DEVELOPMENT OF UNAM' INSTITUTE OF ENGINEERING MULTIPURPOSE SEISMIC DATA LOGGER

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Abstract

We present a low-cost seismic recording system intended to fulfill multiple seismic experiments and monitoring. The instrument was designed and crafted at the Institute of Engineering of the National Autonomous University of Mexico with the main objective of expanding the strong ground motion network and the pool of instruments for site and crustal characterization. The system consists of: 1) a 3-channel digital recorder with 24-bit resolution, 2) a selectable sample rate of 100 or 200 samples per second, and 3) a time control based on a real-time clock corrected by a GPS receiver. Moreover, the amplification stage input can select between various types of sensors, such as geophones, force balance accelerometers (FBA), MEMS type accelerometers, etc. The instruments will be used for large arrays in multiple experiments for recording earthquakes, aftershocks, seismic noise and the measurement of vibrations in structures. Due, to their low cost and the fact that they are assembled in-house, modifications of the instruments can be made quickly to adjust the specific experiment requirements. Currently, three versions have been developed. The first version uses 2G force balance servo-accelerometers with the ability to continuously send data in real time through the Internet to a central registration point. The second instrument uses 1Hz geophones for noise measurements in large autonomous arrays; the data is stored in a microSD flash memory. The last version uses MEMS type low noise capacitive accelerometers mainly for strong earthquakes and measurements in structures.

Introduction

Among the priority projects of the Seismic Instrumentation Unit (UIS) of the Institute of Engineering of the UNAM is the development and construction of equipment for the recording of seismic signals, this to complement and expand the wide variety of commercial equipment available in the different seismological and accelerographic networks that the Institute operates both in Mexico City and in the rest of the Mexican Republic.

This work shows the development of a general purpose signal acquirer that resulted in three specially constructed versions for different studies in the fields of Seismological and Civil Engineering.

General system of data acquisition

The central part of the different acquisition equipment is a card designed in the coordination of Electronics of the Institute (Fig. 1), which has the following characteristics:

a) Input of up to 3 analog channels of simultaneous registration
b) Adjustable gain instrumentation amplifiers according to the sensors used.
c) Filters low pass and high pass adjustable according to the signals that are required to measure
d) 24-bit analog-digital acquisition system with a resolution up to 21 bits.
e) Adjustable sampling system for acquisition speeds of 100 or 200 samples per second.
f) Real-time clock disciplined with GPS.
g) Data storage system of up to 16GB in interchangeable micro SD memory.
h) Serial port for sending data acquired in real time.
i) Liquid crystal display for programming the operating parameters.
j) The system uses a microcontroller in which the specific program for each version resides.
k) Everything is mounted on a printed circuit board and was designed to have very low power consumption so it could be powered by a 12 volt battery.

