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YCCE Earthquake Data Analyzer

Apeksha M. Jangde[1], Mandar A. Joshi[2], Mohini D. Masram[3], Rohit B. Koltakke[4]

Final Year B.E. Student, Department of Computer Technology, Yeshwantrao Chavan College of Engineering, Nagpur, India.[1,2,3,4]

Abstract: This paper introduces a software module which will convert the unformatted text file of earthquake data into an uniform format containing time, acceleration, velocity and displacement in transverse, longitudinal and vertical directions recorded at various earthquake stations during an earthquake. The paper contains methodology adopted in converting the raw data into useful data. The paper also presents the graphical representation of available and converted data.

Keywords: Earthquake: Series of vibrations induced in the earth's crust by the abrupt rupture and rebound of rocks, Earthquake data file: The data file created at earthquake station containing various parameters, Earthquake data analyzer: Earthquake data analyzer is a tool to format Earthquake data file and to analyze parameters of earthquake, GUI: Graphical User Interface

I. INTRODUCTION

Earthquakes are one of the most destructive of natural hazards and to reduce the risk, it is important to analyze the data of previous earthquakes. Large data of earthquake occurred at various stations is available .That data is saved in files which contains Acceleration, velocity and displacement of respective directions i.e. longitudinal, transverse and vertical. It is very tedious for an earthquake engineer to bring the file in readable and understandable format for analyzing it. So, our objective is to bring this data into proper format by sorting it on the basis of various parameters (e.g. Acceleration, Velocity, and Displacement) in three directions (Longitudinal, Vertical, and Transverse).

According to the earthquake experts we interacted, they are using Microsoft Office Excel for analyzing the data in the file. But before analyzing they used to take lot of efforts to bring the data in proper format. So, Representation of this data in MS-Excel file was our first aim. The earthquake data information and related parameters are analyzed by earthquake engineers, geophysicist and structural engineers in different manner. We came across some common methodologies they used like creating graph, crating idealized graphs, analyzing frequency and finding time at which P and S waves started. So, we have developed an application that can open the available data file and perform those operations on it. We have data of four earthquakes at India-Burma Border stations, we applied data mining technology with clustering that can suitably arrange this data and can be used for predicting values of some parameters as desired by experts. This technique will help all concern with earthquake data in determining parameters of interest such as location of focus, epicenter and properties of earth crust with ease.

II. METHODOLOGY

As mentioned in introduction the data file contain information about earthquake, along with it also contains other information about location of earthquake station peak acceleration, peak velocity, peak displacement, initial velocity, initial displacement. Information about specific earthquake is stored in form of data points after every 0.020 sec. i.e. acceleration, velocity, displacement at particular time instance. As we can see in Fig 1 a sample of the data file is shown.

