Artikel_2

by Subiyanto32 Subiyanto

Submission date: 27-Sep-2019 09:30PM (UTC+0700)
Submission ID: 1181303630
File name: Artikel_2.pdf (978.81K)
Word count: 2641
Character count: 13557

Proceeding of International Conference on Green Technology
ISSN:2355–3456
September 10th, 2015, Semarang, Indonesia

Geographic Information System as Tool for finding Landslide Evacuation Route using Dijkstra Algorithm in ArcView

Ryan Arya Pramudya[1] and Subiyanto[2]
[1,2]Jurusan Teknik Elektro, Universitas Negeri Semarang, Semarang, Indonesia
ryanaryapramudya@gmail.com[1], subiyanto@mail.unnes.ac.id[2]

***Abstract*—This paper present a development of Geographic information system using Dijkstra algorithm. ArcView provides component for their user to develop their own system. The user interface was made by using ArcView dialog component. For data, requirement is conducted by maps digitation. Transform printed landslide maps into digital maps. Digitation map also added route information. The system development used avenue script modification. To find the optimal route used an ArcView extension called network analyst. Dijkstra algorithm as the method for finding route was containing in network analyst. Dijkstra algorithm has similarity with network analyst, which need starting point, end point and line connection. In network analyst, definite the starting point and finish point for begin the optimal route search. A geographic information system that resulting from this research is able to give information about the distance route also the direction when use in evacuation process later.**

***Keywords*—Network analyst, Dijkstra algorithm, GIS**

I. INTRODUCTION

Nowadays the utility of technology applied by using geographic information system. It can be interpreted as a system that function can be used for input, save, and call back, processing, analyze, and produce data with geographic oriented. Geographic information system ability is capture, store, manipulate, analyze, manage is able to combine multiple source as long as have same spatial reference [1].

Dijkstra algorithm use as a standard reference in short route algorithm by single source [2]. Dijkstra algorithm is an algorithm which more efficient than Warsha algorithm[3]. Adjacent node in Dijkstra algorithm is efficient fo alculating a huge data and also using less space [4]. Dijkstra algorithm is faster than bellman ford algorithm. Bellman-Ford algorithm is not suggested for larger networks [9].

The reason why using network analyst in ArcView is the ability for doing route finding based on Dijkstra algorithm, that can make route finding process quicker.

II. OVERVIEW

In order to build geographic information system evacuation route, the basic thing that should be prepared is data availability for using at route finding process. Data which was collected later would be generated by using network analyst.

A. Data Preparation

Before building up, geographic information system should prepare data about a maps and attribute data. The requirement data is:

a) *Road map*: is a major map for path finding process. In road map contain data attribute that used as the reference by network analyst when analyzing the path. Network analyst uses distance same real length of the road. Length of the road is the sum of the weight of the edge on the path [2].

b) *Landslide map:* maps that contain landslide scope area in some place. Not only contain scope area but also as stop event in path finding process.

c) *Shelter maps:* has a function as start event in path finding process. It can be start form city town hall or disaster mitigation agency.

B. Network Analyst

Network Analyst extension aims creating, editing and analyze network datasets [13]. A network analysis approach having a potentially powerful approach to solving transportation and routing problems [11]. Network in geographic information system software context can be described as a system which the component (geographic substance) is connected each other according to linear.

In Arcview, network depends on structure (substance) line data that created a theme network. All function or network analyze can be applied in a theme with line or polyline type, it will doing based on existed of various attribute that usually place on arc and node, directly read by ArcView that supporting its theme. Arc is representation of linear element that start and end by node [5]. The nodes represent road junctions and each edge of the graph is associated with a road segment between two junctions [9].

Almost all type of network has some similar characteristic, among of them is: [5]

1. Has a phenomenon when an exists object or resource which is moving inside relevant network.
2. Has a phenomenon when a movement from start location into end location inside network needs connected path between start location and end location.

By using network analyst, user is capable to: [6].

