A REPORT
ON

DEVELOPING A WEB APP FOR DISPLAYING EARTHQUAKE PARAMETERS

BY

Rigvita Sharma 2016A7PS0067P

AT

Institute of Seismological Research
(Government of Gujarat, India)

INSTITUTE OF SEISMOLOGICAL RESEARCH, GANDHINAGAR

A Practice School-I station of

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Prepared in partial fulfilment of the Practice School-I
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BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE
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Title of the Project: Developing A Web App For Displaying Earthquake Parameters

ID Number	Name of Student	Discipline
2016A7PS0067P	Rigvita Sharma	B.E. (Hons.) Computer Science

Name of Mentor: Mr. Ketan S. Roy

Name of PS Instructor: Mr. Pratik N. Sheth

Key Words: Earthquake Analysis and Visualisation(Seisan, SAC, CPS, GMT), Website Development, Database Management(SQL), Client Side Scripting(HTML, CSS), Server Side Scripting(PHP), Web Server.

Project Area(s): IT, Seismology

Abstract: The goal of this project was to learn and design an earthquake catalogue website using PHP, HTML, MySQL.The website aims to shows various event parameters like time, magnitude, epicentre, depth etc.of the earthquake. The first focal mechanism is used to find the parameters. The same parameters are also be found to construct synthetic seismograms using tensor moment inversion technique to correlate with the original seismogram. This intends to provide the required thrust for all ISR internal research activities.

We used our knowledge of databases during our internship. This internship allowed us to increase our knowledge in HTML, CSS languages used in front-end for development of this application and PHP, MySQL used in back-end for development of this application. This project also gave us an opportunity to learn earthquake analysing tools.
This project not only improved our knowledge in technical aspect but also in group abilities and professional behaviour.

Signature(s) of Student

Date: 13th July, 2018

Signature of PS Faculty

Date: 13th July, 2018

Note:

1. Title of the project in this performa should be the same as that on the cover page and title page.
2. Abstract should briefly describe the information given in the report in about 200 word.
3. It is essential for both the students and faculty to sign the abstract sheet.

ACKNOWLEDGEMENTS

I would like to extend my sincerest gratitude to Institute Of Seismological Research and our mentor Mr. Ketan S. Roy for giving us the opportunity to work on this project and for providing us with constant guidance and support. I would also like to thank Mr. Vishnu Kant Verma, M.Sc. Geophysics, IIT Powai for helping me learn the theory of earthquake seismology.

Furthermore, I would like to thank our faculty instructor Mr. Pratik N. Sheth and co-instructor Mr. Anuj Dixit for their instrumental role in the project allotment.

Finally, I would like to thank the Practice School Division for providing me with the unique opportunity to work at this premier research institute.

TABLE OF CONTENTS

INTRODUCTION

The Institute of Seismological Research (ISR) under the Science and Technology Department, Government of Gujarat is functioning from 2006. ISR is the only institute in india fully dedicated to seismological research and is planned to be developed into a premier international institute in few years time.

Earthquake Monitoring Program at ISR:

Gujarat seismic network of 60 Broadband Seismographs and 50 Strong Motion Accelerographs is operated since 2006. Data of 36 broadband stations is processed in real-time through VSAT and Auto location software round the clock to determine the epicenter and magnitude of earthquakes within minutes of arrival of the seismic waves and the information is disseminated to administrators for taking appropriate mitigation measures. Space-time pattern of seismicity gives information about newly active faults. One Earthquake Research Center has been started at Bhachau in Kachchh.

Advancing the program:

Earthquake detection centres across the state of Gujarat have been installed by the Institute. This is to facilitate the detection of earthquakes so that an appropriate warning can be sent to any city/town nearby. So to classify the data of all the previous earthquakes and for ease to access those data we are creating an interactive website for ISR that displays all the information about the earthquakes that hit Gujarat, with its location displayed on the map on the website. This website also shows various attributes like date, magnitude of the earthquake, its location and depth etc.

