A Neural Network Approach for the Noise Identification and Data Quality of the VIRGO Antenna

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Abstract. We are exploring the possibility of using neural networks for noise identification and extraction in connection with the environment monitoring and within the global architecture of Data Quality. We report here the very promising results of a test of real-time acoustic noise identification and extraction for a bench test Michelson interferometer.

INTRODUCTION

The identification of the environmental noise effects on the VIRGO[1] output signal is essential both for data analysis and system check. This task requires the development, implementation and test of suitable on-line and off-line noise identification techniques, fully adaptable to the interferometer and to the changes of the environmental conditions. Moreover, these techniques must be easily integrated within the Virgo Data Quality scheme (see Fig.1), that is the general scheme of the Virgo antenna in which data quality algorithms are running at the level of the macro-systems in which Virgo has been subdivided.

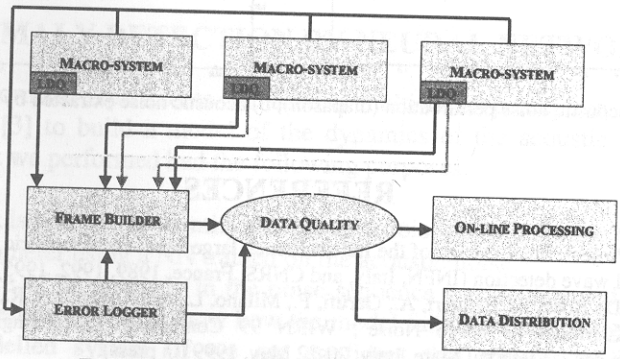

FIGURE 1. Virgo Data Quality Architecture.

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In particular, neural network techniques can be easily matched to such dynamic architecture and are very powerful. We are exploring now if they can be really helpful for VIRGO and can be integrated with the classic ones[2,3]. Here, we report an example of a real-time acoustic noise identification with a neural network obtained combining a tapped delay line with an ADALINE applied to a bench test uncontrolled Michelson interferometer in air with a microphone along one of the two arms. The neural network was trained to identify the acoustic noise, so that when a perturbation was applied (in this case with a diapason) it was able to extract this noise directly from the Michelson photodiode output in real-time. We are now extending and improving these techniques also for the identification and study of other environmental noises.

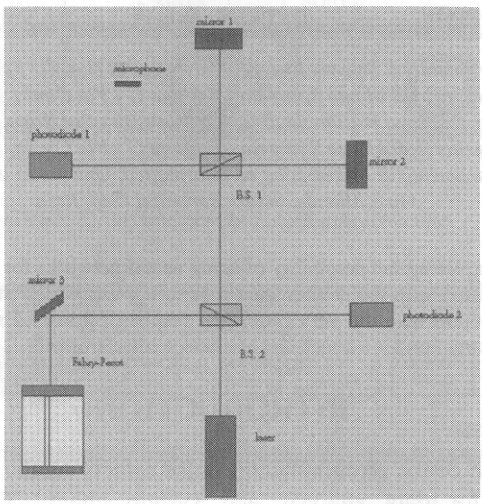

FIGURE 2. Michelson bench test interferometer of Napoli VIRGO lab.

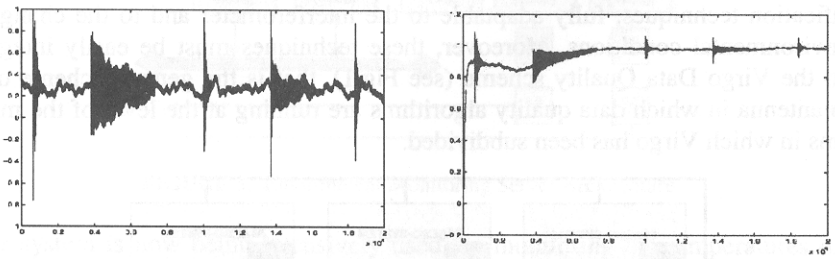

FIGURE 3.a) acoustic noise perturbation (diapason); b) acoustic noise extracted by the neural network.

REFERENCES

1. The Virgo Project, Final Design of the Italian-French large base interferometric antenna VIRGO for gravitational wave detection (INFN, Italy, and CNRS, France, 1989, 1992, 1995).
2. Barone, F., De Rosa, R., Eleuteri, A., Garufi, F., Milano, L., and Tagliaferri, R., "A neural network-based ARX Model of Virgo Noise", WIRN 99 Conference Proceedings, M.Marinaro and R.Tagliaferri eds., Vietri sul Mare, Italy, 20-22 May, 1999 (in press).
3. Barone, F., Ciaramella, A., Eleuteri, A., Garufi, F., Milano, L., and Tagliaferri, R., IEE Trans. Computer and Digital Techniques (1999) (submitted).