1. Find efficient travel route
2. Determine nearest distance based on facility or vehicle.
3. Generate travel direction.

In order to the routing problem, network analyst can be generated by two criterion [12]:

1. Distance criteria: The route is generated taking only into consideration start point until finish point. The volume of traffic in the roads is not considered in this case.
2. Time criteria: The runtime of the vehicle is calculated by considering the length of the road and the speed of the vehicle in each road.

Reference [14] used network analyst for finding urban transportation optimal route.

C. *Dijkstra Algorithm*

Dijkstra Algorithms is the algorithm for finding the shortest distance from one vertex to another vertex in the weighted graph, which the distance between vertex is weight from every edge on that graph. which the distance between vertex is weight from every edge on that graph. It can solve directed graph, also true for solve undirected graph too[16].

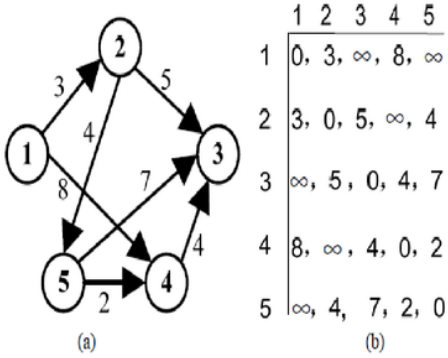

Figure 1. Example of weighted graph and adjacency matrix [8]

$G = (V, E)$ V is representing of the vertex. E is representing of edge.

Reference [15] doing the comparison about single source shortest path problem.

Some case of finding shortest line that can be solved by using Dijkstra algorithm is:

1. Do the shortest path finding between two nodes.
2. Seeking shortest path between all vertex inside the graph.
3. Solving for do find the shortest path from the certain node to all node inside the graph.

The road information that would respond about above solving problem ability are usually large and have thousands of streets, that is why one should pay more attention how the information processed [7].

Some step that can be use in Dijkstra algorithm [10].

1. Assign every tentative node distance value, set it to zero for the initial node and infinity to all other.
2. Mark all nodes as the unvisited node, set an initial node as starting. make a set unvisited nodes which contain all nodes except the initial.
3. For the starting node, calculate neighbor node tentative distance although it is unvisited. if a neighbor was examined it is not marked as "visited" at this time, and it remains in the unvisited set.
4. After finish with considering all neighbor from the starting node, mark the current node as visited and remove it from the unvisited set. A visited node will never be checked again.
5. If the destination node has been marked visited or if the smallest tentative distance among the nodes in the unvisited set is infinity then stop. The algorithm has finished.

Reference [15] doing the comparison about single source shortest route problem. Another implementation of Dijkstra algorithm is route optimization for vehicle evacuation route [13].

Suppose that is $G = (V, E)$. V is representing of the vertex. E is representing of edge. $V = \{V_1, V_2, V_3, \ldots, V_n\}$ is including with n nodes. For weighted direct graph adjacency matrix $A = (a_{ij})\ nxn$ is defined by: [8]

$$a_{ij} = \begin{cases} W_{ij}, (V_i, V_j) \in E \\ \infty, (V_i, V_j) \notin E \end{cases}, i, j = 1,2 \ldots . n \qquad (1)$$

Where W_{ij} is denoted the weight of arc $<V_i, V_j>$ and ∞ is denoted that there is no edge between V_i and V_j.

L denotes the set of the end points that have found the shortest route from the original point[8]. $(V - L)$ denotes the set of nodes that have not yet calculated the shortest route.

Use adjacency matrix W to store network information. W_{ij} denotes the weight of arc $<V_i, V_j>$. If there is no arc between V_i and V_j, then W_{ij} is set to ∞. d_i is defined as the weight from the source points to node V_i. Initialize starting point as $d_s = 0$ and $D_i = C_{si}$

$w(i, j)$ contain line weight from start point until end point that connected in a graph. The starting point is i and the end point is j.

$$V(G) - L = \{V_a, V_b, V_c, \ldots, V_n\} - \{\} = \{V_a, V_b, V_c, \ldots, V_n\} \quad (2)$$

To noted which node that have been chosen in the calculation process use (2).