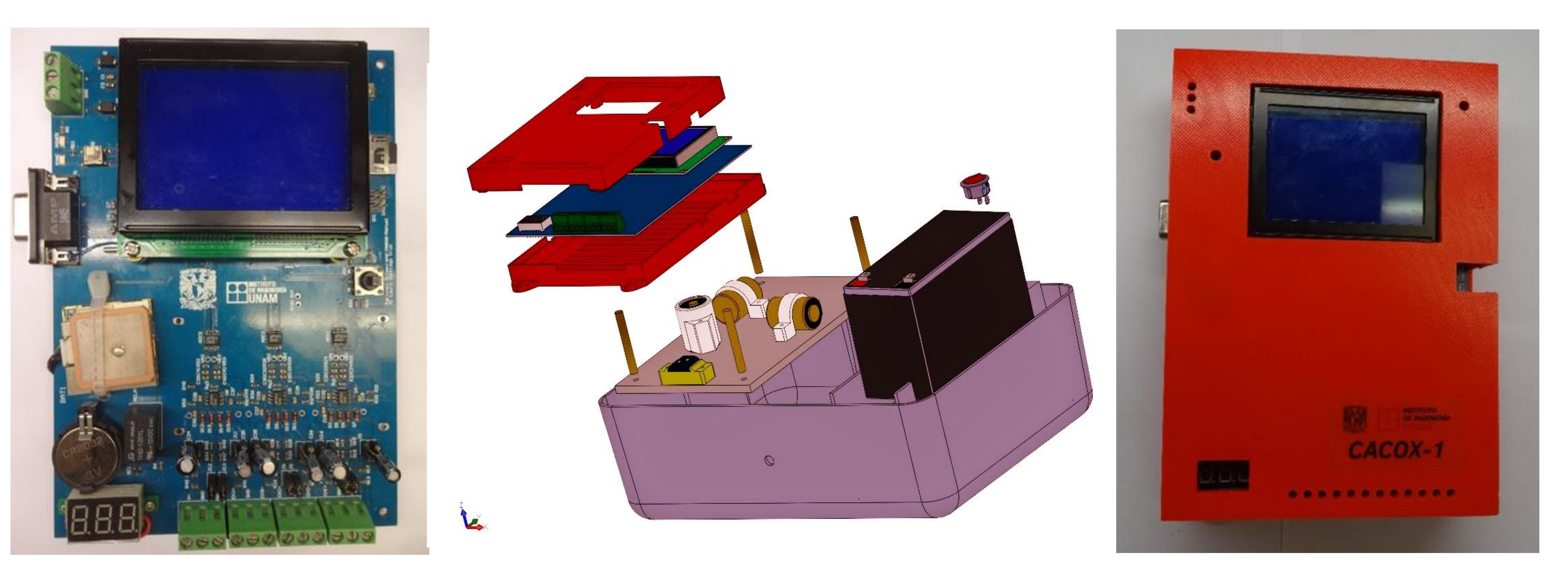

FIGURE 1. Acquisition card and acquisition card with its shell

"A" Version for noise and microsimicity measurements

The first version developed was for the measurement of seismic noise and small earthquakes, in these measurements are displayed temporarily a large number of similar receivers that register simultaneously, the sensors used were a triaxial arrangement of geophones of 4.5 Hz modified to have flat response from 1 Hz (Fig. 2), this version used a high gain of the input amplifier since these sensors are passive and generate voltages of the order of millivolts, this version was designed to keep the data continuously, only in the internal memory micro SD.

The entire system, including a sealed lead-acid battery, is contained within a lightweight, weather-resistant polypropylene case that allows easy installation and leveling at the selected site and then quickly transport it to the next measurement point (Fig. 3), the case has a connector for the external GPS receiver and another connector for the external power supply.

FIGURE 3. Briefcase and protective casing of the recorder

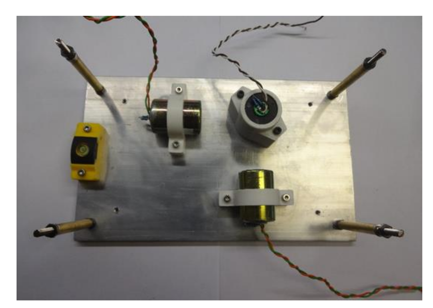

FIGURE 2. Triaxial sensor arrangement

. Version “B” for permanent accelerographic stations

The second version was designed to be installed permanently in accelerographic stations, in this case it uses a triaxial arrangement of balanced forces accelerometers, these are active sensors that require power and deliver a signal of ± 2.5 volts in its total acceleration range, they can use sensors of several brands and models, in this occasion FBA23 accelerometers of the Kinemetrics brand were used (Fig. 4).

This version was designed to send data in real time through the RS232 serial port, later using a Serial Port server Lantronix UD1100001-01 the Internet connection is made to the Central Registration Post in the Engineering Institute, here it is they receive data from all the accelerographic stations in an Earthworm system.

