AN OPTIMIZED PATH PLANNING ALGORITHM BASED ON SOFT COMPUTING

THESIS SUBMITTED IN PARTIAL FULFILLMENT OF REQUIREMENTS FOR THE AWARD OF THE DEGREE OF
Master of Technology
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Information System

Under the esteemed guidance of
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Finally, I am grateful to our Institution and colleagues whose constant encouragement served to renew my spirit, refocus my attention and energy and helped me in carrying out this work.

Date: **Saurabh Kumar Mishra**

ABSTRACT

The existing guidance systems for panoramic areas facing various traversal problem during the path selection,whenever any path select by the Ant it is select only by seeing the lowest path cost. As we know very well that in particular panoramic spot,there are two type of roads, plane roads and other are steep roads,these steep roads some time are not suitable for children or the age and also consume huge energy by tourist vehicle. The existing guidance systems for panoramic areas facing various traversal problem during the path selection. Traditional path planning algorithm focus on shortest path but they did not focus on tourist demand,it means former methodology based on best strategy instead of optimal. Our proposed methodology for path selection of tourist vehicle based on two parameter: link steep probability which is based on steep angle and steep cost of link. If Ant want to go from node i to node j then first of all it will compare all value of steep probability and steep cost,the value which is very less as compare to other values then this min value link will be selected by ant and Pheromone rate on this link will be more as compare to others links. This modification in previous methodology will surely increase the performance of our algorithm ,hence this algorithm has given better optimal route for tourist with less time, cost and energy consumption as well as tourist requirements.

Keywords: Ant Colony Optimization,Panoramic Area,steep Road,Steep probability,Steep angle.

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LIST OF ABBREVIATIONS

ACS	Ant Colony System
ACO	Ant Colony Optimization
UGV	Unmanned Ground Vehicle
PSO	Particle Swarm Optimization
GE	Genetic Algorithm
SA	Simulated Annealing
CS	Cuckoo Search
QACA	Quantum Ant Colony Algorithm
GA	Green Ant
SI	Swarm Intelligence
AS	Ant System
VRP	Vehicle Routing Problem
FANT	Forward Ant
BANT	Backward Ant
CPRV	Capacitated Vehicle Routing Problem
TSP	Travelling Salesman Problem
DVRP	Dynamic Vehicle Routing Problen
IP	Internet Protocol
NP	Non-polynomial Problem
HR	Heuristic Search
IPTBK	IP Trace back Problem

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LIST OF SYMBOLS

α	Importance coefficient of Pheromone intensity
β	Importance coefficient of route cost
τ_{ij}	Pheromonr intensity on link {i,j}
d_{ij}	Cost of link {i,j}
ρ	Pheromone evaporation rate
m	Number of ants
Q	Constant value
D^k_{ij}	Function w.r cost and steep probability on link {i,j}
$P^k_{sr}(ij$	Steep probability of link {i,j}
θ_{ij}	Steep angle of link {i,j}

CHAPTER 1

INTRODUCTION

This improved algorithm is used to find the optimal tour in a particular panoramic area with many spots. Panoramic spots resemble to complete graph where nodes of graph represent panoramic spots and edge represent link between spot i and spot j.Complete graph is best for any panoramic spots because it cover all possible links whether any link present in particular panoramic area,i just put the null values of steep path and steep path angle if this link not present in particular panoramic area.

As we know very well that in particular panoramic spot,there are two type of roads, plane roads and other are steep roads,these steep roads some time are not suitable for children or the age and also consume huge energy by tourist vehicle.It may be that these roads neither plane nor steep but curve type roads, so this type roads functionality still not taking into account in my methodology, in further research this functionality should be added.But steep and crowded roads are totally covered by this algorithms.

Traditional path planning algorithm focus on shortest path but they did not focus on tourist demand,it means former methodology based on best strategy instead of optimal. In formal methodology,if any path is best path but this path is slightly steep then they blindly reject these path with out think that this path how much steep. Focusing on steep roads, we have defined a pheromone updating function on link (i,j), which is based on optimal value of link cost and link steep probability. In the traditional path planning of panoramic area ,the panoramic area is constructed as a simple graph that includes only particular panoramic site while the actual area as a whole is ignored. An actual panoramic area should be represented by a complex graph with multiple types of points including the entrance, internal scenic spots, public service points, road forks, and so on. This improved algorithm is used to find the optimal tour in a particular panoramic area.In our algorithm,actually we have to use optimal path selection in which, every best path is not suitable for tourist because some path may be crowded or steep. So these path may be rejected by tourist.If we choose these paths then we will pay extra energy as well as time.

