

## Statment of Research Interests

My work focuses on Earthquake Early Warning Systems (EEWS), especially understanding the strength and limitations of online applications. Basically, problems of EEWS can be divided into two general areas: backcasting and forecasting. Backcasting is a more seismological problem involving the estimation of the magnitude and location of an earthquake from the very beginning of the rupture process. In contrast, forecasting aims to solve the problem of determining the amplitude of shaking far from the seismic source areas using an engineering perspective. The most significant countermeasures focused in mitigating the effects of destructive earthquakes on society are based on forecast estimates for both automatic and manually operated systems, such as the shutting down of bullet trains, nuclear power plants, and special equipment. I focus on the latter and have developed a technique to evaluate initial ground motion by incorporating an artificial neural network based methodology which takes into account source parameters and soil classification or site amplifications in frequency domain. I and our project group integrate national EEWS of Japan and our newly developed regional EEWS (in Miyagi Prefecture, Japan) to enhance reliability and to issue more informative warnings within a few seconds of detection. My determinations encompass peak ground motions (PGA and PGV) as well as Fourier amplitude spectrum and response spectrums.

While developing real-time online warning system, I used latest communication technologies, TCP/IP, UDP protocols and network oriented digital seismic data acquisition systems. The improved generic recording format which is an open device and platform independent of transporting and storing digital waveform data created by field digitizer hardware is used and made our system the fastest in the world on this matter. This contribution is very satisfying as an engineer. I developed client software which is capable of real-time online seismic data processing including online recursive digital filtering (classical IIR, Butterworth Chebyshev etc.), STA/LTA and various P wave triggering algorithms. For this purpose I studied and than applied advanced seismic instrumentation, Linux based embedded systems using advanced MEMS sensors, high resolution 24-bit DAQUSB analog-to-digital converters (ADC), logger and GPS. This system made it possible not only advanced early warning system but also real-time structural health monitoring of structures. In this respect we achieved the fundamental problems in EEWS technologies and accomplished that ground motion at distant sites can be forecast depending on initial ground motion information by EEWS. At the end, I believe I have built a bridge between scientific and networking aspect of seismology with expertise in software development and real-time seismic data processing.

As part of my investigation on EEWS application, I have learned automatic control of devices and system identification. Before the deployment of the regional system, I confirmed the developed methodology by shake table tests. To duplicate the similar earthquakes, I used two degree of freedom types of controller after obtaining transfer function of the shaking table experimentally. Online measurement is acquired by LabVIEW software and I have specialized in electrical control systems (patlite etc) using various on board DAQ computer hardware.

My research interests also consist of the engineering adaptive systems of artificial intelligence. This secondary interest with respect to cognitive modeling is focusing on application of artificial neural network in all kinds of engineering application including, pattern recognition, self organizing maps etc. My research shows how to use the advanced supervised learning ANN techniques for EEWs applications. I wrote an ANN based general program which has selectable options for architecture (feed –back and –forward), for algorithm (Levenberg-Marquardt, quasi-Newton and scaled conjugate gradient) and lastly automatic evaluation of optimum configuration of the architecture depend on trial by various hidden layers. I have gained expertise in sophisticated artificial intelligence methods to tackle problem in this seismological and earthquake engineering environment.