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Floyd-warshall algorithm to determine the shortest path based on android

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Abstract. The development of technology has made all areas of life easier now, one of which is the ease of obtaining geographic information. The use of geographic information may vary according to need, for example, the digital map learning, navigation systems, observations area, and much more. With the support of adequate infrastructure, almost no one will ever get lost to a destination even to foreign places or that have never been visited before. The reasons why many institutions and business entities use technology to improve services to consumers and to streamline the production process undertaken and so forth. Speaking of the efficient, there are many elements related to efficiency in navigation systems, and one of them is the efficiency in terms of distance. The shortest distance determination algorithm required in this research is used Floyd-Warshall Algorithm. Floyd-Warshall algorithm is the algorithm to find the fastest path and the shortest distance between 2 nodes, while the program is intended to find the path of more than 2 nodes.

1. Introduction

A donation program is one of the ideas developed and run by social institutions with the aim of collecting as much aid as possible to be distributed to refugees and victims of natural disasters. In order to be immediately channeled, the collection of donations must be carried out with a fast process that requires the mechanism as effectively and efficiently as possible. We need a medium that adapts to current trends, and one solution is to make an application based android donation pickup using the application of digital maps. Particularly in this research, the shortest route selection algorithm named Floyd-Warshall Algorithm is applied to a digital map of donation pickup program, which is expected to streamline the distance that must be passed by donation pickup institution to donor location.

1.1. Geographic Information System (GIS)

Technological advancements have given people more access to more difficult information. One of the ease that can be felt is access to a spatial and geographic area or geographic information that currently has been digitized or commonly called digital mapping.

Long ago, the use of maps is very important in many areas of life. For example, visiting a new place in the city or out of town is a very reasonable thing. The problem is sometimes some people difficult to recall the location of a place or direction of the route to the place. So, some people take a long time to rediscover [1].In the event of a disaster, the inhabitants of the hospital are mostly running around with no direction or guidance. There are several empty areas that can be used as assembly points, ie in the north, west, and south. However, this area of utilization has not been maximized because most hospital residents are unaware of the existence of the assembly point. With the evacuation map, expected during a disaster, residents can easily follow the direction of the evacuation arrow to the designated place. The simulation model will also be performed to evaluate the direction of the grooves in the evacuation map being applied [2].

For this reason, the importance of developing Geographic Information System (GIS) capable of storing or documenting spatial information in digital form, so that in various practice the use of the current map can be done more easily. Features not previously included in the mapping can be manifested such as navigation, GPS, more specific place/location search, and so on.

1.2. Android Operating System

Android is a popular and licensed free mobile platform (open source) that has taken over the mobile phone world on a large scale. Most of the smartphone industry chose to use Android as its operating system, so quickly android became the trend center among smartphone users. The developers of programs and applications are competing to create various android apps, so the development of Android in the world into a wave of great changes that have even changed the lifestyle of the crowd [3].

As an open platform, everyone is free to develop application and customization of the operating system from Android without worrying about licensing issues as Google releases Android codes under the Apache license, a software license and an open standard mobile device. Android Studio is one of the IDE for Android development which is a spin-off version of Intellij Java IDE. Android Studio is the latest solution from Google Inc. in the middle so crowded android development needs of late. Android Studio has a new unified build system called Gradle that is fully integrated to support the flexibility of the Android development process [4]**.**

2. Method

Floyd-Warshall's algorithm is one of the variants of dynamic programming, a method that solves problems by looking at the solution to be obtained as an interrelated decision. This means that solutions are formed from solutions that come from the previous stage and there is the possibility of more than one solution [5]**.**

The problem solving that is the focus of the discussion in this study using the Floyd-Warshall algorithm is the shortest path selection between 2 or more marker positions or location markers in a digital map. The Floyd-Warshall algorithm compares each route variation with the distance from each point to the destination point and accumulates the distance between the nodes (intersection points) that are passed. The line that connects between nodes has a value in the magnitude of the number indicating the distance weight. The Floyd-Warshall algorithm will take each line as a calculation material in determining the shortest route. The solution of the shortest route selection problem using the Floyd-Warshall Algorithm will be described in following steps [6-7]:

Step 1: Delete all loop paths

Delete all loop paths in the node set. Each path that starts and ends on the same node is a loop as in node A. A loop path is not needed in route selection because it does not connect more than one node.

• Step 2: Erase the parallel path

Remove parallel paths or paths more than one between two nodes and leave only one path with the smallest weights. Removing the parallel path and making it a single path will streamline route selection.

