On the Establishment of an Automatic Earthquake Information Broadcast System in Taiwan

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Abstract

An efficient earthquake auto-location algorithm has been developed by the Central Weather Bureau (CWB), Taiwan. The CWB can now routinely obtain earthquake information in one minute after the occurrence of an earthquake using this new algorithm. In order to take full advantage of this capability, four automatic information broadcast media, namely, e-mail, World Wide Web, FTP server and pager system, have been configured to receive and transmit automatically the earthquake information from the CWB seismic monitoring system. This new automatic earthquake information broadcast system will enable the CWB to disseminate information about felt earthquakes even more quickly and widely than its current practice through the fax and paper reports.

1 Introduction

Interest in rapid access to earthquake information had grown enormously in the past few years. In addition to satisfying the public and media needs, the rapid notification programs provide valuable information for rapid earthquake disaster response, thereby mitigating the loss. Recognizing the importance of rapid earthquake information for seismic hazard mitigation, efforts to design and implement systems to provide rapid earthquake information have expanded over the last 10 years. Recently, a real-time strong-motion network was installed in the Taiwan area by the Central Weather Bureau (CWB) for monitoring purposes. In order to maximize the use of data from this network, a rapid earthquake information and early warning system is under active development. A rapid response information release system for large earthquakes in Taiwan has been implemented CWB through a Taiwan Rapid Earthquake Information Release System (TREIRS). In this paper, we shall describe the instrumentation and system performance of the TREIRS.

2 Instrumentation

The CWB of Taiwan has deployed a modern digital accelerograph network. The network headquarters receives a continuous digital data stream input from 58 strong-motion stations (Fig. 1) on a real-time basis. At a digitization rate of 50 samples/sec, three channels of strong-motion data take up the 4800-baud band of the CWB leased telephone lines, whereas an additional 4800-baud band is used for transmitting short-period velocity data. A group of PC respectively operates under MS-DOS, Windows/95, and Windows/NT system for data acquisition, processing, and communication (Fig. 2).

A block diagram of two major data processing systems used for the TREIRS is shown in Figure 3. One system is for the continuous recording, and the other for triggered recording. For rapid earthquake information release sys-

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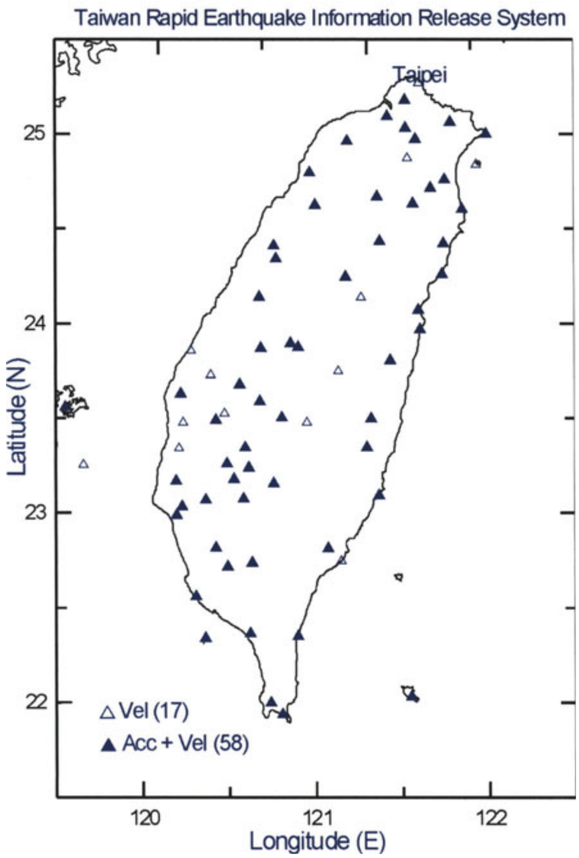

Fig. 1. Map showing station locations of telemetered digital accelerographs and short-period seismographs (solid squares), and telemetered digital short-period seismographs (open squares) in Taiwan