As long as $V_n \notin L$ do:

a. Chose point $V_k \in V - L$ with lowest D(k)

b. For every $V_j \in V - L$ do

$$(D(j), (D(k) + W(k, j)) \qquad (3)$$

if $(D(j) > (D(k) + W(k,j))$ (4)

at the next iteration change the weight value

$D(j)$ with $(D(k) + W(k,j))$ (5)

III. Dijkstra for Short Path Finding

A. Description of Dijkstra for Short Path Finding

Doing the manual calculation for proving if the distance that generated is valid by picking up another point accept disaster point and shelter point. Its taken by random. The notation of V_1 in this paper changed to V_a and so with the other . The first step process to do is write the value of $w(i,j)$.

TABLE I. TABLE $w(i,j)$

W_{ij}	V_a	V_b	V_c	V_d	V_e	V_f	V_g	V_h	V_i
V_a	0	65.13	∞	45.94	∞	∞	∞	∞	∞
V_b	65.13	0	64.54	∞	44.05	∞	∞	∞	∞
V_c	∞	64.54	0	∞	∞	45.90	∞	∞	∞
V_d	45.94	∞	∞	0	77.50	∞	46.34	∞	∞
V_e	∞	44.05	∞	77.50	0	71.95	`	44.11	∞
V_f	∞	∞	45.90	∞	71.95	0	∞	`	43.02
V_g	∞	∞	∞	46.34	∞	∞	0	94.44	∞
V_h	∞	∞	∞	∞	44.11	∞	94.44	0	70.83
V_i	∞	∞	∞	∞	∞	43.02	∞	70.83	0

In Table 1 which adjacent matrix, not all node have connected path between one to each other, that's why node which not connected to another node will note by sign ∞ in Figure 2 $w(i,j)$ are line weight from starting point until finish point. For further information, see figure artificial node and length road.

TABLE II. TABLE $D(k)$

$D(a) = W(c,a) = \infty$	$D(f) = W(c,f) = 45.902$
$D(b) = W(c,b) = 64.54$	$D(g) = W(c,g) = \infty$
$D(d) = W(c,d) = \infty$	$D(h) = W(c,h) = \infty$
$D(e) = W(c,e) = \infty$	$D(i) = W(c,i) = \infty$

Table 2 explain about node which adjacent with starting point, so node that didn't have line connection with starting point will be noted with ∞ that mean infinity.

In this graph, $V(G) = \{V_a, V_b, V_d, V_e, V_f, V_g, V_h, V_i\}$

L is a union point $\in$V(G) that chosen in shortest path

And then $L = \{\}$ and $V(G) = \{V_a, V_b, V_d, V_e, V_f, V_g, V_h, V_i\}$ so

$V(G) - L = \{V_a, V_b, V_d, V_e, V_f, V_g, V_h, V_i\} - \{\} = \{V_a, V_b, V_d, V_e, V_f, V_g, V_h, V_i\}$

From Table 2 it can be find the lowest value of $D(k)$ is $D(f)$ which the value is 45.902 with the result that value of $V(k) = V_f$,

L = $L \cup V_k$ where $\{\} \cup V_f = V_f$

$V(G) - L = \{V_a, V_b, V_d, V_e, V_f, V_g, V_h, V_i\} - \{V_f,\} = \{V_a, V_b, V_d, V_e, V_g, V_h, V_i\}$

For the first iteration beginning by find the value of

$(D(a), (D(f) + W(k,j))$

The result that obtain from manual calculation shows the distance as far as 221.918 meters.