• Step 3: create a matrix with the Distance Table and Sequence Table

To find the shortest path between two nodes, there are several requirements in the form of a matrix with two tables called Distance Table (D) and Sequence Table (S). Distance Table (D) contains the value of the distance between two nodes, and the Sequence Table (S) contains the name of the node that serves to indicate which nodes are passed and included in the route. If a routing graph has an

number of ns then table D and table S will have n rows and n columns (table n x n). To do the problem solving used iteration method or looping k as much as n times.
K = iteration
n = number of iterations
D_k = Table D on the k-iteration
S_k = Table S on the k-iteration
d_{ij} = distance between node i and node j
C_{ij}= cell holding d value between node i and j

There is a 0 iterations condition or k = 0 ie the state before any change of value or initial condition of the table based on the distance weight on the original route graph. Then in Table D_0 inserted a value of the weighted distance between every two nodes in accordance with the route graph. In cells that have the same row names and column names, a zero value (0) indicates the absence of a distance weight. Whereas between 2 nodes that do not have a direct connecting line (inserted value) is inserted value infinity (∞).

For Table S_0 we include values in the name of the node in which the node must be passed or is in the middle of node i and node j called pit stop node. However, on the 0th iteration, the value in table S_0 is still adjusted to table D_0 which uses the direct line so it does not have a pit stop node. The value entered into table S_0 is the value of the original node. Especially in cells that have value ∞ or 0 in table D_0 then adjust to the condition value entered in table S_0 is strip (-).

• Step 4: Iterate
The iteration is done as many times in sequence and each subsequent matrix of the input value is heavily dependent on the previous matrix. In iteration 1 and so on begin to enter value pit stop node to find the combination of routes along with the distance variation. More detailed information regarding the use of pit stop nodes on each iteration can be seen in Table 1.

Table 1. PitstopNodeat Each Iterations

Iterations Number	Table	*Pitstop (p)*
0	D_0, S_0	-
1	D_1, S_1	*A*
2	D_2, S_2	*B*
3	D_3, S_3	*C*
4	D_4, S_4	*D*
N	D_5, S_5	p_n

The purpose of using a pit stop node is to compare the distance (d_{ij}) from node i to node j. The smallest value of the result of the comparison is what will be the value in the table in the next iteration. Mathematically filling the value in the 1st iteration table and so on using the formula as follows:

$$d_{ij} = min\left\{\left(d_{ij}\right)^{k-1}, \left(d_{ip}\right)^{k-1} + \left(d_{pj}\right)^{k-1}\right\} \quad (1)$$

The 1st iteration begins by creating D_1andS_1tables and entering values based on the comparison results using the above formula. Similar to Table D_0 and S_0, in cells with the initial node and the same destination node (C_{ij} | i = j) it loads zero (0) and strip (-) values. Next, each cell of the row and column A in Tables D_1 and S_1 is filled with the jo from Table D_0 and S_0. This is because the 1st iteration uses node A as a pit stop (p) in which the accumulated distance will not gain an addition so that the value will be equal to d_{ip} + d_{kp}. As for the remaining cells are filled with values in accordance with the formula, namely by comparing the value of the dip with d_{ip} + $d_{kp}$and find the minimum value.

In the Floyd-Warshall Algorithm, if a numeric value is confronted with an infinite value (∞) then the minimum value of a number is determined because it is assumed that the infinity value (∞) is always more likely. The same is done for other remaining cells, all looking for the least possible distance if the node travel route is always through the pit stop A (p = A) node. Any change of value is found in table D_1, in table S_1 is also given a change of value by filling the value according to the pit stop node in the iteration. The iteration is stopped at the nth iteration as the limit of the number of iterations to be performed in accordance with the number of nodes present. Back to step making of matrix which explains that Table D is Distance Table (distance) and Table S is Sequence Table (node name), then Table D and Table S which is requirement to find the shortest path between nodes is Table Dn and Table Sn.

• Step 5: check the shortest path using Table D and Table S
In the last step, it is about how to use Table D and Table S to find the shortest path between nodes. Each value in the rows and columns connected in Table D is the value of the shortest distance between the two connected nodes so that it is obtained from table D the value of the dij. After knowing the shortest distance, the next thing to know is which line is used. For that, we will switch to Table S with respect to the value of C_{ij}in it. With regard to the shortest distance (d), it will be known the route of the node to be passed.

3. Result and Discussion
The use of Floyd-Warshall algorithm in this research will use case study of donation picking from donors located in Samarinda City area of East Kalimantan.

3.1. Sample of Reseach
Used 20 respondents as the research sample. This number is an estimate of the number of requests for picking up daily donations.

