientific recommendations,” Aquatic Mammals, vol. 33, no. 4, pp. 411–521, 2007.
2. A. N. Popper, T. J. Carlson, A. D. Hawkins, B. L. Southall, and R. L. Gentry, “Interim criteria for injury of fish exposed to pile driving operations.” 2006.

ACKNOWLEDGEMENTS

Many thanks to all the technicians involved in producing prototype hardware for this project.

This work was carried out within a PhD studentship sponsored by EPSRC.

Paul Barker
Paul Lepper
School of Electronic, Electrical and Systems Engineering
Loughborough University
Leicestershire LE11 3TU, UK
E. P.R.Barker@lboro.ac.uk
http://www.lboro.ac.uk/departments/eese/