SKILLS LEARNT

We began by learning SEISAN which is an earthquake analysis software, a complete set of programs and a simple database for analyzing earthquakes from analog and digital data. The data is organized in a database like structure using the file system. The smallest basic unit is a file (the S-file) containing original phase readings (arrival times, amplitude, period, azimuth, and apparent velocity) for one event. The name of that file is also the event ID, which is the key to all information about the event in the database. So to access the data from this database we decided to write a PHP script. PHP: Hypertext Preprocessor is an open source client-side scripting language. Hence in order to write that script, we learnt about PHP by referring to various online sources and completing several tutorials. Once the data was collected from SEISAN database we needed our own database to store that data. For that purpose, we decided to use the SQL database and so learning MySQL was now our primary goal. Having referred to multiple websites, we obtained the necessary skills to be able to maintain the data in our own SQL database.

We learnt how to use various HTML elements including but not limited to the Head, Title, Body tags that provide the basic framework to the webpage, Div tag for dividing the webpage into multiple divisions, class and id tags for uniquely identifying the various divisions, p tags (for paragraphs), ol and ul tags (for lists), the form tag for generating forms. We also learnt how to populate the webpage with multimedia (photos and videos), using the img tag whilst using the a href tag to anchor links to specific text.

CSS is a stylesheet language that describes the presentation of an HTML (or XML) document. CSS describes how elements must be rendered on screen, on paper, or in other media. We link the HTML document to the CSS sheet by placing <link rel="stylesheet" type="text/css" href="mystyle.css"> in the head tag of the HTML.

The styling is then carried out in the separate “spreadsheet”. We refer to the different HTML elements that we wish to style and then change the backgrounds (color, image, position etc.), font (family, style, size etc.), text (color, alignment, decoration etc.), border (style, width, color). CSS implements the Box Model to alter the Margin and Padding surrounding the content. The height and width of different elements and pictures can be controlled and their display properties selected (inline, block, inline-block) as per the demands of the webpage. Furthermore, CSS makes provisions to hide certain elements by setting the display property to none or visibility to hidden. CSS also provides for changing link properties on hovering and visiting, while also

providing a skeletal framework for all web pages; a function that is greatly enhanced by using the Bootstrap framework.
Now, we were supposed to create an image, a map to be more specific, which displays the exact location of the occurrence of the event (earthquake) using a beachball. For this purpose, we learnt GMT software. Generic Mapping Tools (GMT) is an open source collection of about 80 command-line tools for manipulating geographic and Cartesian data sets (including filtering, trend fitting, gridding, projecting, etc.) and producing PostScript illustrations ranging from simple x–y plots via contour maps to artificially illuminated surfaces and 3D perspective views; the GMT supplements add another 40 more specialized and discipline-specific tools. GMT supports over 30 map projections and transformations and requires support data such as GSHHG coastlines, rivers, and political boundaries and optionally DCW country polygons. In order to deal with GMT, we also learnt some shell scripting.
We also needed to automate the mySQL database updation in a specific time interval. For the same, we utilised cron, which is a time-based job scheduler in Unix-like computer operating systems.
After learning about all the skills required to gather this data and displaying it on the web page, the final step was to host our website which required a sound knowledge of apache web server. Hence we were able to host our website using Apache Web Server.
Following this, we started working on SAC and GSAC. A number of public-domain data processing programs are available to analyse seismic data. However, having these program is not enough, and require some basic understanding of seismological problems to be solved. During this period, we touched various fields of work including signal processing, green's function and non-geographic data visualisation using GMT. Post-Website work is more of learning opportunity rather than the practical implementation of the program. Our primary work was to understand and familiarise with various seismological libraries available. We learnt about synthetic seismograms and their scope of research.