The traditional route planning of panoramic area is not focused on the customers real demands.The shortest tour path is defined as the best tour path. But in a real panoramic area, some roads may be steep and difficult to pass for the children and the aged, moreover some roads may be crowded. So a better path planning algorithm should avoid the special roads according to path travel probability and supply the suitable paths for tourists

In our methodology there are some changes made in path selection approach,these changes are of two parameters: Optimal tour,it means not always choose the best path but choose the path which has less probability value from a given path travel probability value and time-energy of tourist vehicle. In real the panoramic area is abstracted as complete graph and there are some road which have less distance but these are steep and crowded road so if we are not choosing the road which are best but steep and crowded then it may be that algorithm output will not give better result.

In this,we are consider that if length of path is more then time travel by tourist vehicle is also more in case average speed of vehicle and also energy consume by vehicle also more , on the other hand if there is steep road or crowded road ,the speed of vehicle will be slow result travel time will also increase and vehicle energy consumption will also increase because of steep road. we will define a function for pheromone updation which is based on time and energy consumed by tourist vehicle .This pheromone updation function perform better if path distance is shortest and energy consumed by vehicle is less. This modification in previous methodology will surely increase the performance of our algorithm ,hence this algorithm will give better route for tourist with less time, cost and energy consumption as well as tourist requirement.

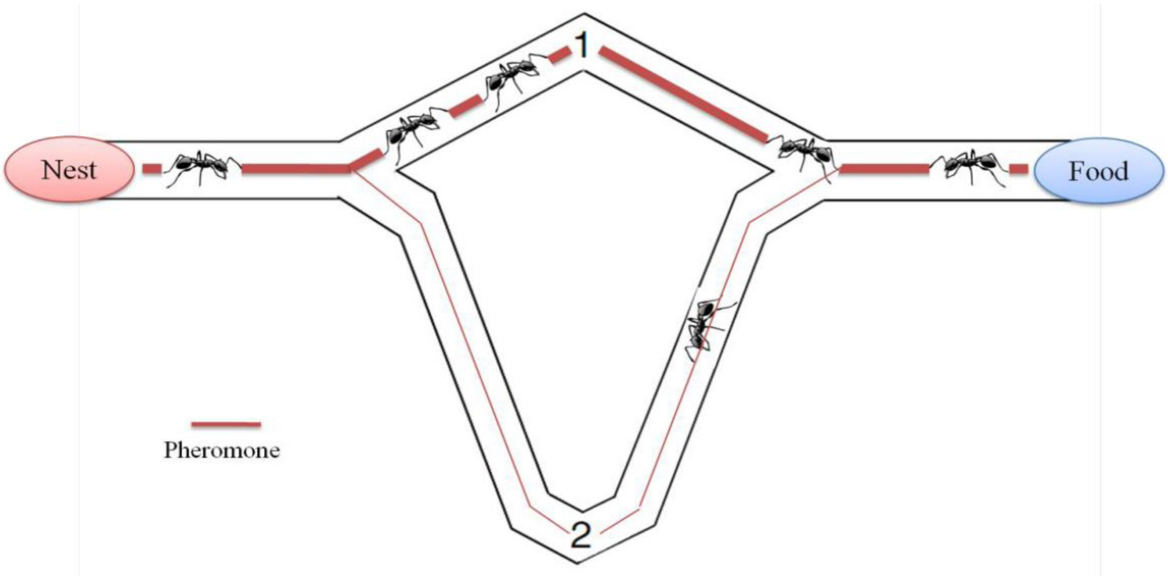

Figure 1.1: Double bridge experiment.

Ant system algorithms have four steps.These phase describe as follows-

(a) **Environment Description:**
The panoramic area should be resemble into a graph with N nodes and e edges. Nodes represent panoramic spots, middle and last points, while edges represent existing link and routes between spots.It look like complete graph where each spot has N-1 outgoing link and each link have two parameter cost and steep probability of that link.

(b) **Initilization:**
At this step, a predefined number of ants are located on start point and a weight is allocated to each existing link. Various values can be assigned as initial weight for links such as distance, random number or a number calculated through a formula. At each specified time intervals ants are regenerated to explore the problem graph for finding proper solution. The value of these variables should be assigned via experiments or trial and error approaches. The ants use probability function to select the next node in their path from origin to destination.