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                    N.E. INDIA EARTHQUAKE, MAY 06, 1995
 BAIGAO          Lat & Lon25 24 N 92 52 E Comp: S28W
Accelerogram Bandpass filtered between  .550- .700 and  25.00-27.00 hz.
Initial Velocity =      -.6200E-03 m/s Initial Displacement =   0.2700      mm
Peak Acceleration =       0.55919    m/s/s at    2.360  sec
  609 Acceleration data points (in m/s/s) at .020 sec
-.393E+00 -.361E+00 -.114E+00 0.289E+00 0.307E+00 -.123E+00 -.377E+00 -.819E-01
0.457E+00 0.548E+00 0.238E+00 -.262E+00 -.507E+00 -.266E+00 0.615E-01 0.177E+00
0.154E+00 0.131E+00 0.130E+00 0.456E-01 -.851E-01 -.183E+00 -.293E+00 -.246E+00
0.630E-01 0.208E+00 0.101E+00 0.589E-01 0.372E-01 -.219E-01 -.807E-01 -.129E+00
-.949E-01 0.205E-01 0.672E-01 0.273E-01 -.331E-01 -.288E-01 0.984E-01 0.133E+00
0.129E-01 -.509E-01 0.343E-01 0.128E+00 0.631E-02 -.129E+00 -.145E+00 -.996E-01
-.329E-01 0.859E-01 0.109E+00 0.427E-01 0.478E-01 -.260E-01 -.182E+00 -.169E+00
0.445E-01 0.262E+00 0.179E+00 -.144E+00 -.280E+00 -.191E-01 0.248E+00 0.446E-01
-.315E+00 -.337E+00 -.394E-01 0.395E+00 0.379E+00 0.151E+00 -.594E-02 -.123E+00
-.162E+00 -.132E+00 -.158E+00 -.580E-01 0.169E+00 0.332E+00 0.198E+00 0.348E-01
Peak Velocity =          -0.2215E-01  m/s at   2.340  sec
  609 Velocity data points (in m/s) at .020 sec
-.620E-03 -.828E-02 -.132E-01 -.115E-01 -.566E-02 -.393E-02 -.904E-02 -.137E-01
-.101E-01 -.180E-03 0.765E-02 0.742E-02 -.250E-03 -.797E-02 -.100E-01 -.760E-02
-.426E-02 -.140E-02 0.122E-02 0.300E-02 0.258E-02 0.200E-04 -.461E-02 -.988E-02
-.116E-01 -.875E-02 -.554E-02 -.381E-02 -.273E-02 -.245E-02 -.350E-02 -.542E-02
-.749E-02 -.806E-02 -.701E-02 -.589E-02 -.578E-02 -.622E-02 -.535E-02 -.286E-02
-.142E-02 -.165E-02 -.167E-02 0.110E-03 0.161E-02 0.530E-03 -.207E-02 -.436E-02
-.554E-02 -.486E-02 -.294E-02 -.135E-02 -.360E-03 -.700E-04 -.207E-02 -.550E-02