By reading backward, so the shortest path finding by manual method is as follow:

1. Decreasing occur at index $K = d$ in $D(g)$, so the chosen path is $V_d \rightarrow V_g$.
2. Decreasing didn't happen at index $K = h$ in $D(d)$, so this not the chosen path.
3. Decreasing occur at index $K = a$ in $D(d)$, so the chosen path is $V_a \rightarrow V_d \rightarrow V_g$.
4. Decreasing didn't happen at index $K = e$ in $D(a)$, so this not the chosen path.
5. Decreasing didn't happen at index $K = i$ in $D(a)$, so this not the chosen path.
6. Decreasing occur at index $K = b$ in $D(a)$, so the chosen path is $V_b \rightarrow V_a \rightarrow V_d \rightarrow V_g$.
7. Decreasing didn't happen at index $K = f$ in $D(b)$, so this not the chosen path.

So the result of the shortest path from manual calculating is $V_c \rightarrow V_b \rightarrow V_a \rightarrow V_d \rightarrow V_g$ with total length is 221.918 meter.

B. Testing

Random point that was taken at manual calculation by network analyst will do path finding process.

In real map actually doesn't exist of a node, so in Figure 4 the artificial node is made in purpose to make easier when manual calculation. Finding quickest path starting from node C until node G.

Indeks D(k) minimum	L	V-L	D(a)	D(b)	D(d)	D(e)	D(f)	D(g)	D(h)	D(i)
-	0	Va,Vb, Vd,Ve, Vf,Vg Vh,Vi	W (c,a) =∞	W(c,b) =64.549	W (c,d) =∞	W (c,e) =∞	W(c,f) =45.902	W (c,g) =∞	W (c,h)= ∞	W (c,i) =∞
D(K)f	Vf	Va,Vb, Vd,Ve, Vg, Vh,Vi	∞	64.54	∞	117.85	45.90 ~	∞	∞	88.92
D(K)b	Vf,Vb	Va,Vd, Ve,Vg, Vh,Vi	129.68	64.54 ~	∞	108.60	45.90 ~	∞	∞	88.92
D(K)i	Vf,Vb,Vi	Va,Vd, Ve,Vg, Vh	129.68	64.54 ~	∞	108.60	45.90 ~	∞	159.76	88.92 ~
D(K)e	Vf,Vb,Vi, Ve	Va,Vd, Vg,Vh	129.68	64.54 ~	186.11	108.60 ~	45.90 ~	∞	152.718	88.928 ~
D(K)a	Vf,Vb,Vi, Ve,Va	Vd,Vg, Vh	129.68 ~	64.54 ~	175.57	108.60 ~	45.90 ~	∞	152.718	88.92 ~
D(K)h	Vf,Vb,Vi, Ve,Va,Vh	Vd,Vg	129.68 ~	64.54 ~	175.57	108.60 ~	45.90 ~	247.16	152.718 ~	88.92 ~
D(K)d	Vf,Vb,Vi, Ve,Va,Vh Vd	Vg	129.68 ~	64.54 ~	175.57 ~	108.60 ~	45.90 ~	221.91	152.718 ~	88.92 ~
D(K)g	Vf,Vb,Vi, Ve,Va,Vh Vd,Vg									

Figure 2. Finishing Table

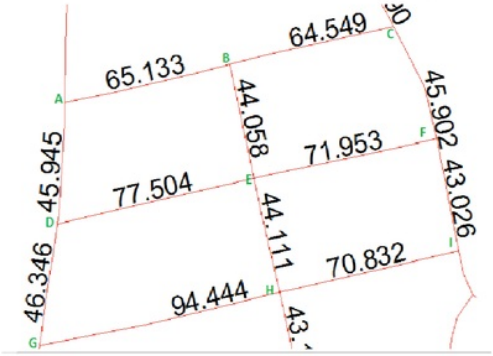

Figure 3. Artificial node and length road

TABLE III. TABLE CODE AND LENGTH

Route	Code	Length
A->B	2816	65.133 meter
B->C	1659	64.549 meter
A->D	1655	45.945 meter
D->E	1678	77.504 meter
E->F	2807	71.953 meter
B->E	1665	44.058 meter
C->F	793	45.902 meter
D->G	1656	46.346 meter
E->H	1664	44.111 meter
F->I	794	43.026 meter
G->H	1657	94.444 meter
H->I	1658	70.832 meter

Figure 4. Road code

Figure 5. Shortest path result

IV. Result and Discuss

The distance that generated by network analyst as far as 220.13 meters from node C until G.