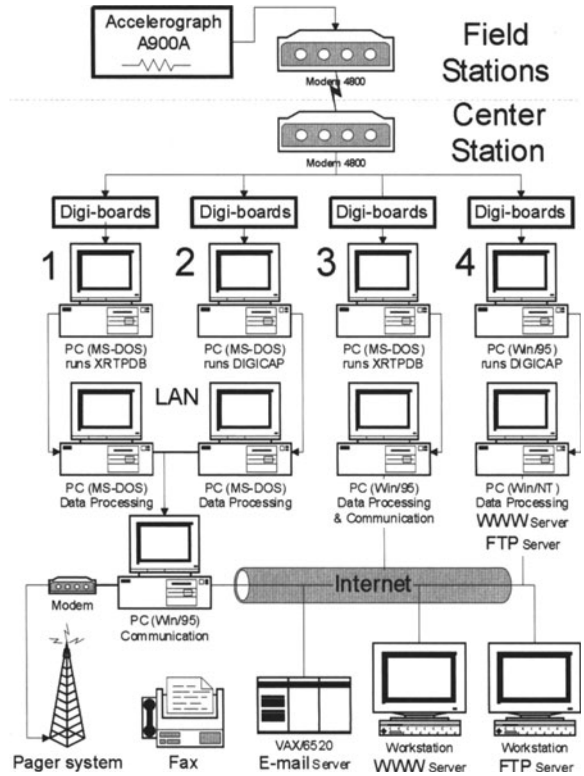

Fig. 2. A block diagram showing the hardware of the Taiwan Rapid Earthquake Information Release System (TREIRS)

tem, the incoming data is processed by a software XRTPDB written by Tottingham and Mayle (1994). Whenever a set of pre-specified trigger criteria are met, digital waveforms are saved and analyzed by a program for automatic phase picking, and for automatic earthquake location. Results are disseminated in four different ways, namely, through E-mail, World Wide Web, FTP sever, and pager system (Wu et al. 1997 a).

The incoming data is also processed by another PC system. The data is continuously recorded at 1-minute intervals per file by a software DIGICAP written by Mayle (1995). Each one-minute file is then subjected to automatic triggering, phase picking, earthquake location, and PGA calculation. The results are included in the earthquake report for official announcement in routinely manner.

3 System Performance

Taiwan Rapid Earthquake Information Release System (TREIRS) had been operational since March 3, 1996. While most M_L>4.0 earthquakes were recorded by TREIRS, only the events having P (or S) arrivals from six stations have been processed. Up to December 14, 1997, seventy-nine events were identified and automatic reported (Fig. 4).

3.1 Location Difference Between Automatic and Manual Picking

As a comparison, the epicenters of seventy-nine earthquakes as determined by the TREIRS automatic location versus off-line manual location from March 5, 1996 to December 14, 1997 are shown in Figure 4. The average difference in epicenter location is about 7.2 km, and with a standard deviation of 9.7 km. In general, the earthquakes which occurred inside the TREIRS network had smaller location difference compared to the ones outside the network.