-.666E-02 -.352E-02 0.970E-03 0.141E-02 -.286E-02 -.585E-02 -.357E-02 -.640E-03
-.335E-02 -.987E-02 -.136E-01 -.101E-01 -.234E-02 0.296E-02 0.439E-02 0.304E-02
Peak Displacement =        0.7400       mm at   2.060  sec
  609 Displacement data points (in mm) at .020 sec
0.270E+00 0.270E+00 0.140E+00 -.400E-01 -.120E+00 -.120E+00 -.150E+00 -.300E+00
-.470E+00 -.490E+00 -.380E+00 -.110E+00 0.700E-01 0.800E-01 0.000E+00 -.800E-01
-.100E+00 -.500E-01 0.500E-01 0.190E+00 0.280E+00 0.410E+00 0.470E+00 0.420E+00
0.290E+00 0.190E+00 0.150E+00 0.150E+00 0.190E+00 0.240E+00 0.210E+00 0.210E+00
0.160E+00 0.800E-01 0.200E-01 -.300E-01 -.600E-01 -.100E+00 -.130E+00 -.130E+00
-.140E+00 -.110E+00 -.900E-01 -.400E-01 0.400E-01 0.120E+00 0.170E+00 0.160E+00
0.120E+00 0.800E-01 0.200E-01 0.300E-01 0.500E-01 0.900E-01 0.120E+00 0.800E-01
0.000E+00 -.700E-01 -.500E-01 0.300E-01 0.400E-01 -.100E-01 -.700E-01 -.700E-01
-.500E-01 -.150E+00 -.350E+00 -.560E+00 -.640E+00 -.590E+00 -.480E+00 -.350E+00
-.250E+00 -.220E+00 -.250E+00 -.330E+00 -.430E+00 -.470E+00 -.390E+00 -.240E+00
```

Fig.1 Data File From Earthquake Stations.

As we can see in figure firstly all data points of Acceleration are stored with the interval of 0.020 sec. followed by velocity data points acceleration and displacement data points. Data points are stored in exponential form i.e. "-.623E-03". Firstly we converted these data points into regular decimal point format i.e. "0.000623". To analyze data parameters of each direction is required i.e. Longitudinal, Transverse and Vertical. So, for analysis of one station we have to process three files (.l, .t and .v).

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After preprocessing the data file, we used Net Beans for development of user interface in java swing. The facility of selecting the data file (Fig 2 and 3)(any one out of three with extensions .l, .t or .v) and getting the formatted output in swing tables is provided in GUI(Fig 4). Also additional details in the file can be viewed in the Details tab (Fig 5).