During this process, we read some theoretical topics-

- Signal Processing
    - Filtering
        - High pass filter (or low cut) at frequency f1: Removes signals below frequency f1.
        - Low pass filter (or high cut) at frequency f2: Removes signals above frequency f2.
        - Bandpass filter at frequencies f1 to f2: Removes signals above f2 and below f1.

    - Down Sampling
- Green's Function - is the impulse response of an inhomogeneous linear differential equation defined on a domain, with specified initial conditions or boundary conditions.
    - Wavenumber Integration Technique
    - Modal Summation Technique
- Inversion- Determination of Moment Tensor Solution (MTS) using damped least square inversion by singular value decomposition
    - Single Value Decomposition

RESULTS

The interactive website that I created for ISR, displays all the earthquakes (turkey earthquake April 2018 data used for the study). This page of the website also shows various attributes like date, the magnitude of the earthquake, latitude and longitude of the earthquake, its depth. The strike, dip and rake are also displayed which are found using by inverting polarities of first motion by grid-search technique. The same parameters will also be found using moment tensor inversion techniques. Another column on this same page of the website is for obtaining the description for the corresponding earthquake. By selecting that link, a client can obtain all the required information about that particular earthquake. A map is also shown on this page, with a beach ball at the exact location of the origin of the earthquake.

Below are some screenshots that illustrate the points mentioned about the 'website' previously:

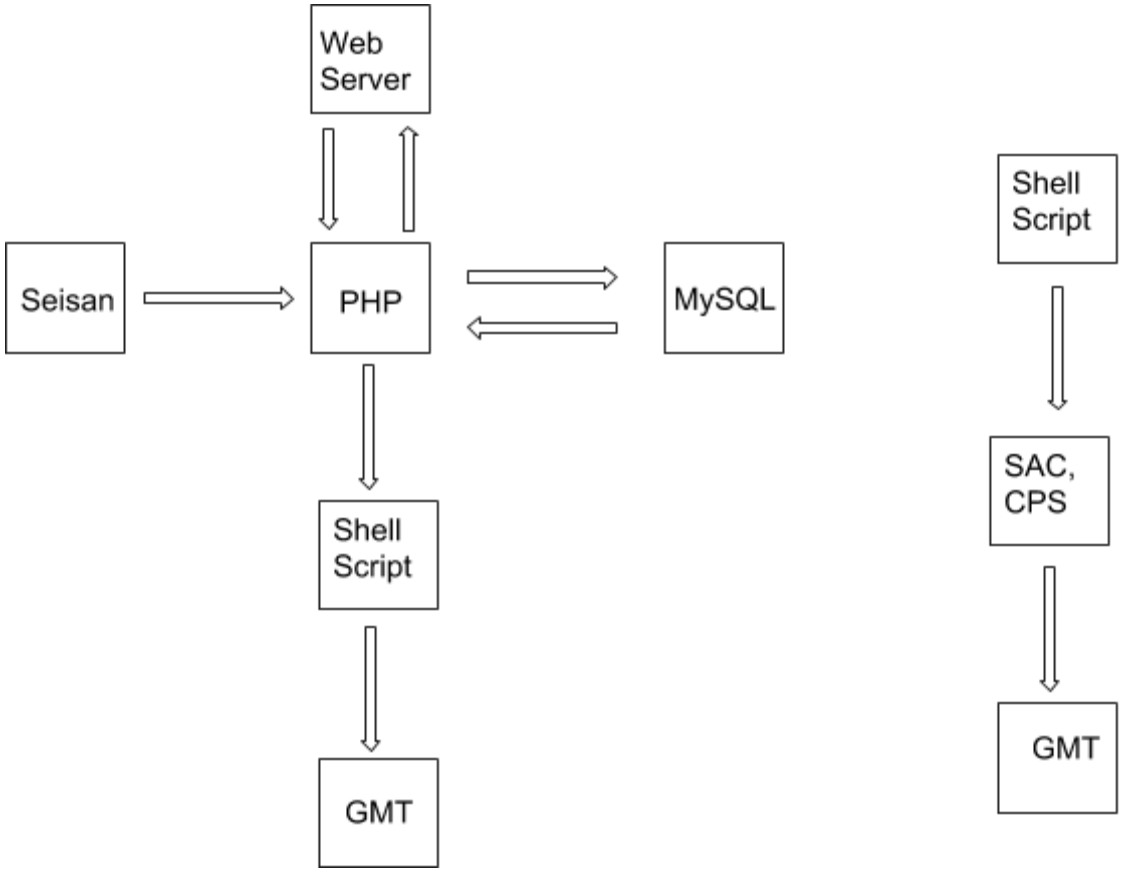

Fig.1a)Block Diagram of the website,b)Block Diagram of MTS technique

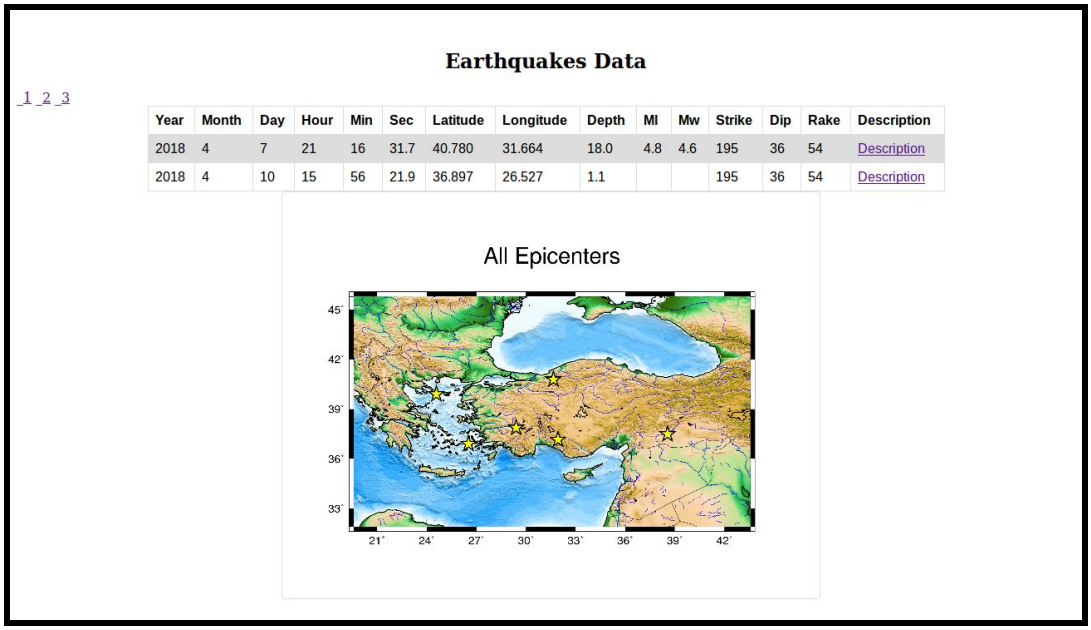

Fig.2 Screenshot of the main page of the website.

