Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)


SSS24-P01 Room:Convention Hall Time:May 27 18:15-19:30

# Application to display Earthquake Information using Mobile Terminal

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Recently, the users utilize emergency earthquake information using mobile terminals. The mobile terminals run on multiple OS as Android or iOS etc. and have been developed using multiple programming language as C++, Java or Objective-C etc. It is difficult to execute these programs on multiple platforms. But it is easy to execute these program on web browser with standard as HTML5.

In this survey, I evaluate processing performance and compatibility of HTML5 programs

and make applications to display earthquake information. I tested smart phones, tablets, laptop PCs. First I evaluated performance and compatibility using programs for numerical calculation, 2D display, 3D display. The results show that programs using HTML5 have compatibility for terminals with Windows, Android, iOS. The performances of latest mobile terminals are about 1/2 to 1/3 compared with PC. Next, I made applications to display earthquake information and evaluate the compatibility. The programs are for information display on local map and global map, real-time seismic wave data display, semblance processing display. The programs have compatibility for multiple mobile terminals.

I conclude that the programs using standard HTML5 have compatibility for multiple mobile terminals with Windows, Android, iOS. The performances have been catch up to PC.

I plan to more survey and revamp the applications.

Keywords: mobile terminal, earthquake information, HTML5, WebGL

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# Array observation of strong motion for the precise estimation of current wavefield

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We conduct a research for the next generation of earthquake early warning based on the concept of Hoshiba (2013), where we will predict ground motion without estimating hypocentral information. Recently, Hoshiba and Aoki (2015) presented examples of ground motion prediction with observed records based on this concept.

For estimating current wavefield, Hoshiba and Aoki (2015) uses only amplitude at each station. It is expected that some more information about current wavefield such as propagation direction and apparent velocity leads to more accurate estimation of current wavefield. Array observation is one of the powerful tools to observe propagation direction and apparent velocity, so that we started array observation at the premises of our institute.

Our array network are consisted by six CV-374 type strong motion seismometers. Sampling frequency is 500 Hz. Except one station buried under the ground, five stations are fastened to the floor of each building. The size of array network is about 300 m.

We applied semblance analysis (Neidell and Tarner, 1971) to the records of the earthquake at Northern Nagano Pref. (2014/11/22, M6.7) using 1 s time window in several frequency ranges. At the time ranges of direct P wave arrival and P coda waves, semblance value of UD component is high even in a high frequency range. Backazimuth, however, is slightly southward than the expected arrival direction. Apparent velocity is also higher than the expected velocity, which means that the low velocity layer under the array may affect the backazimuth and apparent velocity. At the time range of direct S wave arrival, semblance value is relatively high for frequency under 4 Hz of horizontal component, although the backazimuth and apparent velocity at that time is not stable compared with those of direct P waves. Backazimuth and apparent velocity becomes unstable at the time range of S coda waves in spite of high semblance value.

To estimate the velocity structure under the array, we conducted seismic interferometry (e.g. Nagaoka et al., 2012) using continuous records. Dispersion relation of phase velocity of Rayleigh waves from 400 to 300 m/s for 1 to 4.5 Hz, which means the existence of low velocity layer under the array. We will further estimate the velocity structure under the array with other information.

Rapid calculation is needed in semblance analysis for the purpose of earthquake early warning. We will work on the development of effective calculation considering the velocity structure, as well as the parallel computation.

Keywords: Array observation, Earthquake early warning, efficient calculation

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# Fast Estimate of Rupture Process of Large Earthquakes via Real Time Hi-net Data

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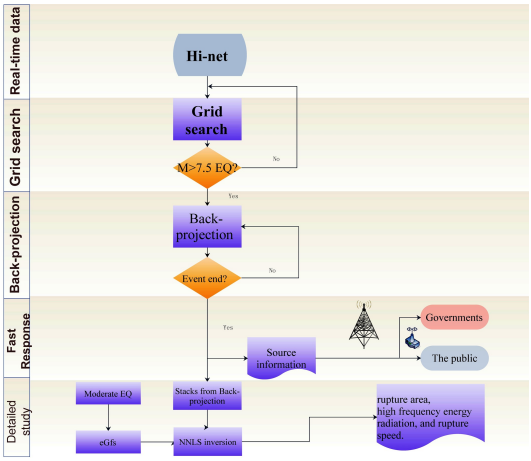
We developed a real time/automated system based on Hi-net seismic array that can offer fast and reliable source information, for example, source extent and rupture velocity, for earthquakes that occur at distance of roughly 30- 85 degrees with respect to the array center (Figure 1).?

We perform continuous grid search on a Hi-net real time data stream to identify possible source locations (following?Nishida, Kawakatsu, and Obara, 2008, JGR). Earthquakes that occurred off the bright area of the array (30- 85 degrees with respect to the array center) will be ignored. Similarity of the waveforms, and location variations of the local maxima from neighboring windows are used to verify the occurrence of large earthquakes. Once a large seismic event is identified successfully, back-projection will be implemented to trace the source propagation and energy radiation using pre-calculated station corrections derived from nearby earthquakes that occurred previously. An inversion will be then applied to get the detailed high frequency energy distribution.

The time required is mainly due to the travel time from the epicenter to the array stations, so we can get the results between 6 to 13 min depending on the epicentral distances. This system can offer fast and robust estimates of source information for large earthquakes, which may be useful for disaster mitigation, such as tsunami evacuation, emergency rescue, and aftershock hazard evaluation.