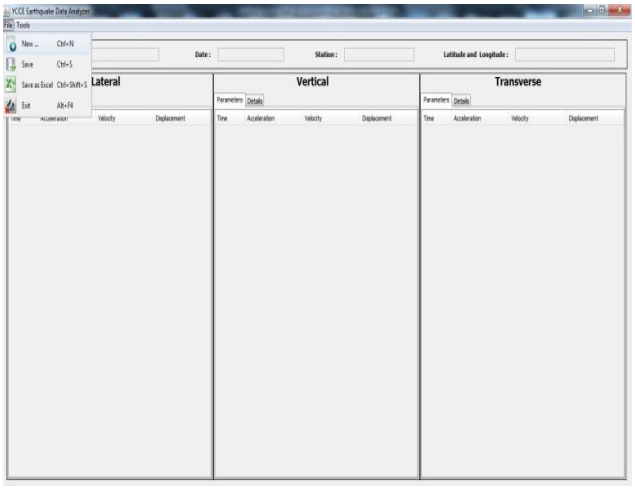

Fig 2 Using File Menu for opening a Data File.

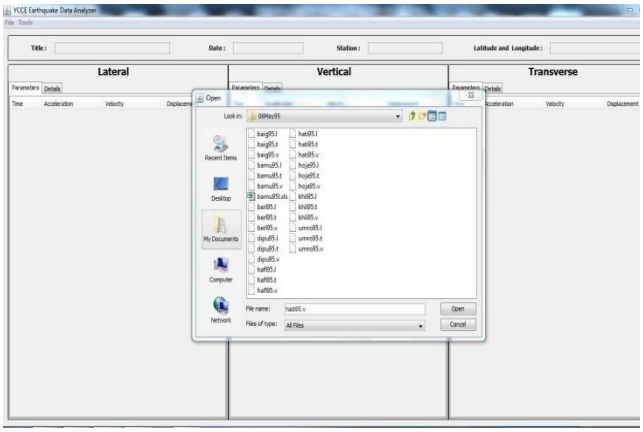

Fig 3 Browsing a Data File into Computer.

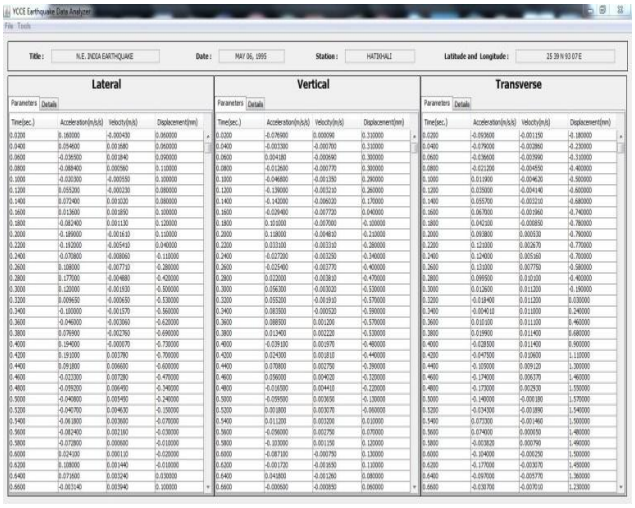

Fig.4 Displaying all files into a Swing Table.

Fig. 5 Details tab.

Two types of graphs can be drawn using this tool. JFreeChart APIs are used for development of the module that draws required graphs. Data values of any parameters available can be given as input to the JFreeChart Interface and the required graphs can easily be drawn. First type of graph draws graphs according to the contents of the file, in input we have to give the specific parameter of which a graph is to be drawn.(Fig 6 and 7)

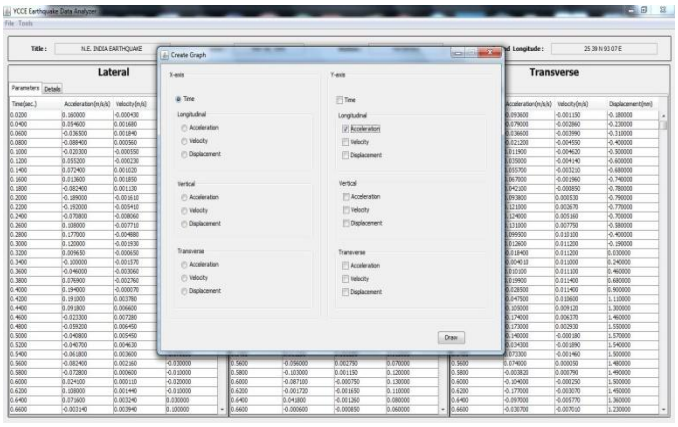

Fig. 6 Selecting X-Y Parameters to draw Graph.

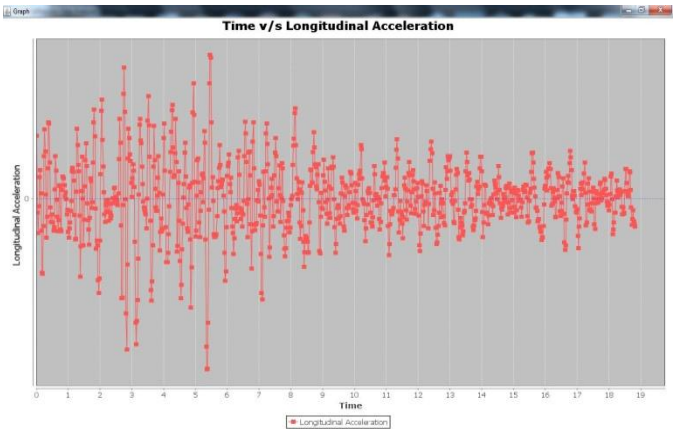

Fig. 7 Graph Drawn from mentioned Parameters.

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Second type of graph that can be drawn from the tool is Idealized graph. As we can see in Fig 7 there are too many points in graph to be analyzed. So, just to ease the user only maximum and minimum points are used to draw a graph. In this case also we have to select a parameter to draw a graph. (Fig 8 and 9).

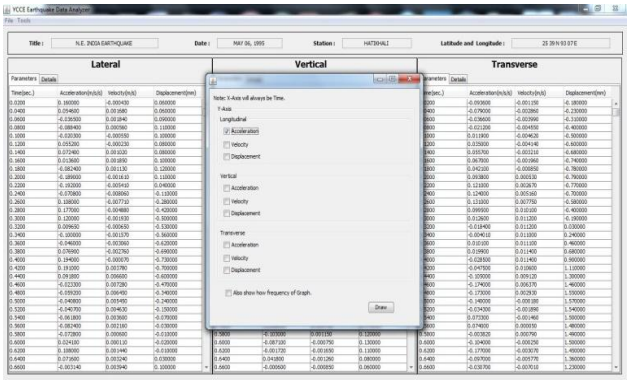

Fig. 8 Selecting a parameter to draw Graph.

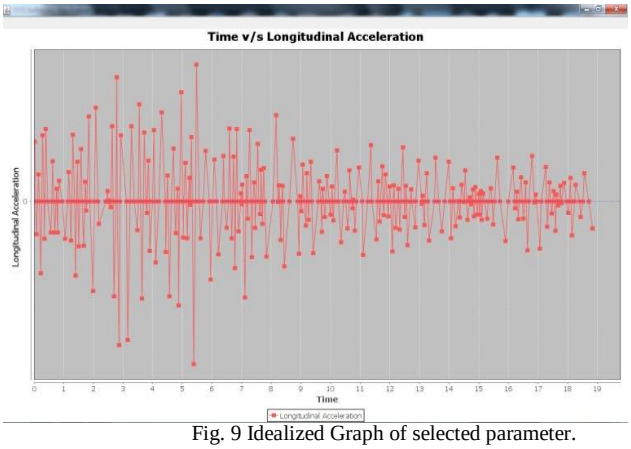

Fig. 9 Idealized Graph of selected parameter.

With the help of Jxl APIs, module for creation of Microsoft Excel file from available data is implemented. This MS-Excel file is very helpful to earthquake experts regarding further processing. Finding S-wave and P-wave has become easy (Fig 10a and 10b).

