UNITED STATES DEPARTMENT OF THE INTERIOR

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XDETECT is a program that controls data acquisition and processing in a PC-based seismic system for operating a small telemetered analog seismic network. XDETECT uses a faster algorithm than its predecessor, MDETECT.

Hardware Requirements:

(1) A 100\% IBM compatible PC/AT or 286 PC (8 MHz or faster CPU speed), running under the IBM PC-DOS operating system (version 3.3). The system should include one serial and one parallel port, and a keyboard.
(2) At least 1,536 kilobytes of RAM memory (120 nsec or faster, depending on the CPU speed). The first 640 kilobytes of RAM must be placed in the base memory, and the remaining RAM must be configured as the extended memory. We recommend a 2 megabyte memory board to supplement the RAM already on your PC/AT's motherboard.
(3) A math coprocessor, i.e., Intel 80287 (8 MHz or faster).
(4) A hard disk with at least 30 megabytes of free space. The access time of your hard disk must be at most 40 msec.
(5) A 1.2 MB, 5.25 inch floppy disk drive.
(6) A Hercules graphics adapter and a compatible mono\-chrome monitor (720 by 350 pixel). Optionally, you may configure a dual monitor system by adding an EGA or CGA adapter/ monitor.
(7) A Data Translation DT2821 or DT2824 analog-to-digital I/O board with a DT707 screw terminal connecting panel.

Software Requirements:

(1) IBM PC-DOS Version 3.3.
(2) Microsoft C, Version 4.0
(3) Microsoft FORTRAN, Version 4.1
(4) Microsoft Macro Assembler, Version 4.0
(5) Data Translation ATLAB, Version 1.10

OF89-205-A, Introduction, description of algorithm and software

OF89-205-B, Source code diskette with copy of documentation in OF89-205-A, and sample files ..... 5 1/4 inch standard double side, double density diskette (IBM PC compatible).

1. INTRODUCTION

Lee, Tottingham, and Ellis (1988) described a low-cost PC-based seismic data acquisition, processing, and analysis system. In that system, a program called MDETECT is used to control the data acquisition and processing in realtime. The detection algorithm used in MDETECT is based on the work of John Rogers, and the maximum digitizing rate is about 120 samples per second per channel for 16 channels. In order to speed up the digitizing rate, a new program (called XDETECT) was written using a faster detection algorithm based on the work of Stewart, Lee, and Eaton (1971). With XDETECT, the maximum digitizing rate is 500 samples per second per channel for 16 channels using a standard 8 MHz PC/AT personal computer.

In this report, we will briefly describe (1) the detection algorithm used, and (2) the contents of the accompanying floppy diskette. Please contact: Books and Open-File Report Section, U. S. Geological Survey, Box 25425, Denver Federal Building, Denver, CO 80225 for information on ordering a copy of this report and/or the floppy diskette.

2. DETECTION ALGORITHM

The design of a fast algorithm for automatic detection of local earthquakes is constrained by a few simple considerations. First, the algorithm must be simple so that a standard 8 MHz PC/AT can keep up with the incoming flow of seismic data. We use a double buffering scheme such that while the data is being written to a buffer, processing is taken place on a preceding buffer. If the size of the buffer is 16 kilobytes, then it will be filled in 2.048 seconds, if there are 16 channels of seismic signals being digitized at 500 samples per second and each sample is a 2-byte integer.

During the 2.048 seconds, the monitoring program must (1) transfer 16 kilobytes of digitized data from the extended memory to the DOS memory, (2) demultiplex 16 channels of data, (3) display these data on the monitor screen, (4) apply a detection algorithm, and (5) if an event is detected, pick arrival times, locate the earthquake, and save the digitized data on the hard disk.

Because we set up at least 6 buffers in the extended memory, we can fall behind several seconds when an event is detected and there are additional tasks to be performed. However, we must not fall too far behind. Otherwise, it will become impossible to catch up, and the system will crash when the buffers are

over-run. Therefore, the time for executing the detection algorithm must be kept small because the time required for doing the other tasks is more or less fixed for an 8 MHz PC/AT.

A general discussion on various detection algorithms has been presented by Lee and Stewart (1981). Automatic detection based upon waveform correlation from one channel to another will not work for local earthquakes, because the signatures written by a local event at stations only a few kilometers apart are remarkably dissimilar. Moreover, the processing time required for a correlation method would be excessive. Therefore, each incoming seismic signal must be examined separately for the possible onset of a local earthquake.

Further considerations have to do mainly with the realities of real-time monitoring. Seismic noise levels will vary from station to station. Unwanted transients having frequency components within the range of local earthquakes will appear from time to time. Stations will occasionally not functioning properly.

A detection algorithm developed by Stewart, Lee, and Eaton (1971) has been shown to be effective (Stewart, 1977). Since the algorithm has been described, readers are referred to be the above cited work. In brief, the incoming signals are differenced and rectified. Differencing of adjacent data points has the effect of filtering out low frequency components, and improving the signal-to-noise ratio for local earthquake signals.

Short-term and long-term averages are then computed successively and three parameters: alpha, beta, and gamma are determined.

The alpha parameter is used to see if there is an abrupt change in the incoming signal, and a flag is set if alpha exceeds a critical value. The beta parameter is used to confirm if there is sufficient ``energy'' in the signal. An event is then declared if three or more confirmations occur within a given time window. Finally, the gamma parameter is used to determine if an event is over.

3. XDETECT SOFTWARE

The source code for XDETECT is contained in the accompanied floppy diskette. Two sample data files are also included to illustrate how to set up the required input files. Source code written by the authors is given in a file called XDETECT.SRC. This file refers to several sub-files in the PCQUAKE.SRC file released with the report by Lee, Tottingham, and Ellis (1988). Readers are referred to Lee (1989) for details on how to effectively use this software.

The contents of the accompanying floppy disk are :

(1) XDETECT.SRC -- Source code for XDETECT written by the authors.
(2) XSAMPLE.INP -- An example showing you how to set up an input file required by XDETECT. We recommend that you set up an input file similar to this file, and name it XDETECT.INP (the default name used by the XDETECT program).
(3) XSAMPLE.STA -- An example showing you how to set up a station file required by HYP020 within the MDETECT program for earthquake location. The station file must be named HYP020.STA and must have the same station code as given in the XDETECT.INP file.
(4) READ.ME -- An introduction file.

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