Direction that generated by network analyst are:

Starting from Graphic pick 1 (C) Turn left onto 792. Travel on 792 for 0.56 m. Turn right onto 1659 Travel on 1659 for 64.55 m Continue straight onto 2816.Travel on 2816 for 65.13 m. Turn left onto 1655 Travel on 1655 for 45.94 m. Continue straight onto 1656. Travel on 1656 for 43.94 m. Turn left into Graphic pick 2 (G) Total distance traveled is 220.13 m

The distance that result between manual calculation and network analyst previously be rounded become 220 meters and 222 meter.

The differences between manual calculation and network analyst adrift as long as 2 meters. It causes of the starting point and finish point not exactly in node C and node G. Its proving if the network analyst is accurate for use in finding shortest route when evacuation process happen.

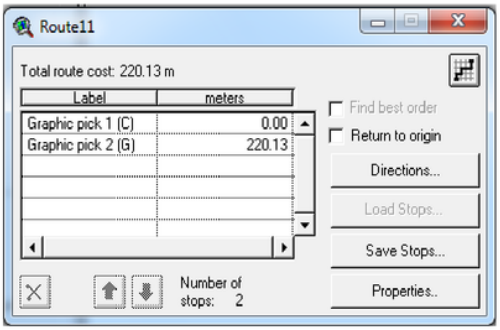

Figure 6. Distance from node C to node G

V. Conclusion

Supplying information about evacuation route by using network analyst as route finder tool. Network analyst gives detail information for supporting evacuation process. Dijkstra algorithm inside network analyst can be a solution that use for as path finding by using geographic information system. Later, this needs to combine with GPS so the direction that generated can be show by real-time.

References

[1] Huang Hongchun, Song Yinghua. "Research on the Construction and Improvement to the Emergency Response Mechanism in Public Emergencies." Information Engineering and Applications. 2012; 154:458-459

[2] Kai, N., Z. Yao-ting, M. Yue-peng. 2014. " Shortest Path Analysis Based on Dijkstra's Algorithm in Emergency Response System." TELKOMNIKA Indonesian Journal of Electrical Engineering. 12(5): 376-482

[3] Siang, J. J. Matematika Diskrit dan Aplikasinya pada Ilmu Komputer. Andi. Yogyakarta. 2004.

[4] Zhang Fuhao, L. Jiping, "An algorithm of shortest path based on Dijkstra for huge data", 6thInternational Conference on Fuzzy Systems and Knowledge discovery, 2009.

[5] Prahasta, E. Sistem Informasi Geografi Tools dan Plug-Ins. Informatika. Bandung. 2004.

[6] Karadimas. V. Nikolaos, M. Kolokath, G. Defteraiou, V. Loumos. 2007. "Municipal Waste Collection of Large Items Optimized with ARC GIS Network Analyst." Proceedings 21st European Conference on Modelling and Simulation.

[7] R. Rodríguez-Puente and M. S Lazo-Cortés. "Algorithm for shortest path search in Geographic Information Systems by using reduced graphs". Rodríguez-Puente and Lazo-Cortés SpringerPlus. 2:291. 2013.

[8] Y. Huang, Q. Yi, and M. Shi. "An Improved Dijkstra Shortest Path Algorithm." Proceedings of the 2nd International Conference on Computer Science and Electronics Engineering (ICCSEE 2013).

[9] V. Patel and C. Baggar. "A Survey Paper of Bellman-Ford Algorithm and Dijkstra Algorithm for Finding Shortest Path in GIS Application". International Journal of P2P Network Trends and Technology (IJPTT) – Volume 5 – February 2014

[10] M.GEETHA and G.M.KADHAR NAWAZ. "User-Based Intelligent Decision Support System in Route Selection on Road Network." ORIENTAL JOURNAL OF COMPUTER SCIENCE & TECHNOLOGY Vol. 6, No. (2): Pgs.67-74 June 2013.