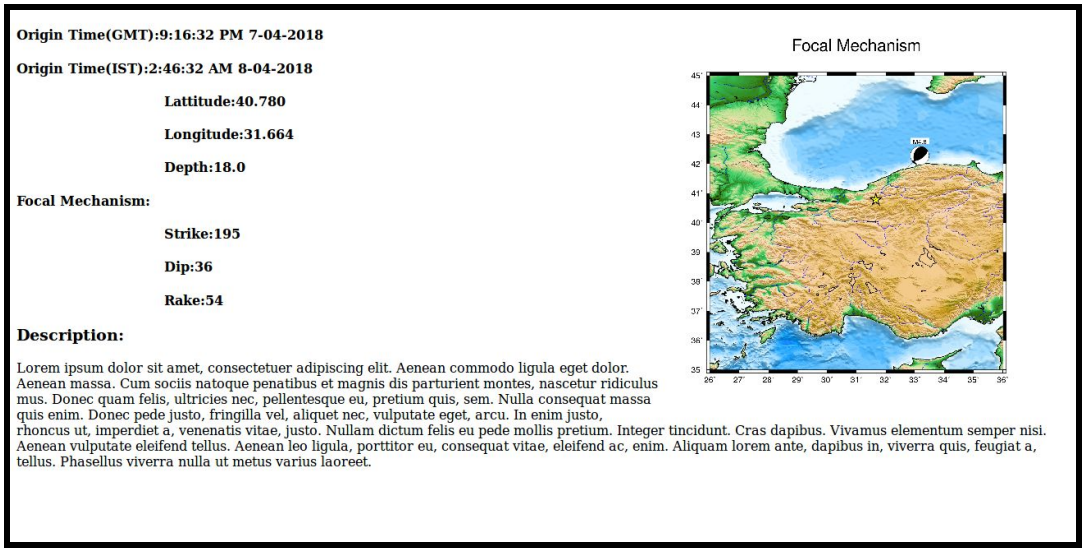

Fig.3 Screenshot of Description of a single event.

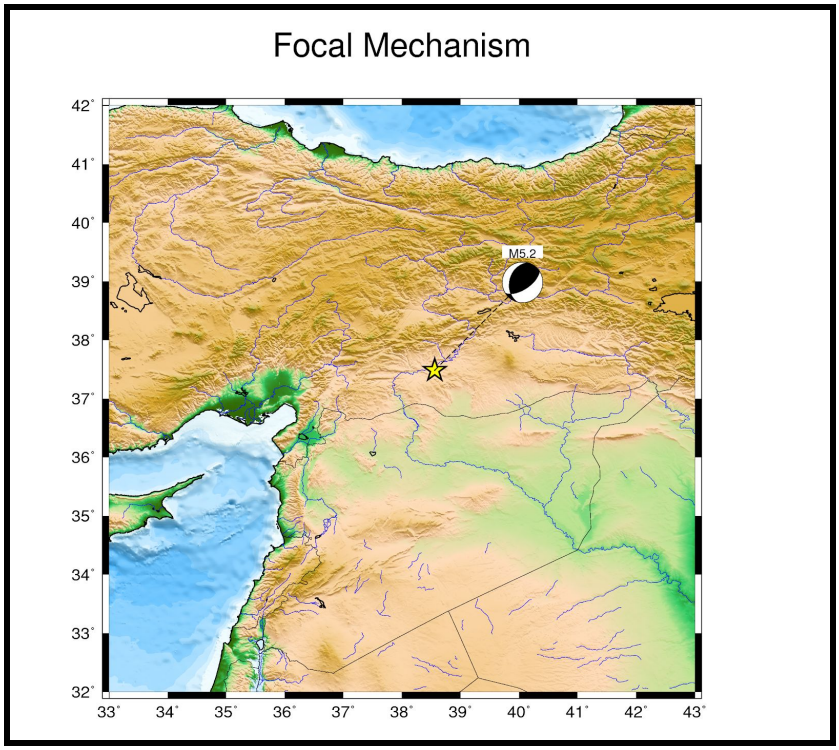

Fig.4 Map Developed using GMT.

