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Can mobile phones used in strong motion seismology?

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Micro Electro-Mechanical Systems (MEMS) accelerometers are electromechanical devices able to measure static or dynamic accelerations. In the 1990s MEMS accelerometers revolutionized the automotive-airbag system industry and are currently widely used in laptops, game controllers and mobile phones. Nowadays MEMS accelerometers seems provide adequate sensitivity, noise level and dynamic range to be applicable to earthquake strong motion acquisition. The current use of 3 axes MEMS accelerometers in mobile phone maybe provide a new means to easy increase the number of observations when a strong earthquake occurs. However, before utilize the signals recorded by a mobile phone equipped with a 3 axes MEMS accelerometer for any scientific porpoise, it is fundamental to verify that the signal collected provide reliable records of ground motion. For this reason we have investigated the suitability of the iPhone 5 mobile phone (one of the most popular mobile phone in the world) for strong motion acquisition. It is provided by several MEMS devise like a three-axis gyroscope, a three-axis electronic compass and a the LIS331DLH three-axis accelerometer. The LIS331DLH sensor is a low-cost high performance three axes linear accelerometer, with 16 bit digital output, produced by STMicroelectronics Inc. We have tested the LIS331DLH MEMS accelerometer using a vibrating table and the EpiSensor FBA ES-T as reference sensor. In our experiments the reference sensor was rigidly co-mounted with the LIS331DHL MEMS sensor on the vibrating table. We assessment the MEMS accelerometer in the frequency range 0.2-20 Hz, typical range of interesting in strong motion seismology and earthquake engineering. We generate both constant and damped sine waves with central frequency starting from 0.2 Hz until 20 Hz with step of 0.2 Hz. For each frequency analyzed we generate sine waves with mean amplitude 50, 100, 200, 400, 800 and 1600 mg0. For damped sine waves we generate waveforms with initial amplitude of 2 g0. Our tests show as, in the frequency and amplitude range analyzed (0.2-20 Hz, 10-2000 mg0), the LIS331DLH MEMS accelerometer have excellent frequency and phase response, comparable with that of some standard FBA accelerometer used in strong motion seismology. However, we found that the signal recorded by the LIS331DLH MEMS accelerometer slightly underestimates the real acceleration (of about 2.5%). This suggests that may be important to calibrate a MEMS sensor before using it in scientific applications. A drawback of the LIS331DLH MEMS accelerometer is its low sensitivity. This is an important limitation of all the low cost MEMS accelerometers; therefore nowadays they are desirable to use only in strong motion seismology. However, the rapid development of this technology will lead in the coming years to the development of high sensitivity and low noise digital MEMS sensors that may be replace the current seismic accelerometer used in seismology. Actually, the real main advantage of these sensors is their common use in the mobile phones.