Table 2. The Nodes of Research Sample

Node	Nama	Latitude	Longitude
0	Kantor KNRP Kaltim	-0.5046652	117.1082298
1	M. Sabransyah	-0.478543	117.151212
2	Richa Rosmita	-0.4722673	117.1508941
3	E. Mutmayanti	-0.4512754	117.1675302
4	Lasiyo	-0.4979957	117.1207656
5	MegaPutri	-0.4536098	117.1585432
6	Suhartanto	-0.4623663	117.1164232
7	HadiMulyadi	-0.4772829	117.1333146
8	Irvana	-0.458934	117.1593112
9	Windy	-0.4618985	117.1839463
10	Thamrin	-0.4527096	117.1332746
11	Siti Fatimah	-0.4944913	117.1545706
12	M. Ubaid	-0.4743301	117.1802164
13	Aditya H.	-0.4778609	117.127978
14	AyuFadhilah	-0.4631318	117.1499509
15	TopanYudha	-0.473763	117.163867
16	Firza	-0.5011503	117.1417186
17	Asmiliyani	-0.47919	117.124319
18	AzrinaNindia	-0.489814	117.107383
19	Robby A.	-0.4895625	117.1407127
20	Nur Wahidah	-0.464537	117.153216

3.2. Route Graph

After the location or coordinates of the donors obtained then will form a routing graph that shows the connection between the nodes (the position of each donor). With Google Maps API and Google service, each node symbolized with a marker will appear in the fragment folder. Each marker has a weighted distance to another marker in a different location. Visually the graph of the formed route can be seen in Figure 1.

Table 3. DistanceTablefrom Node 0 to 20

D	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
0	99999	5588	5948	8855	1578	7952	4765	4118	7609	9664	6385	5279	8686	3690	6531	7073	3748	3338	1644	3982	6690
1	5588	99999	694	3519	4014	2875	4265	1997	2348	4082	3485	1802	3262	2587	1709	1504	2713	2994	5035	1688	1564
2	5948	694	99999	2969	4397	2231	3990	2033	1746	3853	2919	2491	3271	2624	1015	1453	3353	3055	5217	2223	892
3	8855	3519	2969	99999	7333	1033	5819	4772	1246	2172	3816	4991	2914	5293	2355	2519	6218	5715	7936	5180	2165
4	1578	4014	4397	7333	99999	6463	3969	2682	6088	8086	5197	3782	7116	2366	5041	5495	2358	2116	1742	2408	5170
5	7952	2875	2231	1033	6463	99999	4787	3839	594	2972	2814	4542	3327	4332	1422	2305	5580	4744	6961	4443	1345
6	4765	4265	3990	5819	3969	4787	99999	2501	4789	7516	2158	5536	7223	2142	3733	5429	5130	2057	3197	4043	4102
7	4118	1997	2033	4772	2682	3839	2501	99999	3534	5887	2717	3036	5231	597	2424	3423	2800	1023	3201	1588	2625
8	7609	2348	1746	1246	6088	594	4789	3534	99999	2761	2978	3966	2883	4067	1140	1716	5062	4493	6713	3969	918
9	9664	4082	3853	2172	8086	2972	7516	5887	2761	99999	5731	4866	1435	6475	3786	2591	6397	6907	9064	5702	3433
10	6385	3485	2919	3816	5197	2814	2158	2717	2978	5731	99999	5192	5746	2842	2184	4125	5438	3093	5013	4158	2576
11	5279	1802	2491	4991	3782	4542	5536	3036	3966	4866	5192	99999	3622	3484	3505	2514	1608	3768	5278	1636	3315
12	8686	3262	3271	2914	7116	3327	7223	5231	2883	1435	5746	3622	99999	5828	3589	1821	5211	6245	8286	4708	3194
13	3690	2587	2624	5293	2366	4332	2142	597	4067	6475	2842	3484	5828	99999	2938	4020	2995	433	2646	1919	3172
14	6531	1709	1015	2355	5041	1422	3733	2424	1140	3786	2184	3505	3589	2938	99999	1944	4302	3360	5581	3098	395
15	7073	1504	1453	2519	5495	2305	5429	3423	1716	2591	4125	2514	1821	4020	1944	99999	3905	4443	6533	3113	1564
16	3748	2713	3353	6218	2358	5580	5130	2800	5062	6397	5438	1608	5211	2995	4302	3905	99999	3106	4022	1286	4245
17	3338	2994	3055	5715	2116	4744	2057	1023	4493	6907	3093	3768	6245	433	3360	4443	3106	99999	2221	2155	3601
18	1644	5035	5217	7936	1742	6961	3197	3201	6713	9064	5013	5278	8286	2646	5581	6533	4022	2221	99999	3710	5817
19	3982	1688	2223	5180	2408	4443	4043	1588	3969	5702	4158	1636	4708	1919	3098	3113	1286	2155	3710	99999	3097
20	6690	1564	892	2165	5170	1345	4102	2625	918	3433	2576	3315	3194	3172	395	1564	4245	3601	5817	3097	99999

With the use of Google Maps API then the creation of Sequence tables becomes very simple because basically, the weight of the distance drawn from the line between the marker is already the shortest distance selection.

