A NEW VERTICAL SEISMOMETER BASED ON THE MOIRE TECHNIQUE

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ABSTRACT

This paper describes a new optical seismic sensor for geophysical applications. Following the work done Institute Advance studies in Basic sciences in Zanjan, we have built a new vertical short period seismometer based on the Moiré technique. This seismometer consisting of a spring-suspended mass whose position is monitored using the moiré technique. A pair of gratings in relative displacement, magnifies the amplitude of the displacement of the oscillator inside the seismometer. The intensity of a light beam passing through the moving moiré fringes changes with time, and a detector converts these power fluctuations to a voltage signal. This voltage signal gives the time-series of the ground motion. We derive the theoretical response of the moiré readout system. The natural frequency of our sensor is 8 Hz and the damping factor is 0.65. Also, a 12 bit A/D device is used to digit the analog responses of optical seismometer. We compare the actual response of the moiré seismometer and a conventional seismometer (6TD Guralp, 0.1 Hz). Comparisons with conventional seismometers show that, in terms of both noise and signal fidelity, the optical approach is quite viable. Also, our sensor has some additional advantages.

INTRODUCTION

Seismometers are instruments that record ground vibration during the propagation of elastic waves in the earth. These sensors are based on damped oscillation of an inertial-pendulum system. The pendulum is an inertial proof mass attached to a spring. The frame of the sensor is fixed to the ground. During ground shaking, the movement of the mass is delayed relative to the movement of the frame. A damping mechanism restores the mass to its equilibrium position after a small transient perturbation. In most seismic sensors, the readout system consists of a moving coil-transducer that converts the motion of the mass to voltage signal. These electromagnetic systems have some disadvantages, for example they are susceptible to environmental EM noise. So, scientists have been looking at using optical methods. Optical approaches have some advantages respect to the other techniques that are higher signal to noise ratio, sensitivity, and precision, and etc. Recently, scientists used Michelson interferometry as a readout system in seismometery.