(c) **Update Pheromone intensity value:**
Ants utilize probability function to select next node and store any visited node in their memory. As soon as an ant finds a food source, it evaluates both quantity and quality of the food source and takes some food and starts return trip. During the return trip, each ant deposits a pheromone on the return path based on the obtained information from food source. In ant-based algorithm this procedure is called pheromone update rule which contains two concepts, namely, pheromone reinforcement and pheromone evaporation, at the same time. In the former case, the pheromone intensity of the links which are traversed by ants are increased, while, in the latter case, the pheromone intensity of the other links is reduced. Pheromone update rule has a direct impact on the exploitation characteristics of ant algorithms.
The ant k in node i can calculate the probability of visiting node j according to following equation-

$$\Delta P_{ij}^{k}(t) = \begin{cases} \frac{\tau_{ij}^{\alpha}(t)\eta_{ij}^{\beta}(t)}{\sum_{r \in allowed_k} \tau_{ir}^{\alpha}(t)\eta_{ir}^{\beta}(t)}, & j \in allowed_k \\ 0, & j \notin allowed_k \end{cases}$$

The concentration of pheromones on path (i,j) is updated as follows-

$$\tau_{ij}(t+T) = (1-\rho)\tau_{ij}(t) + \sum_{k=1}^{m} \Delta\tau_{ij}^{k}(t, t+T)$$

where $\Delta\tau_{ij}^{k}$ represent the released pheromonce of ant k on the path (i,j) .

$$\Delta\tau_{ij}^{k} = \begin{cases} \frac{Q}{L_k}, & (i,j) \in \mathrm{T} \\ 0, & \text{otherwise} \end{cases}$$

(d) **Finishing step:**
Reaching a predefined number of iter- ation indicates that the ant-based algorithm is completed, while, reaching a predefined maximum number of nodes before arriving to the destination point leads to ant drop.

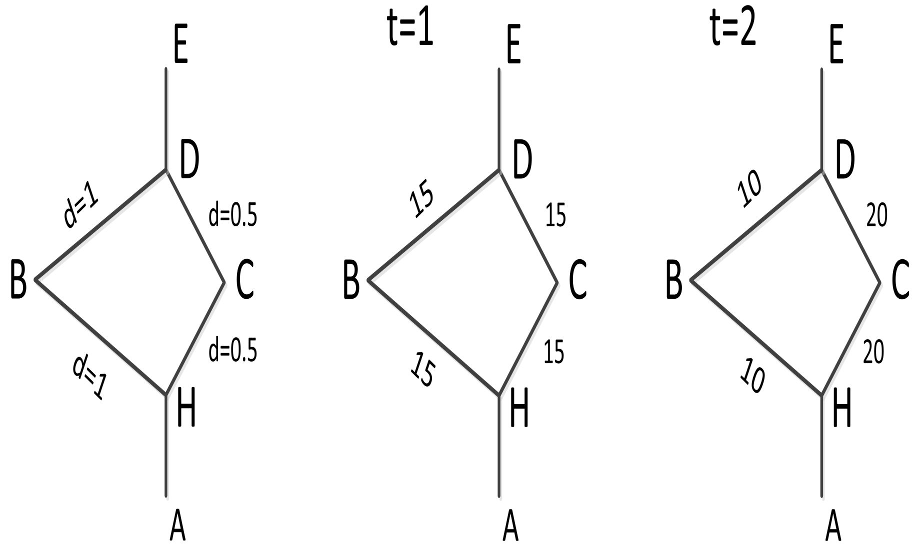

Figure 1.2: Sketch graph of ant colony foraging.