3.3 Route Selection Algorithm

In order for the purpose of research and the making of this donation pickup program can be achieved, it takes a method or a path or route determination algorithm. Basically, the Floyd-Warshall algorithm is the algorithm for finding the fastest path and the shortest distance between 2 nodes, while the donation pickup program is intended to find paths between more than 2 nodes [6][7].

Theoretically, determining the route can be done by finding the shortest distance from one node to another node in the sequence. Because the actor who runs the pick-up system is KNRP Kaltim, the initial node of the route starts from the KNRP office in East Kalimantan. In table D, the location or coordinates of the KNRP East Kalimantan office marker are located at node 0. The problem is on the determination of which next node will be the second, third, and so on markers. For that, it takes a special algorithm as follows:

a. Anested loop is performed to check the smallest value in each row of Table D.
   $K_1, K_2, K_3, K_4, \dots K_n$

b. For each c where i = j changed its value to a high value, in this study used the number 99999 meters or 99 km, assuming there is no distance between 2 nodes in the city of Samarinda (Area 712km^2) that exceeds 99 km.C | i = j, C_{ij} = 99999
c. Perform a value comparison of each cell within each row of Table D with the formula: $d_{ij} = min \{C_{i0}, C_{i1}, C_{i2}, C_{i3}, \ldots C_{in}\}$.
d. Each value of the column with the smallest distance in the previous iteration is replaced with a value of 99999. C | j=(j)$^{k-1}$, $C_{ij} = 99999$.

The creation of distance tables will be based on the weighted distance information between the nodes of the route graph formed using the Google Maps API in Figure 1and Figure 2.

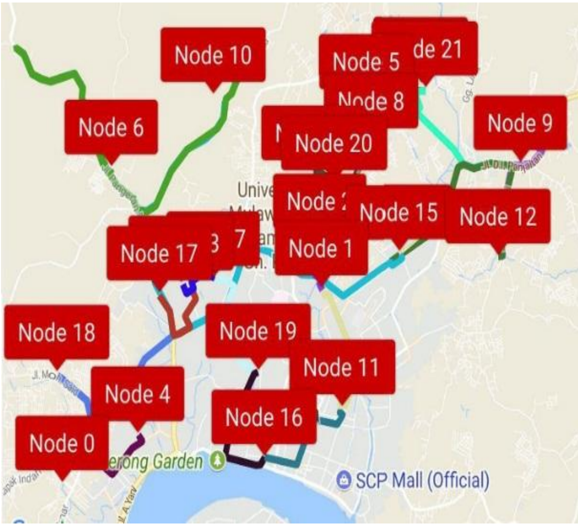

Figure 1. The Route Graph Between the Nodes

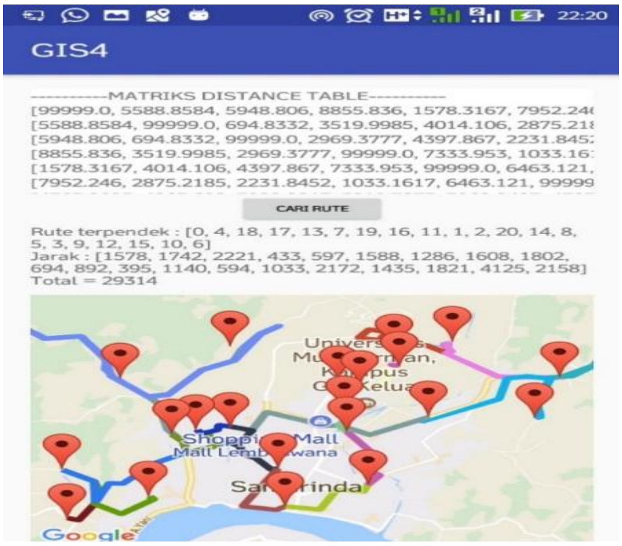

Figure 2. Application Output

3.4 Testing Program

To test whether the program has been created and all the output generated from the program is appropriate, then required comparative data. Using the formula contained in the route selection algorithm, we get:

Table 4. Testing Program

Iteration	Distance value between node i and j	
K_1	$d_{0j} = min \{ 99999, 5588, 5948, 8855, 1578, 7952, 4765, 4118, 7609, 9664, 6385, 5279, 8686, 3690, 6531, 7073, 3748, 3338, 1644, 3982, 6690 \} = \mathbf{1578}$	$j=4$
K_2	$C_{40} = 99999$ $d_{4j} = min \{ 99999,4014,4397,7333,99999,6463,3969,2682,6088,8086,5197,3782,7116,2366,5041,5495,2358,2116,1742,2408,5170 \} = \mathbf{1742}$	$j=18$
K_3	$C_{18\,0} = 999999$ $C_{18\,4} = 999999$ $d_{18\,j} = min \{ 99999,5035,5217,7936,99999,6961,3197,3201,6713,9064,5013,5278,8286, 2646,5581,6533,4022,2221,99999,3710, 5817 \} = \mathbf{2221}$	$j=17$
$K_4, K_5, \ldots K_{20}$		

In the same way, we get the d value from the next iteration up to the last iteration. Manual calculations of the overall iteration performed result in the selection of routes with the shortest weights in sequence as follows:

Table 5. Manual Calculations

Nodes i to j				Distance
0	→	4	=	1578 meters
4	→	18	=	1742 meters
18	→	17	=	2221 meters
17	→	13	=	433 meters
13	→	7	=	597 meters
7	→	19	=	1588 meters
19	→	16	=	1286 meters
16	→	11	=	1608 meters
11	→	1	=	1802 meters
1	→	2	=	694 meters
2	→	20	=	892 meters
20	→	14	=	395 meters
14	→	8	=	1140 meters
8	→	5	=	594 meters
5	→	3	=	1033 meters
3	→	9	=	2172 meters
9	→	12	=	1435 meters
12	→	15	=	1821 meters
15	→	10	=	4125 meters

From the manual data calculation formed a route pattern in the sequence: 0-4-18-17-13-7-19-16-11-1-2-20-14-8-5-3-9-12-15-10-6. This pattern shows the route that must be taken and the order of donor locations that must be visited starting from node 0 to node 6. As for the total distance from node 0 to node 6 is: 0 ➔ 6 = 1578 + 1742 + 2221 + 433 + 1802 + 694 + 892 + 395 + 1140 + 594 + 1033 + 2172 + 1435 + 1821 + 4125 + 2158 = 29314 meters

After the manual testing that has been done, it is found that conformity with the output of the donation pickup program as shown in figure 2 and the program making in this research has resulted in a donation pickup route to 20 donor markers scattered throughout the area in Samarinda with a total distance of 29,314 meters or about 29 km follows the line path of the route to be skipped shown in the map fragment view.

4. Conclusion

The design and implementation carried out to get some conclusions that can be submitted as a result of research, among others; A digital map from Google Maps can be used in making a donation pickup application. The donor location can be poured into a marker form on Google Maps so that the purpose of picking up donations becomes clearer and from the existing 20 donor nodes or markers can be found the best route that has the shortest distance using the Floyd-Warshall algorithm and the route-specific algorithm.

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References

[1] Hati, GM, Suprayogi, Andri, S and Bandi 2013Aplikasi Penanda Lokasi Peta Digital Berbasis Mobile GIS pada Smartphone Android *Jurnal Geodesi Undip* **2(4)**pp 26-40
[2] Iftadi, Irwan, Jauhari, Wakhid A &Nugroho, Beny 2011Perancangan Peta Evakuasi Menggunakan Algoritma*Floyd-Warshall* untuk Penentuan Lintasan Terpendek *Performa* **10(2)** pp 95-104
[3] Annuzi, J., Darcey, L., and Conder, S. (n.d.) *Introduction to android application development*.
[4] Grant, K. and Haseman, C. 2014 *Beginning Android programming*. [S.l.]: PeachPit.
[5] Novandi, Raden AD. 2017 Perbandingan Algoritma Dijkstra dan Algoritma *Floyd-Warshall* dalam Penentuan Lintasan Terpendek (Single Pair Shortest Path). *Makalah IF2251 Strategi Algoritmik, 2,* pp. 1-5
[6] Gutenschwager, Radtke, V¨olker, and Zeller 2012 The Shortest Path Comparison of Different Approaches and Implementations for the Automatic Routing of Vehicles. Proc., of the 2012 Winter Simulation Conference, pp 3312-3323.
[7] Kairanbay M, Hajar M J. 2013 A Review and Evaluations of Shortest Path Algorithms, *International Journal of Science & Technology Research (IJSTR*) **2(6)** June, ISSN 2277-8616 pp 96-104