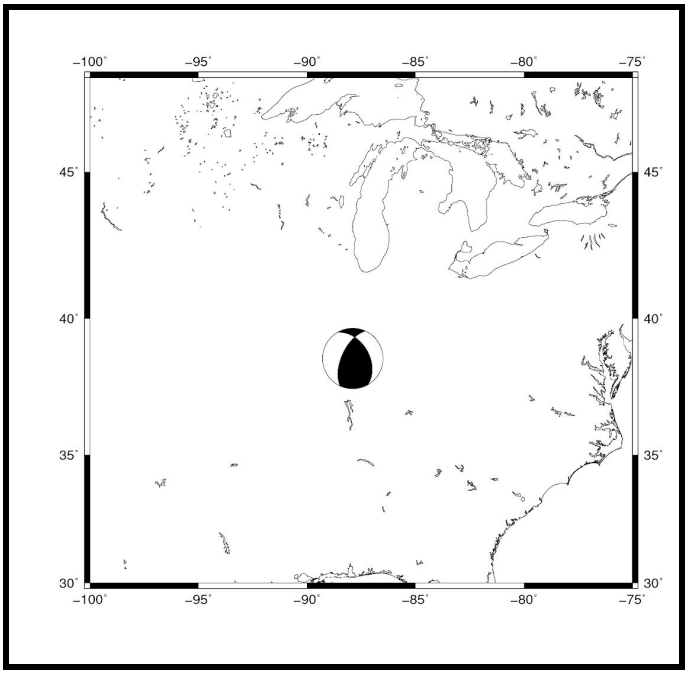

Fig.5 Beachball generated using GMT.

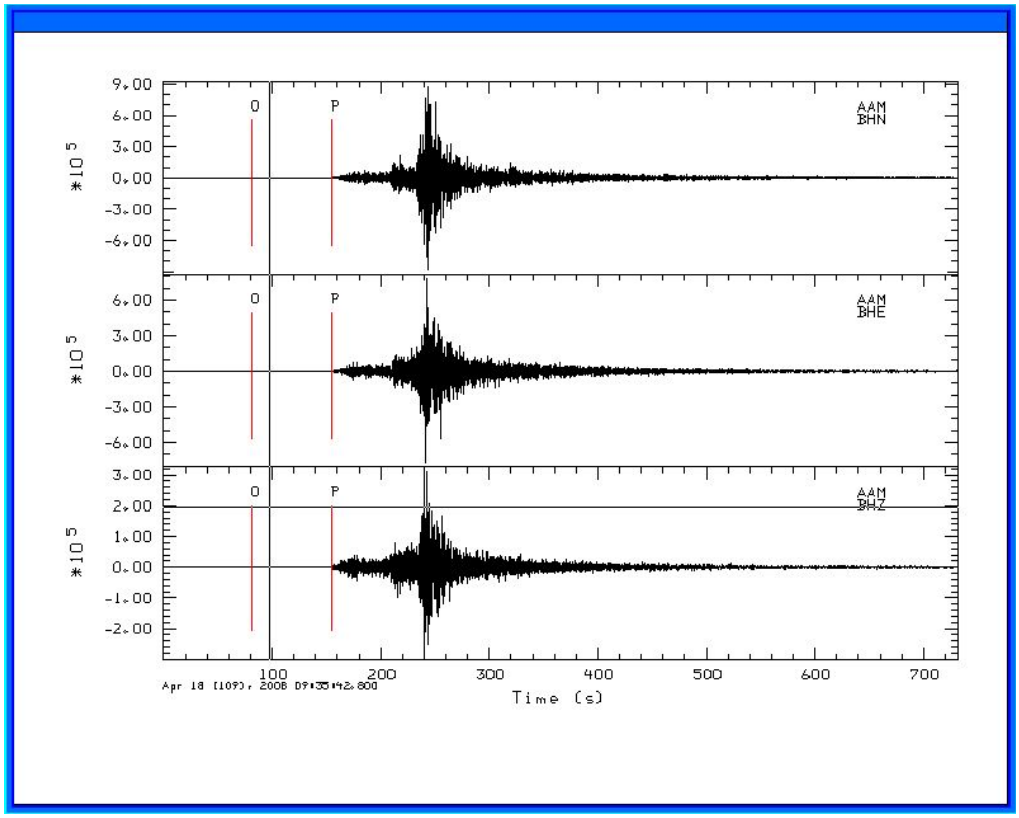

Fig.6 Quality Marking of single earthquake event using GSAC.

