Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

SSS26-18 Room:103 Time:May 26 15:45-16:00

Simulation of the seismic wave propagation on the tablet computer

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Smartphones and tablet computers are widely used in recent years. Some of those devices have the high-performance CPU and large memory size, which comparable to the PC several years ago. Convenience and intuitive operation are merits of using the tablet computer compared to the desktop PC. In this study, I examine the possibility of the numerical simulation on the tablet PC and create the application to easily simulate the seismic wave propagation. I use the iPad Air as a target.

I consider the seismic wave propagation in 2D. By using the finite difference method with a staggered-grid technique, I solve the equation of motion of elastic body. For the simplicity, the accuracy is 2nd-order in both time and space. The medium consists of four layers including an air layer. The grid spacing is 200m in both horizontal and vertical directions, and the number of the grid points are 512 and 384 in the horizontal and the vertical direction, respectively. That is, the simulation area is 102km wide and 77km deep. The time step is 10ms. In order to decrease user frustration and create the interactive user interface, I simultaneously draw the wave field and calculate the wave propagation rather than playing the video after the simulation. Here, I draw the wave field in every 20 steps (0.2s). I calculate the divergence and the rotation and draw the amplitude of the P and S waves as the wave field. I don't draw the amplitude in pixel by pixel, because it takes too much time. I make a picture of the wave field on the memory and then draw it on the screen. I also plot the seismogram at an arbitrary station. As one of the intuitive operation, layer boundaries and locations of the station and the source are movable by the finger. I set ten points on each layer boundary. The boundary is defined by those movable points. Although the velocity of each layer is fixed, the user can make various settings of the simulation intuitively. For the advanced simulation, the user can introduce the random fluctuation of the velocity in each layer. The user can change the spatial spectrum of the fluctuation intuitively by the finger and arbitrarily change the size of the fluctuation.

Even when I double the number of the grids in both horizontal and vertical directions, I can simulate the wave propagation without any memory problem. However, simulating up to 10s takes close to three minutes. Before I extend the area, it takes only 40s. The wave field is updated in every 0.2s, so the total number of the update is 50 times for the simulation up to 10s. Therefore it takes more than 1s to update the wave field. It is too slow and leads to the frustration of the user. For the tablet computer, the light performance is required. If I shorten the rate of the update such as 0.1s, the interval of the update of the wave field is also becomes short. However updating the image of the wave field becomes heavy load, so the user isn't satisfied the speed of the simulation. The size of the image rather than the resolution of the image is also one of the main load of the application.

We can perform the 2D seismic wave propagation on the iPad. By using the tablet computer, we can simulate it interactively and intuitively. It is useful to explain the seismic wave propagation for non-specialist users.

Keywords: mobile application, seismic wave propagation, simulation, iOS