Routing the Historical Places with Ant Colony Algorithm

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Abstract: Mobile phones, which were used just for speaking and texting once, have been giving their places to smart phones. By means of these technological developments, we can receive and send mail via our smart mobile phones, get notification before any earthquake via earthquake warning systems, we can get rapid routing while we move from one place to the other, we can make virtual shopping and we can find our friends by using social platforms. İstanbul hosts many domestic and foreign tourists. It is getting importance that these tourists can visit all the historical places that are unique for İstanbul in a limited time. In this study, a mobile solution called as "Quick İstanbul" developed. Being designed for devices with Android operating system, this mobile application called as "Quick İstanbul" provides solutions to the problems such as the information and visuals of historical places; the way to go to any historical places from the point where they are and the order to visit the related historical places. An application has been developed to route the historical places in the shortest way in visiting these historical places for using the time in time – saving manner by Ant Colony Algorithm.

Keywords: Ant Colony Algorithm, Routing, Historical Places, Mobile Application.

I. INTRODUCTION

Rough and cumbersome devices have been getting smaller and moreover, becoming small to portable dimensions [1]. Mobile devices are developed generally for Android and IOS operating systems. These applications used in many fields provide great benefits to the users almost in all fields with the development of technology. Nevertheless, these applications are not sufficient and need continuous update [2].

It is aimed to facilitate the difficulties experienced by the domestic and foreign tourists while visiting the historical places who come to İstanbul for touristic aims. Some of these difficulties contain the lack of sufficient information about the historical places that they want to visit, the loss of time with tours that were made without any plan in the time spared for visits, the way to be used for going from where they are and to the place that they want to visit, the lack of information about the address of place to be visited and the foreign tourists who do not know our language. It is aimed to provide a solution to the mentioned problems with "Quick İstanbul" application developed for solving these problems.

The tourists who want to visit these historical places determined by the developed mobile application can get the opportunity to have information about these places and to get an idea about such place by seeing 3 pictures for each place. Besides, with the aim of saving the time, they can get the option to line the selected places by using the Ant Colony Algorithm [3]. These lined places can be monitored as routed on Google Maps with the help of map screen. In line with the demand of user, the place desired to be visited can be selected and then, the user can see the determined location and the historical places between the selected point by the help of GPS. The historical places with definite diameter of wideness located on the road can be added to the list. Various language options can be selected from language options section of application.

It is aimed to route the determined points to each other from the shortest way by using the Ant Colony Algorithm (ACA) developed after getting inspired from the ants in the nature [4]. This algorithm was used by thinking the compatibility with the current problem. The interface study was made on this application developed by using "Microsoft Visual Studio on-board development environment and Xamarin Cross Platform technology.

II. MODEL

There are various parameters utilized for applying ACA. These parameters are the alpha, beta, rho, ant number and iteration number. α (alpha) stands for the amount of pheromone trace to be used. β (beta) stands for the level of intuitism to be utilized. ρ (rho) defines the vaporization rate of pheromone. The ant number is the number of ants required for the utilized algorithm. Iteration number is about the iteration number to be applied for the current problem.

The parameter values used for the ACA of our study were tested and it is aimed to achieve the most appropriate result. With the aim of ranking 34 historical places included in our application in the best manner, the alpha, beta, rho, iteration number and ant number were included in respective tests. The test combinations of defined parameters were made for our application to ensure that it gives the shortest distance for historical places on determined locations. In the light of parameters determined as success criterion, they were stated as the values giving the shortest distance.