The acquisition card, the triaxial accelerometer and the serial device server UDS1001 are installed inside a case identical to the model "A", the difference is that this model has an RJ45 connector to connect to an Ethernet network and another connector to feed to the recorder with a large capacity external battery recharged by a solar cell or an AC battery charger (Fig. 5 and 6)

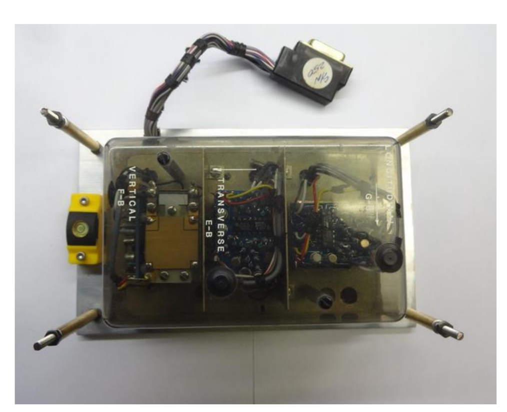

FIGURE 4. FBA23 Accelerometer

FIGURE 5. Connectors on case

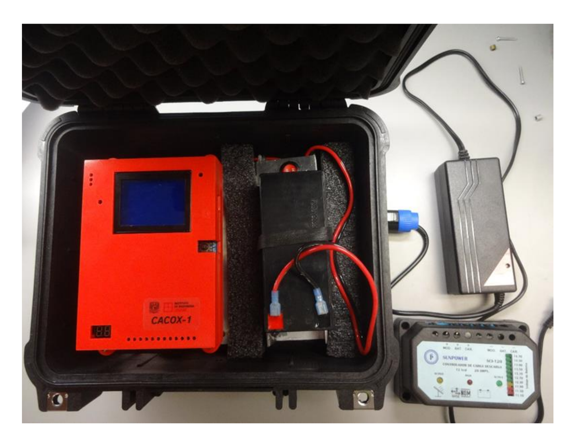

FIGURE 6. Complete installation

From this version real-time data transmission tests were carried out over the Internet, first sine signals were sent for calibration (Fig.7) and later signals were sent from a triaxial accelerometer FBA23 an example of the received signals are shown in the figure 8.

