INTERACTIVE DATABASE FOR GRAPHICAL RETRIEVAL OF STRONG MOTION ACCELEROGRAMS

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SUMMARY

The large number of available strong motion accelerograms creates unique problems for data management and retrieval. Depending upon the type of study to be conducted, an analyst might wish to retrieve data based upon one or more of a number of variables, including empirical measurements, geographic location, date of occurrence, or the availability of other records at the same site.

This paper describes a database retrieval system which has been developed to allow analysts to retrieve strong motion accelerograms interactively while sitting at a CRT. Called the Princeton Interactive Graphical Strong Motion Accelerogram Retrieval Database (PIGSMARD), the system is based upon a graphical interface which allows the analyst to communicate with the machine through simple graphical commands. Using a graphics display terminal, the user can display the location of epicenters and recording stations, plot the recorded accelerograms, and produce analytical summaries of the data. The user communicates with the system in two ways: through simple commands which initiate basic procedures, and through crosshair screen cursors which can indicate graphical locations.

INTRODUCTION

Many studies of strong earthquake ground motion rely on the analysis of historical records, either for the estimation of model parameters or for the validation of theoretical concepts. With the massive amount of data now available, the retrieval of desired records from earthquake databases can be a major undertaking. The current emphasis on interactive data analysis using personal workstations demands a user-data interface which allows the user to select interesting records and to retrieve them while sitting at a CRT display. Graphical methods have proved to be extremely effective in many areas of earthquake engineering, and the maintenance of strong motion databases is no exception.

This paper describes an earthquake database management system which is centered around a two-way graphical communications system for maintenance and retrieval. Developed at Princeton University, the system

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allows users to make interactive queries of the contents of the database and to retrieve selected records, all though graphical techniques. The data consists of time series records obtained from the National Geophysical Data Center and consists of several thousand recorded accelerograms throughout the world. The system provides an important service in enabling researchers to browse through available data and quickly select relevant series for analysis.

ORGANIZATION

Strong motion earthquake accelerograms are typically provided to users in two parts: a header describing information such as epicenter location, position of the recording station, date and time, magnitude and other summary information; and the digitized records, consisting of uniformly sampled acceleration readings throughout the duration of the earthquake. In the Princeton database, the header information has been placed in a separate file which can be quickly loaded into memory together with graphical software to display available information in a selected geographical region. The implementation consists of: (a) a basic APL graphics system to provide a flexible interactive user interface; (b) assembler routines for fast graphical display; (c) a geographical database with country and state boundaries; (d) graphical information on the location of major faults, obtained by digitizing geographical maps; and (e) software for conversion from latitude-longitude information to selected projections. Header information is loaded into an active workspace together with the above data and software, providing a very fast means for displaying the locations of available records.

INTERACTIVE QUERIES

A typical example of the use of the database would involve an analyst interested in studying earthquake records from Southern California. The analyst would sit down at a graphics workstation, link to the disk containing the earthquake database, load the APL workspace containing the graphics interface, and execute the function SHOWCAL. This function would display the image in Figure 1, which shows the major faults within the state of California and the locations of all epicenters contained in the database. To narrow the geographical region displayed, the user may execute the ZOOM function and use a joystick to position screen cursors at opposite corners of a viewing window. The selected region is then expanded and redisplayed, allowing for a more detailed picture as in Figure 2.

The analyst then has several options: (1) to label the epicenters in the current window using the function LABELEPIC; (2) to position the cursor on a particular epicenter and display the header information for that earthquake; or (3) to position the cursor on a selected epicenter and display the location of all recording stations with records of that earthquake (Figure 3). Alternatively, the analyst can ask to see the location of all recording stations in the database, and by selecting a particular station can display all epicenters recorded at that location.

