Application of Steepest Descent Method for Approximating Earthquake Source of Italy

Fauzi Al Aziz[1], **Putu Harry Gunawan**[2]

[1,2]Fakultas Informatika, Universitas Telkom, Bandung
[1]alaziz.fauzi@gmail.com, [2]phgunawan@telkomuniversity.ac.id

Abstrak

Jurnal ini menjelaskan perbandingan metode Newton dengan metode Steepest Descent untuk mendekati koordinat sumber gempa. Metode Steepest Descent digunakan untuk mengefektifkan jalur iterasi yang dihasilkan dari metode Newton karena Steepest Descent merupakan metode berbasis Newton. Studi kasus yang digunakan ialah gempa Italia yang memiliki fase seismik Pg dan terjadi pada 24 Agustus 2016. Perhitungan secara numerik dibantu oleh persamaan koordinat Azimuth untuk mencari koordinat, dan formula Haversine untuk mencari jarak dari lima stasiun pengamat gempa menuju sumber gempa. Hasil akhir dari perhitungan adalah grafik jalur iterasi dari metode Steepest Descent. Setelah itu, hasil tersebut akan dibandingkan dengan hasil dari metode Newton pada penelitian sebelumnya. Hasil perbandingan menunjukkan jumlah iterasi dari dua metode menggunakan toleransi 0,01, kecepatan minimum 3093 m/s dan tiga skenario tebakan awal menggunakan koordinat kota Roma, Milan dan Palermo. Metode Newton menghasilkan 12 iterasi untuk setiap skenario, sedangkan metode Steepest Descent menghasilkan 7, 6 dan 5 iterasi secara berurutan. Sementara kesalahan numerik dari hasil perhitungan kota Roma, Milan dan Palermo sebagai tebakan awal adalah 0,1598 menggunakan metode Newton, sedangkan 0,1566, 0,1567 dan 0,1567 menggunakan metode Steepest Descent.

Kata kunci : Gempa, Azimuth, Haversine, Newton, Steepest Descent, Italia.

Abstract

This paper describes the differences of Newton's method and Steepest Descent method for determining the coordinates of the source of the earthquake. Here, the Steepest Descent method is used for improving the result paths because it is a Newton-based method. The earthquake case using the case study of the Italian earthquake August 24, 2016, which has a phase of Pg wave. The calculation was supported by Azimuth Coordinate equations to find the coordinates and Haversine formula. The Haversine formula is used to find the distance between five earthquake stations to the earthquake source. The final result of calculation was path's graph from the iteration of Steepest Descent method. Moreover, the results will be compared with the results of Newton's method that has been successfully approaching the point of earthquake source in the same case study of previous research. The result shows the number of final iteration of two methods using tolerance number 0.01**, minimum velocity number 3093 m/s and three cases of initial guess city coordinate i.e. Rome, Milan and Palermo. Newton's method generate 12 iteration in every case, Steepest Descent method generate 7, 6, 5 iteration respectively. However, the final numerical error for Rome, Milan and Palermo initial guess are 0.1598 by Newton's method, while Steepest Descent method are 0.1566, 0.1567 and 0.1567.**

Keywords: Earthquake, Azimuth, Haversine, Newton, Steepest Descent, Italy.

1. Introduction

Earthquakes is a natural catastrophic which can causes major damage to the infrastructure, social or economic aspects. Earthquakes can be happened due to several things, such as crust dislocations, volcanic eruptions, the collapse of underground mines (karsts) or even by a deliberate explosion [3]. However, finding the source of earthquakes can be a really important task. The data can we use to avoid collateral damage or for the sake of further research. According to that reason, this paper will be focused on approximating the epicenter of earthquake in mathematically, using the data from the earthquake that happened in central Italy at 24 August 2016. The data itself was gathered from five observation stations (channels) that give variables of arrival time, distance, and azimuth. All of that variables can be used to produce nonlinear system of equation.

There was a work that try to discuss the same topic with the same data [5]. In that previous work, the nonlinear system of equations has been approximated by a method called Newton's method. This method is used because of