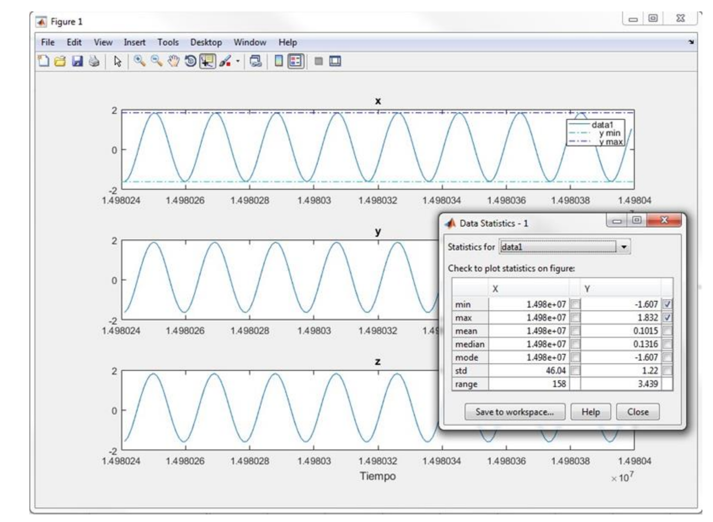

FIGURE 7. Sine signal calibration

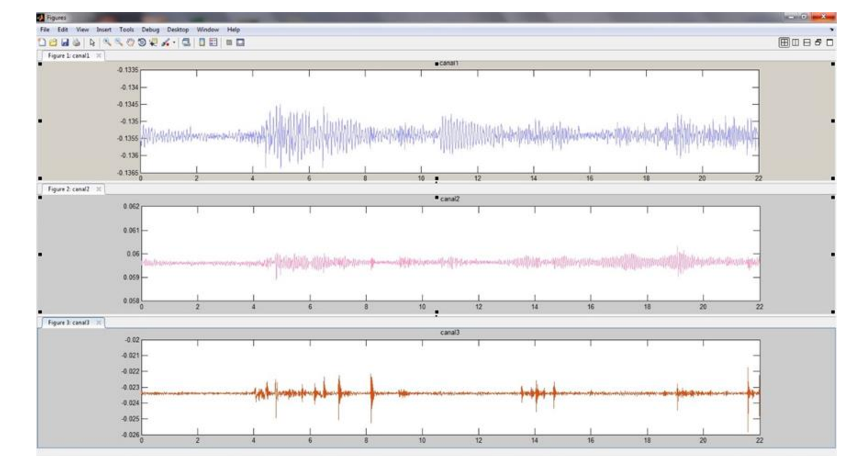

FIGURE 8. Real acceleration signal from FBA23

"C" Version for accelerographic stations in structures

This version was designed to measure the accelerations during an earthquake in several parts of a structure, such as buildings, bridges, aqueducts, etc.

The acquisition card can also be mounted in a metal moisture-proof protection box together with a 12-volt gel backup battery and powered by an external AC charger (Fig. 9).

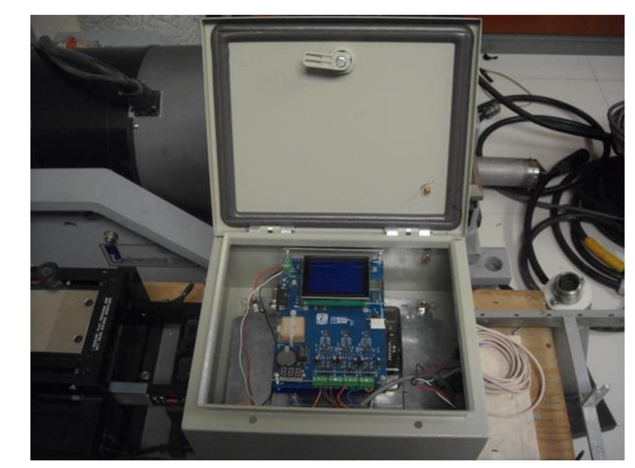

FIGURE 9. Version "C" mounted in metal box

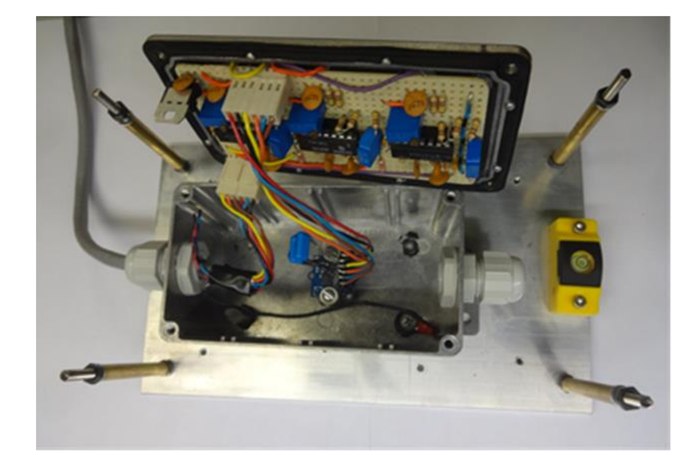

FIGURE 10. Triaxial MEMS accelerometer

The sensors used were low-noise and low-cost MEMS ADXL354 (Fig.10), the accelerometers are mounted in the same metal box in which the acquisition card is located or in another small metal box that is fixed to the structural element that is to be monitored, the input amplifier is adjusted to the output voltages of the MEMS accelerometers.

Conclusions

With the development of this register platform, multiple experiments and measurements can be carried out in the field of seismological and structures engineering, it is intended to continue developing new versions and adding improvements to those already built.

Acknowledgments

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