DATA RETRIEVAL

To retrieve selected time series from the database, the user positions the cursor successively on a selected epicenter and then on a recording station. The selected accelerogram will be retrieved and each component stored as a vector in the active workspace. The function PLOTACC will plot the three components (see Figure 4), while SAVEACC will write them to a special file. Various selection filters are also available to select earthquakes with specified magnitude ranges, at sites with given characteristics, or during certain years. A sample of earthquake records can thus be assembled very quickly for subsequent analysis.

STATISTICAL SUPPORT SOFTWARE

The database management and retrieval system has been designed to integrate closely with a set of statistical functions for the analysis and simulation of strong motion accelerograms. These functions include basic descriptive techniques as well as analytical functions for variance-envelope estimation, ARIMA model-building, generation of simulated series, and response spectrum estimation. The retrieved data is stored as vectors in the active workspace which can then be passed as arguments to the statistical routines. For examples of typical output, see the paper by Cakmak and Sherif elsewhere in this volume.

HARDWARE

The figures displayed in this paper were produced using an IBM3277GA graphics workstation, which consists of a fullscreen IBM3277 display terminal with an attached high resolution Tektronix CRT display. Hardcopy output is available using a thermal printer or via attached pen plotters. A version of the database retrieval system has also been developed for the IBM PC XT, which uses a medium resolution RGB terminal for graphical display. On the PC workstation, hardcopy graphics output is available through screen dumps to a dot-matrix printer or using pen plotters. Information on other possible hardware configurations can be obtained by contacting the authors.

Figure 1

Epicenters and Major Faults in the California Database

Figure 2

Enlarged View of Subregion Indicated by Crosshair Cursors

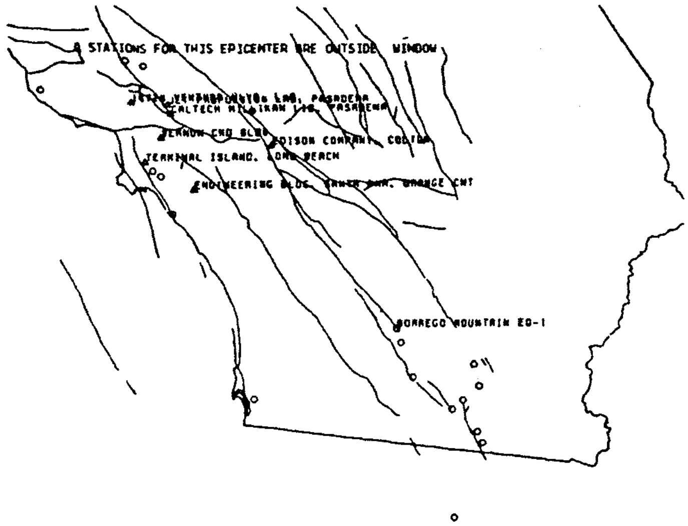

Figure 3

Epicenter Selected by Crosshair Cursors and
all Associated Recording Stations

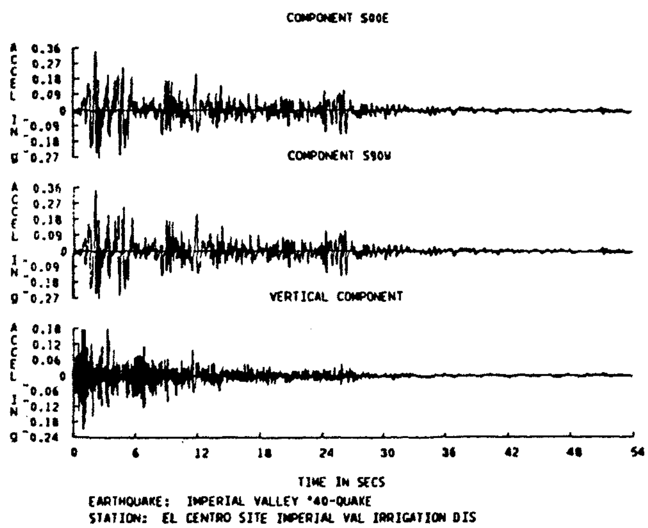

Figure 4

Time Series Retrieved from Database
by Graphical Requests