[11] A. E. Akay, M. G. Wing, F. Sivrikaya, and D. Sakar. "A GIS-based decision support system for determining the shortest and safest route to forest fires: a case study in Mediterranean Region of Turkey" Springer Science+Business Media B.V. April 2011

[12] M. Chipumuro, R. Mawonike, and T. Makoni. "OPTIMIZING ROUTING OF RESIDENTIAL SOLID WASTE COLLECTION: CASE STUDY OF CHIKOVA RESIDENTIAL AREA IN ZIMBABWE." INTERNATIONAL RESEARCH JOURNAL OF MATHEMATICS, ENGINEERING & IT VOLUME-1, ISSUE-3 (JUNE 2014)

[13] Liu, X. Samsung Lim. "A spatial analysis approach to evacuation management: shelter assignment and routing" (unpublished)

[14] M. A. Ismail, M. N. Said. "Modelling Multi-mode Transportation Networks in Kuala Lumpur." Journal of Soft Computing and Decision Support Systems. Vol.2 No.1 February 2015: 1-4

[15] S. Srivastava. "Comparative Analysis of Algorithms for Single Source Shortest Path Problem." International Journal of Computer Science and Security (IJCSS),(6):(4) : 2012

[16] Munir, R. Matematika Diskrit. Infomatika. Bandung. 2012

Artikel_2

ORIGINALITY REPORT

20%	15%	13%	%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	journal.unnes.ac.id Internet Source	3%
2	Huang, Yi Zhen, Qing Ming Yi, and Min Shi. "An Improved Dijkstras Algorithm Based on Search Strategy", Applied Mechanics and Materials, 2013. Publication	3%
3	Chetan Shetty, Sowmya B. J., Anemish S., Seema S.. "chapter 9 IOT and Data Analytics Solution for Reducing Pollution, Accidents, and Its Impact on Environment", IGI Global, 2019 Publication	2%
4	aarf.asia Internet Source	1%
5	how-to-crack-algorithms.blogspot.com Internet Source	1%
6	Kai Sun, Yunhe Hou, Wei Sun, Junjian Qi. "Restoration Methodology and Implementation Algorithms", Wiley, 2018 Publication	1%

7	isa.unomaha.edu Internet Source	1%
8	ejournal.undip.ac.id Internet Source	1%
9	springerplus.springeropen.com Internet Source	1%
10	techylib.com Internet Source	1%
11	www.ijpttjournal.org Internet Source	1%
12	"Preface: 6th International Conference of Education, Concept, and Application of Green Technology", AIP Publishing, 2018 Publication	1%
13	cofe.org Internet Source	1%
14	www.scs-europe.net Internet Source	<1%
15	Miroslaw Boniewicz, Anna Kozlowska, Anna Zawadzka, Zbigniew Lukasiak, Marek Zielinski. "Review of selected algorithms in the method energy evening algorithm in wireless sensor network", 2014 16th International Conference on Transparent Optical Networks (ICTON), 2014 Publication	<1%

16	ceur-ws.org Internet Source	<1%
17	Shashikiran, V., T. T Sampath Kumar, N. Sathish Kumar, V. Venkateswaran, and S Balaji. "Dynamic road traffic management based on krushkal's algorithm", 2011 International Conference on Recent Trends in Information Technology (ICRTIT), 2011. Publication	<1%
18	www.ijser.org Internet Source	<1%
19	Daniel R. Lanning, Gregory K. Harrell, Jin Wang. "Dijkstra's algorithm and Google maps", Proceedings of the 2014 ACM Southeast Regional Conference on - ACM SE '14, 2014 Publication	<1%

Exclude quotes	On	Exclude matches	< 4 words
Exclude bibliography	On		