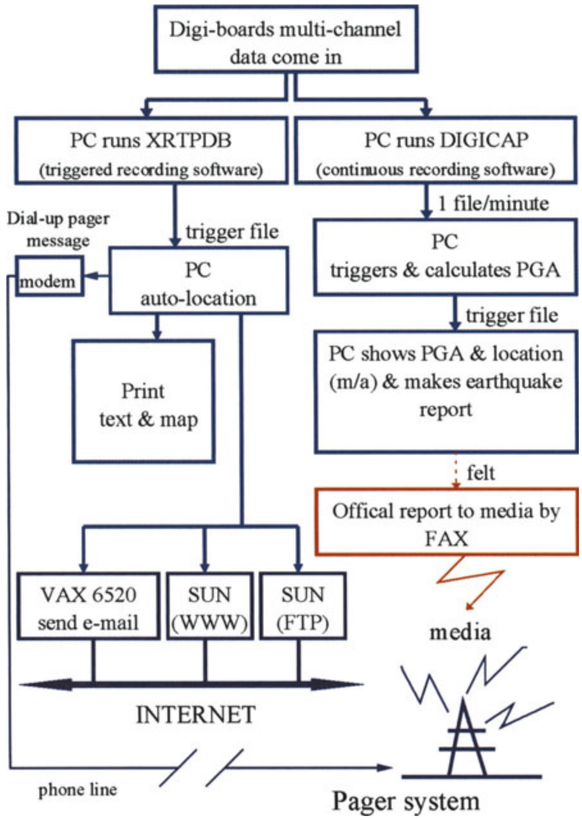

Fig. 3. A flow chart showing the data processing of the TREIRS

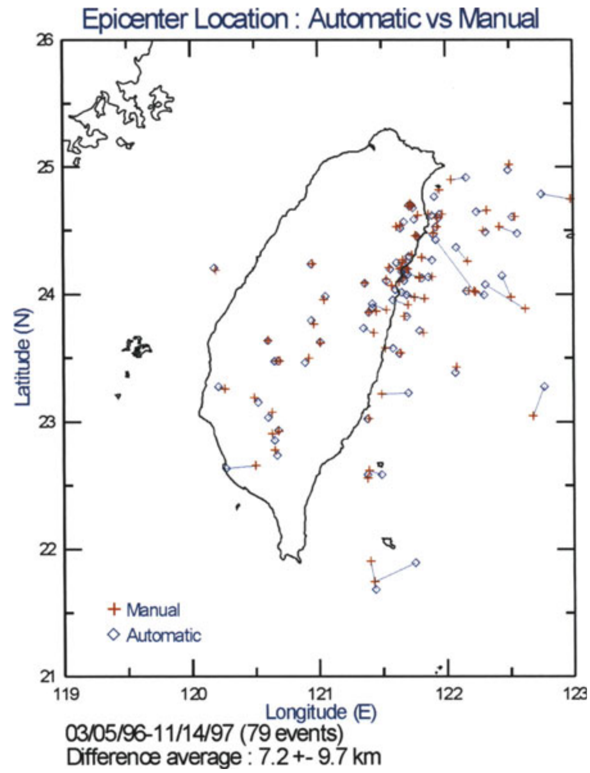

Fig. 4. Location difference of 79 earthquakes determined by automatic and manual picking

3.2 Magnitude Difference Between Automatic and Manual Picking

Figure 5 shows the TREIRS magnitude difference of the seventy-nine events obtained by automatic and manual location. The automatic determined magnitude is generally underestimated by 0.05 and with a standard deviation of 0.16.

3.3 Effective Response Time

In this study, the effective response time is defined as the time interval between system received the *P*-wave arrival of the nearest station and source parameters reporting time. Based on the fifty-one reports that provide the reporting time, we found the average effective response time is 52.5 sec and with a standard deviation of 7.6 sec (Fig. 6).

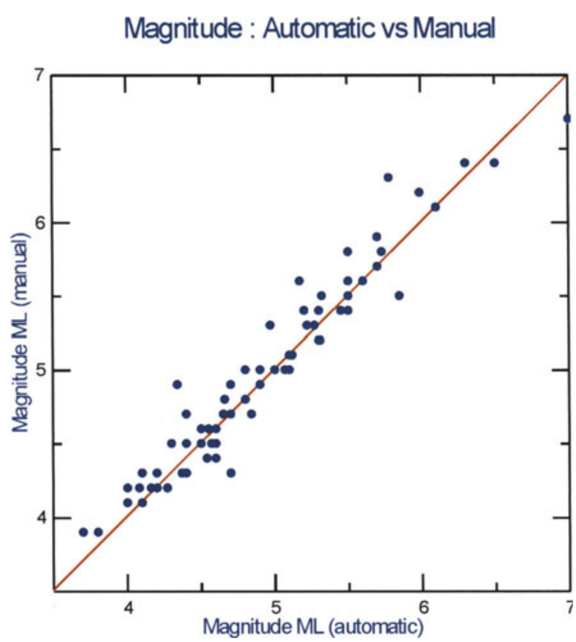

Fig. 5. Magnitude relationship (A) and difference (B) of 79 earthquakes determined by automatic and manual picking

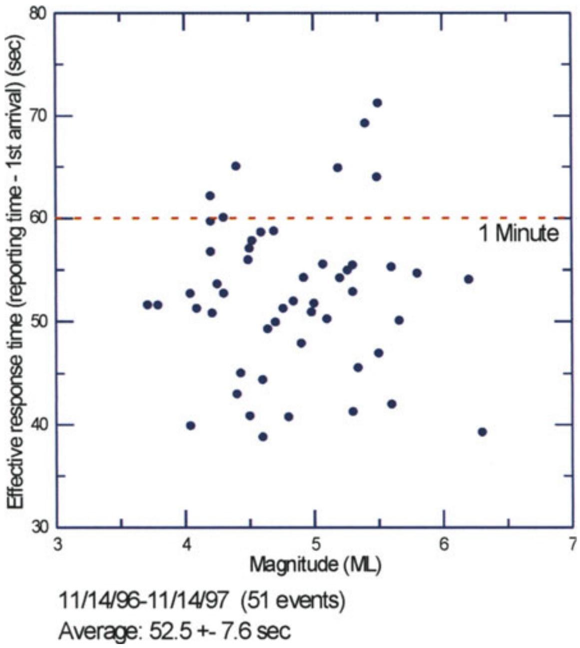

Fig. 6. Earthquake effective response time versus magnitude

4 Summary

We have deployed an inexpensive, real-time telemetered accelerograph network in Taiwan, which is capable of the on-scale recording and rapid reporting of large earthquakes. Our results show that we have achieved earthquake location and magnitude determination in about one minute after the occurrence of the felt earthquake. We are confident that a 30-second earthquake reporting time can be achieved in the future. This paper and other papers of this series published before (Teng et al. 1997; Wu et al. 1997a, 1997b, 1998a, 1998b) essentially pave the way for an earthquake early warning system to be put in operation in Taiwan.

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