Alpha parameter affects the weight of pheromone liquid. It directly affects the increase of decrease of traces of ants left behind with the help of pheromone liquid. The values as 0.25, 0.50, 0.75, 1, 1.25, 1.50, 1.75 and 2 were given for alpha parameter and the best result was gathered when the alpha was 1. Beta parameter is a variable depending on the distance between points. The increase of beta value also increases the intuitive choice probability. Choosing the next neighbor depends on the amount of beta parameter. The values as 1, 1.5, 2, 2.5, 3, 3.5, 4 and 5 were given for beta parameter and the best results was gathered when the beta parameter was 1. Rho parameter means the degradation rate of pheromone liquid. As the pheromone liquid will be vaporized after a while, the update of pheromone liquid is made by considering the degradation rate. The values as 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8 and 0.9 were given for Rho parameter and the best result by these values was gathered when the Rho parameter was 0,7. Iteration parameter shows the number to repeat the functions. By this means, the learning of algorithm is ensured. The more the iteration number increases; the better the quality of ranking results are ensured for the problem but as the response time on the application is going to be extended; this parameter value was shown as 250. The values as 50, 100, 150, 200, 250, 300, 350 and 400 was given for iteration number and the best result was observed while iteration parameter was continuously increased and it was found that 250 times of trial is sufficient by considering the responsive time of our application. Ant Number parameter shows the number of ants used for the determined points. The number of ants is very significant because of the tracing instinct generated by the secreted pheromone liquid. While the insufficient number of ants decreases the tracing rate; excessive number of ants may cause the poor quality of results because of creating density in definite regions. The values as 50, 70, 90, 110, 130, 150, 170 and 190 were given for ant number parameter and accordingly, the best result was gained when the ant parameter was 90. In choosing these parameters, the values giving the shortest distance were taken as base.

The best initials values are determined in line with the results of executed tests and be assigned for these parameters. Then, the ants are placed on definite points randomly. In this study, mentioned historical places stand for the historical venues. Then, the ants randomly move from the point where they are to any point to which they did not go before. The ants make an stochastic choice in moving from their location to the other point.

$$p_{ij}^k = \begin{cases} \dfrac{\tau_{ij}^{\alpha}.\eta_{ij}^{\beta}}{\sum_{l \in \Omega} \tau_{il}^{\alpha}.\eta_{il}^{\beta}}, & \text{if } j \in \Omega \\ 0, & \text{if not} \end{cases} \tag{1}$$

The probability that the ants choose to move from "i point" to "j point" is calculated by Formula 1. In the formula, p_{ij}^k shows the possibility of choosing the "j point" after "i point". Ω stands for the list of closest ones to be chosen after departing from i point. In the formula, T_{ij} stands for the amount of pheromone found in the way between i and j points. η_{ij} stands for the intuitive selection between i point and j point. Ω list keeps the list of neighborhood points which were not visited before. The purpose of this list depends on the rule that the points to be visited in Travelling Salesman Problem are visited just for one time while going to and turning back from the related points. By this means, the tours are completed in the manner that each ant arrives at each point and the distance is calculated accordingly.

$$\tau_{ij} \leftarrow (1-\rho).\tau_{ij} + \sum_{k=1}^{m} \Delta\tau_{ij}^k \tag{2}$$

The pheromone amount is updated by Formula 2 as taking the best value seen during the tours as base. In the formula, T_{ij} stands for the pheromone amount found on the way between i and j points. In the formula, "m" stands for the number of ants, ρ stands for the vaporization factor of pheromone amount. ΔT_{ij}^k stands for the pheromone level left by the ants between i point and j point.

The transactions are repeated until the iteration number is achieved and the steps shall be repeated by randomly distributing the ants. The shortest distance can be found by updating the best tour list depending on the iteration number as long as the shortest distance is found [5].

III. APPLYING THE MODEL

The data to be used in the study includes 34 historical places; in other words, 34 points in İstanbul, Turkey. Historical venue can be defined as the environment; buildings and outdoor areas, briefly everything dating back to the past and embracing us [6].

Depending on this definition, it is aimed to visit a great number of historical venues in a limited time and to provide great easiness to the users. For the historical venues used in the application, the latitude and longitude values of coordinates of a location were taken via Google Maps.

In this study, when the user wants to go to a definite historical venue, the location of that venue can be added as data with the help of GPS. Selected historical venues situated between the selected historical place and the location can create the new data model.