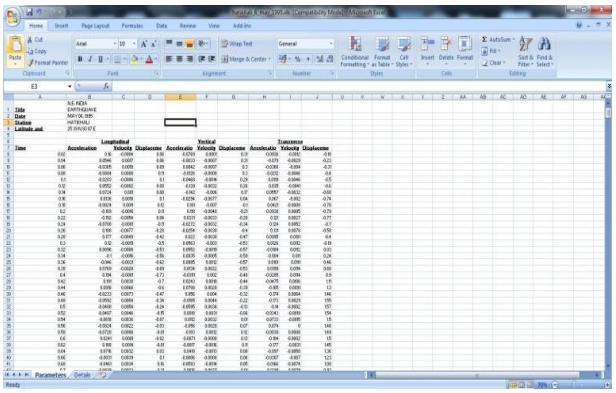

Fig.10a Excel File from the input data Files.

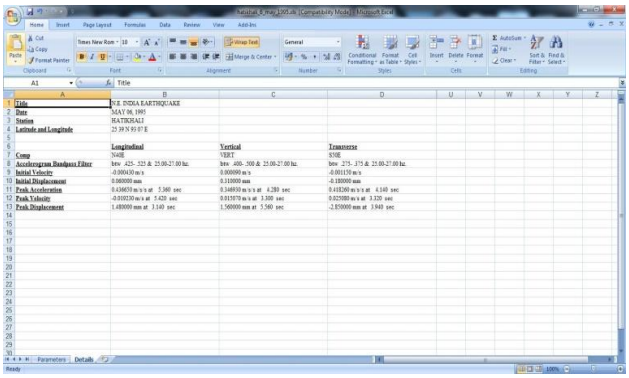

Fig.10b Excel File from the input data Files.

Digitization of Nomogram has been done successfully. Time between the occurrence of S and P wave along with maximum amplitude can be given as input to get the approximate magnitude of earthquake. The backend tool used for saving the available data into standard database is Oracle.

III. DISCUSSION

Designed software module can open data file from any earthquake stations and display it in proper table format which will help earthquake experts to interpret the data in the file. It can represent the available data in graphical form for better understanding.

This tool can also draw idealized graph that is helpful for calculating the average frequency. Software module performs successful search of S-wave and P-wave. It chooses minimum and maximum values from negative and positive data value sets.

IV.CONCLUSION

This tool will prove to be very beneficial for all those who are carrying out research on Earthquake. Parameters get readily available for further use. Conversion of raw data in Excel format is very fast.

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BIOGRAPHY

Mandar Anand Joshi pursuing final year Bachelor of Engineering in Computer Technology, Yeshwantrao Chavan College of Engineering, Nagpur.

Apeksha Moreshwar Jangde pursuing final year Bachelor of Engineering in Computer Technology, Yeshwantrao Chavan College of Engineering, Nagpur.

Rohit Balkrishna Koltakke pursuing final year Bachelor of Engineering in Computer Technology, Yeshwantrao Chavan College of Engineering, Nagpur.

Mohini Dilip Masram pursuing final year Bachelor of Engineering in Computer Technology, Yeshwantrao Chavan College of Engineering, Nagpur.