The School of Computer Science – College of Engineering

School of Computer Science
MS Thesis Defense
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MODELING APRORI COMPLEX 3D GEOLOGIC STRUCTURES USING FINITE DIFFERENCE SCHEMES

ABSTRACT

The major research goal of my thesis is to build geologically realistic 3-D velocity models of earth structure. Currently complex 3-D velocity models are unavailable in academia, having such a realistic models helps students and researchers to carry out more realistic experiments in field of Geophysics and Geology. The velocity models computes travel times of the seismic waves as part of forward calculations and will update velocity model while calculating inversion. Transit times for the seismic waves can be calculated either by applying Raytracing or Finite difference methods. The raytracing method is one of the technique which was constructed upon the fact that seismic energy of infinitely high frequency follows a trajectory. These trajectories are calculated based on raytracing equations which describe how energy travels or continues in same direction until it is refracted by change is velocities. The drawbacks of raytracing method comes with difficulty in finding the true first-arrival path of seismic rays especially in 3-D complex models. The alternate way of calculating transit times for the seismic waves is using finite difference methods. Finite difference methods can be used to calculate seismic travel time by approximating finite differences to the Eikonal equation to propagate first-arrival times through complex velocity models. The development goal of my thesis is to create a velocity model which can model 3D complex Earth structures like underlying geology, topography, faults and fractures. A fault occurs due to earth movement which is a discontinuity in volume of rock, where there will be a significant displacement along the fracture. A method has been developed to calculate seismic reflection travel times in complex 3-D velocity models which contain complex 3-D structures like reflector geometry. There is a existing finite difference algorithm for calculating first-arrival travel times in 3-D velocity model which can handle very large, sharp velocity contrasts accurately. Our modified algorithm can calculate travel times of a 3-D velocity model with apriori Geology information. A 3-D initial model which contains depth and velocity values will be input for the model and based on Depth and Velocity, initial 3-D velocity model is created. The shots positions and model parameters are passed as input to forward model which calculates travel times. The model is then refined based on initial velocity model parameters, location of geophones, picks(the arrival time of the first wave, picked by the user from the seismogram data) and Grid information. Next Ray Coverage is calculated as part of inversion. Velocity perturbations are calculate and are smoothed as part of inversion. Finally updated velocity model is calculated. We are looking forward to accurately model apriori geology, fault and fracture information based on initial 3D velocity model. Our implementation is an improvement on the the previous version as realistic 3D geologic information can now be given as a starting model for travel time calculations. The outcome of this thesis helps to understand seismic modeling in more detail. Aprori knowledge of faults can add much more information to 3-D complex velocity models which helps to understand much better about Earth structure.

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Place: Devon Hall room **220**

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