

Modification of the shortest path method to permit sources and receivers of arbitrary positions

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Shortest path method calculates travel times between sources and receivers by searching the shortest travel time path connecting nodes distributed in the target area. The source and the receiver are located on the node. There are two ways of constructing the nodes and the paths in general. One way is that the nodes are located on the square grids of the region. Each node has paths connecting neighboring nodes. The other way is that the region is divided into rectangular cells. The nodes are located on the cell boundary. The paths connect only the nodes in the same cell. The latter with the smaller node number achieves the same travel time precision as the former. However, the source and the receiver should coincide with the nodes which are located on the cell boundary. Therefore, it is difficult to locate the source and the receiver arbitrarily. Besides, the travel time error becomes large when the source or the receiver is located on the node of specific position, due to the path distribution confined in a single cell.

To resolve the above difficulties, we add paths connecting the source or the receiver to the node of adjacent cells. We can locate arbitrarily the source and the receiver and achieve the travel time of small error.

With this modification, we can calculate the travel time in the media including interfaces of any shape, because the interface can be seen as a group of sources or receivers on it. We can set the interface in any position in the media.

To calculate the first arrivals in the media including the interface, we should consider all transmitted and reflected waves at the interface. Following the next procedure, we can obtain the first arrivals. First, we calculate travel time in the layer including the source. If the travel time at the node in the layer is shorter than the previous calculated one, the time is updated. When the travel time at the interfaces sandwiching the layer is shorter than the previous one, it is also updated and we carry out the travel time calculation in adjacent two layers. When not updated, nothing is done. We repeat this process until any travel time on the interface is not updated.

Keywords: shortest path method