TABLE 1 GEOGRAPHICAL LOCATIONS OF HISTORICAL PLACES

No	Historical Places	Latitude (N)	Longitude (E)
1	Mihrimah Sultan Mosque	41.0292193	28.9357580
2	Hirka-i Serif Mosque	41.0220390	28.9415740
3	Istiklal Street	41.0311430	28.9758530
4	Sent Antuan Church	41.0323160	28.9771020
5	Galata Tower	41.0256320	28.9741350
6	Kiztasi	41.0154190	28.9503120
7	Valens Aqueduct	41.0158210	28.9558700
8	Fire Department Museum	41.0165880	28.9540000
9	Vefa Bozacisi	41.0152540	28.9583970
10	Laleli Fountain	41.0097100	28.9561490
11	Suleymaniye Mosque	41.0161770	28.9641430
12	Yeni Mosque	41.0169620	28.9719160
13	Spice Bazaar	41.0164940	28.9705140
14	Beyazit Tower	41.0129590	28.9651220
15	Mirahur Hasan Aga Fountain	41.0150430	28.9670130
16	Cinili Caravanserai	41.0125400	28.9687450
17	Great Post Office	41.0148500	28.9736030
18	Gotlar Column	41.0146910	28.9854390
19	Gulhane Park	41.0136300	28.9812240
20	Topkapi Palace	41.0115170	28.9833810
21	Cagaloglu Bath	41.0105300	28.9757910
22	Hagia Eirene	41.0095940	28.9811400
23	Hagia Sophia Museum	41.0085830	28.9801540
24	Yerebatan Cistern	41.0083820	28.9778660
25	Cemberlitas Column	41.0085060	28.9713380
26	Hagia Sophia Hurrem Sultan Bath	41.0069040	28.9788290
27	German Fountain	41.0070790	28.9766780
28	Dikilitas	41.0058930	28.9754190
29	Sultan Ahmet Mosque	41.0054080	28.9768140
30	Tarihi Sifa Baths	41.0042260	28.9754980
31	Little Hagia Sophia	41.0027260	28.9721980
32	Istanbul Archaeological Museums	41.0116870	28.9813270
33	Fatih Sultan Mehmet Mosque	41.0196340	28.9501220
34	Grand Bazaar	41.0106990	28.9680670

In Table 1, the data of geographical locations can be seen and the distances between these historical venues are calculated by these degrees. In Figure 1, the physical places of historical places are shown on the map of İstanbul province. As it can be seen from Figure 1 and Table 1, because of the abundancy of mentioned historical places in terms of number and because of the reason that any point may be deemed as a starting point; individual optimizations are required every time in routing problem.
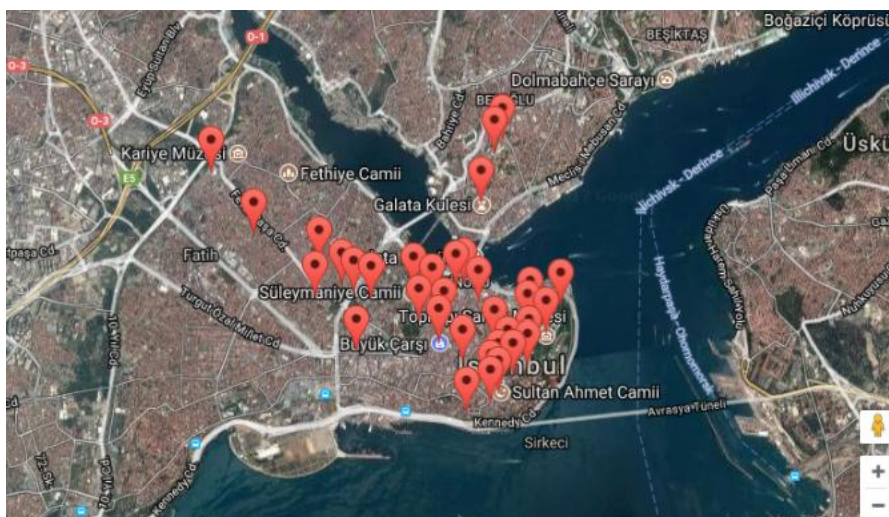
Fig. 1 Historical Places of Google Maps

IV. CONCLUSION AND DISCUSSION

The rapid increase of the need for smart phones and applications is in parallel with the utilization rates. This increase is reflected on the studies made in the field of information collection and routing [7]. In this article, an optimization study was executed for routing the historical places to be visited by tourist in İstanbul through the shortest distance. To this end, a mobile application to run with the devices using Android operating system was developed. In this mobile application, Ant Colony Algorithm was utilized.

The main purpose of this application developed for the domestic and foreign tourists is to have the highest saving on time and to visit the historical places as many as possible. In addition to have the saving on time, the information and images regarding the historical places to be visited were also provided.   34 historical places used in this developed application can be increased in number. The adaptation to the historical places in various provinces can be made. The routing process via map can be more beneficial for the users by adding the traffic information.

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