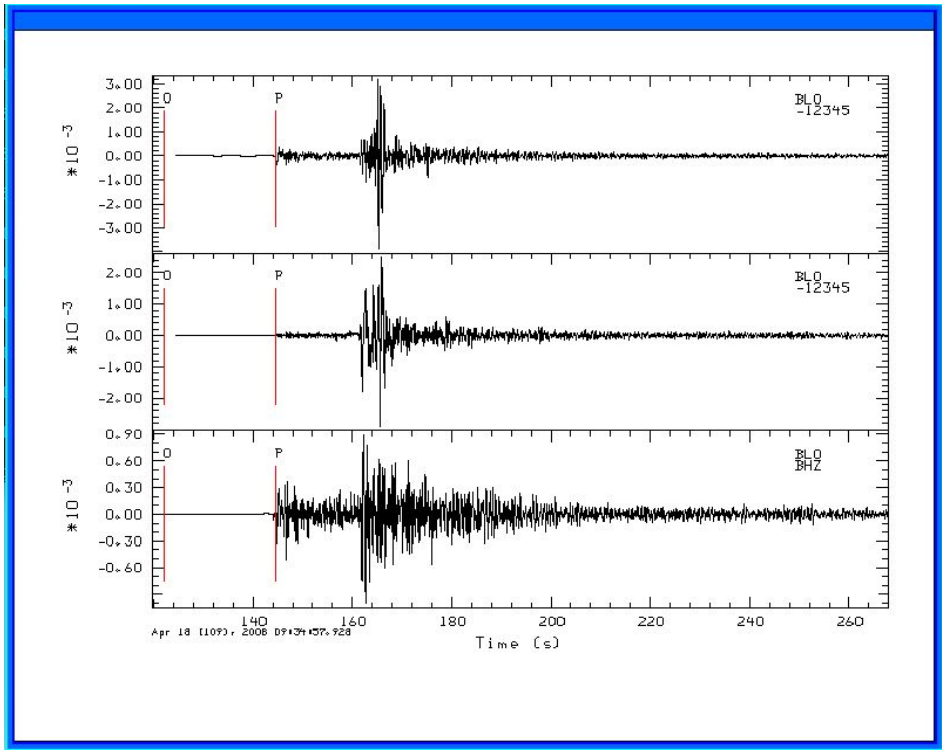

Fig.7 Result of rotating a pair of waveform (N and E waveform are rotated).

FUTURE SCOPE

The above study can be extended to all earthquake data available with ISR till date. The complete process for moment tensor inversion would be -

- Selection of seismograms of local and regional earthquakes.
- Signal processing: instrument response removal, filter, downsample, rotation.
- Forward problem: Preparation of green's function by wavenumber integration and modal summation techniques.
- Inversion: Determination of Moment Tensor Solution (MTS) using damped least square inversion by singular value decomposition.
- Database: preparation of sql database for MTS.
- Webpage: displaying the results in a web page.

The website can be expanded for better user experience where the user can select earthquakes by clicking on the event in the list or on the map. Other filters like magnitude, depth etc. can also implemented in the website.

CONCLUSION

Over the last six weeks, I had the opportunity to work and interact with the scientists at the Institute of Seismological Research. The project enabled me to learn and utilise various languages such as HTML, CSS for the frontend; Shell Scripting for analysing seismic data; PHP language for the backend development. It also allowed to apply my knowledge of Database Management in a practical way. Through this project, I learnt about various C-based seismological tools available for analysing geophysical data i.e. Seisan for the first focal mechanism, SAC and CPS for moment tensor inversion and GMT for visualizing the graphs and maps.

I have successfully completed the data visualisation from first focal mechanism and learnt the techniques to analyse the earthquake data using moment tensor mechanism. Though, the work still demands more knowledge in geophysics and hence, I will be completing the work in future.

Barring changes to make to optimise the code for less power and space consumption, I am hopeful that I have developed a successful web application which will serve as an aide in all the internal research.

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