**Figure caption**
Figure 1 Framework of the Real Time Back-Projection

Keywords: real time seismology, rupture process, Hi-net, disaster mitigation



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# REGARD - Real-time GEONET Analysis System for Rapid Deformation Monitoring -

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Geospatial Information Authority of Japan (GSI) has been operating a continuous GNSS observation network system since 1994. This system is known as GEONET (GNSS Earth Observation Network) and consists of approximately 1300 nationwide GNSS stations (GEONET station) and the analysis center. Most stations collect GNSS data with 1-Hz sampling and transfer them to the analysis center in real time. Those data are available for surveying or research using real-time kinematic positioning technique. This technique is expected for describing cataclysmic earthquake from crustal displacement in short time especially after the 2011 off the Pacific Coast of Tohoku Earthquake in March 2011.

GSI and Tohoku University have developed the Real-time GEONET Analysis System for Rapid Deformation Monitoring (REGARD) since September 2011 to estimate moment magnitudes (Mw) soon after large earthquakes struck. This system consists of three subsystems. First subsystem does real-time kinematic positioning using RTKLIB (Takasu, 2011) and GSILIB (GSI, 2015). Second one detects seismogenic behavior using the RAPiD algorithm (Ohta et al. 2012) or the Earthquake Early Warning (Kamigaichi et al. 2009) and immediately run the third subsystem. This subsystem estimates Mw within three minutes using displacement vectors of GEONET stations (Kawamoto, 2014). Finally, results are mailed to persons involved.

We tested this system in 2012, using 143 GEONET stations located in the Tohoku region. Last year, we expanded its function by using all the stations receiving 1-Hz streaming data covering almost all lands of Japan and enhanced its redundancy by carrying out two independent processing in parallel. In this year, we enhance real-time kinematic positioning by using QZSS and GLONASS as well as GPS. We also improve the browser used in the agency to search for previous results and visually recognize results of the real-time kinematic positioning.

In this presentation, we report the brief overview and the current situation of REGARD, including the accuracy enhancement and the browsing software.

Keywords: GEONET, RTK-GNSS, real-time

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# Real-time Damage Estimation for the 2014 Nagano Kamishiro Fault Earthquake by J-RISQ

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[1]NIED

It is extremely important to quickly assess the damage immediately after an earthquake for providing suitable disaster response. We has constructed prototype of a Real-time Information System for earthQuake (J-RISQ) for appropriate decision-making regarding the initial response at an earlier stage immediately after an earthquake by combining amplification characteristic data for subsurface ground as well as basic data such as population and building information accumulated in J-SHIS development and observation data including real-time strong-motion data observed by K-NET and KiK-net (Aoi *et al.*, 2013, Nakamura *et al.*, 2013). A part of J-RISQ information (including the estimated distribution of seismic intensity and the population exposed to each seismic intensity level) is published as a ”J-RISQ Report” on http://www.j-risq.bosai.go.jp/ immediately after the occurrence of an earthquake. In this study, we describe the estimations by J-RISQ for the 2014 Nagano Kamishiro Fault Earthquake.

J-RISQ issued five reports for this event. The first report was issued by using information from 12 observations approximately 27 seconds after the earthquake. J-RISQ estimated the population exposed to the seismic intensity of 5 lower or greater to be 20,000, one buildings were completely destroyed and 10 buildings partly destroyed. Eventually, the fifth report was made by using the information from 1567 observations approximately 11 minutes after the earthquake. J-RISQ estimated the population exposed to a seismic intensity of 5 lower or greater to be 200,000, the population exposed to a seismic intensity of 6 lower or greater to be 20,000, 46 buildings were completely destroyed and 186 buildings partly destroyed.

Keywords: J-RISQ, real-time, Damage Estimation, 2014 Nagano Kamishiro Fault Earthquake, K-NET, KiK-net

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# A numerical study of real-time source mechanism inversion (GRiD-MT) considering 3D heterogeneous subsurface structure

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Abstract

One of the main objectives in this study is upgrading the GRiD-MT system (Tsuruoka et al., 2009), which performs a moment tensor inversion in real time basis by using both observed waveforms and correlation coefficients of Green's function. To achieve the goal, we firstly simulated seismic wave propagation using the finite difference method (FDM) which takes into account the heterogeneous underground structure, frequency dependence and so on.

GRiD-MT, considering 3D horizontally stratified structure model, is good for rather long period seismic waves (20-50s) and can determine MT solutions of Mw4 class earthquakes. We would like to apply GRiD-MT much smaller magnitude and more accurate determination for MT solution, we have to take into account using more shorter period seismic waves (less than 20s). We initially investigated effects of number of observation stations and frequency ranges for MT inversion. We used 2D model to know the features of MT inversion under the heterogeneous structure. Because, in the future, we would like to use Green's function under 3D heterogeneous structure model for the calculation.

We performed 2D simulation of seismic wave propagation and estimated hypocenter locations using the FDM method. We beforehand set 96 virtual sources in the model and computed 96 Green's functions for each observation point at the surface. So, we determine real hypocenter by comparing actual waveforms and Green's functions and using cross correlation coefficients. We adopt the highest point of cross correlation coefficient as a real hypocenter. In this study, we used maximum 5 stations to compare them.

In the future, we would like to compute 3D Green's function for 3D heterogeneous subsurface structure. Furthermore, we have a plan to use reciprocal theorem in the GRiD-MT.

Keywords: GRiD-MT, hypocenter location, correlation coefficient