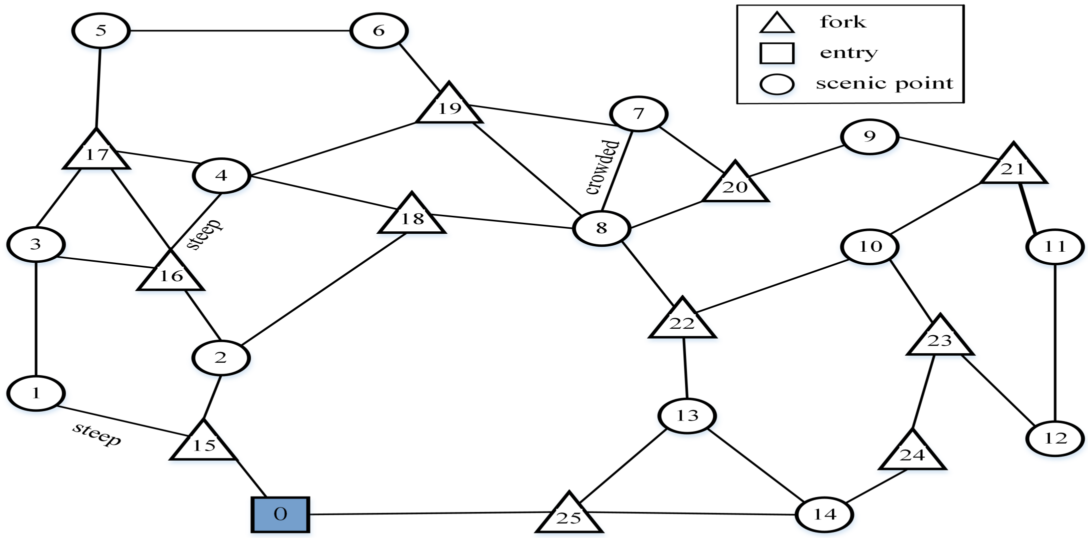

Figure 1.3: Scenic area graph.

Ants looking for a new food source do not yet have pheromone guidelines, so they undergo a completely ran- dom search in which all paths are given equal probability.Optimal paths are slowly introduced to the whole colony via the pheromones described above; longer or otherwise unde- sirable paths are gradually abandoned, while better, more heavily traversed paths are lined with pheromones to make them clearer to new ants entering the search process. This forms a positive feedback loop through which all the ants in the colony ultimately follow the optimal path to the food source.

In panoramic area there are numerous number of path which have steep probability these path are best path,there are many fork ,joint road and many steep road which are curve size so these are the part of panoramic area , in most of cases ,these panoramic area will be looking.

1.1 Optimization

It is a population based stochastic optimization approach inspired from the ant movement and can be applied to the combinatorial optimization problems with minimal changes. It transcribes the cooperative behavior of the ant colony in solving an optimization problem. During the traversal in search of food, ants secrete a chemical trail called pheromone. The role of the trail is to share the experience of the ants about their already traversed journey. Though, ACO provides a better solution to a wide class of combinatorial optimization problems but the parameter mapping of this technique with the tuned constraint of the given problem is a difficult task.

Distributive cooperation is observed in the ant colony using the smell of a chemical secreted by each ant during the path construction. Message of good constructive path is conveyed to the ant colony by the pheromone concentration deposited on the path. Pheromone evaporation also takes place with the passage of time otherwise a path of forgotten ants may mislead other ants for- ever. Due to this evaporation, the attraction of a less frequently used path diminishes for other ants. The stochastic nature of the algorithm is derived from the fact that at each step ants take the decision based on two parameters; attractiveness and trail. Attractiveness, in this context, is the prior information of the promising solution and trail represent the posterior information of the previously obtained good solution. Combination of the above two information is achieved nicely by a probabilistic formula, which plays a crucial role in the exploration of the solutions.

In the traditional path planning of scenic areas, the scenic area is abstracted as a simple graph that includes only particular scenic spots while the actual area as a whole is ignored. An actual scenic area should be represented by a complex graph with multiple types of points including the entrance, internal scenic spots, public service points, road forks, and so on.The scenic area is directly abstracted as a complete graph with a direct pathway between any two scenic spots. In actuality, the scenic area can only be defined as a connected graph with such pathways between any two scenic spots though the real pathway may not directly connect them.

The traditional path planning of scenic areas is not focused on the customersâĂŹ real demands. When the scenic spots are numerous or the tourists only have limited time to visit specific spots, the traditional path planning algorithm does not reflect the manner in which they select scenic spots drawing their immediate interest.The shortest tour path is defined as the best tour path. But in a real scenic area, some roads may be steep and difficult to pass for the children and the aged, moreover some roads may be crowded. So a better path planning algorithm should avoid the special roads and supply the suitable paths for tourists

1.2 Path planning

Several existing travel path planning systems informed the present study, as well. Designed a travel path planning system for individual tourists traversing the Andalusian Autonomous Region. also developed a travel path planning system in which tourists can select scenic spots on-demand and in real time. Sui developed a travel path planning software based on an improved ant colony algorithm. These systems are all focused on path planning between cities and scenic areas, while spots within a single scenic area are ignored. Our primary focus on this study was a novel path planning algorithm tailored to individual scenic areas.

We redefine the path planning of scenic area as a partial node traversal problem in a weakly connected graph to better reflect the dynamic behavior of individual tourists. The nodes are abstracted from the scenic spots in one scenic area and an improved ant colony algorithm is built accordingly.In the improved ant colony algorithm, the partial nodes traversal problem in the weakly connected graph is resolved through a temporary weight matrix and a shortest path matrix. By calculating the weight value of paths dynamically, specific paths in the scenic area can be avoided as necessary. Pheromone initialization and other problems are resolved to prevent premature convergence. The pro- posed method is demonstrated to be suitable for actual path planning applications.

The ant is a small but powerful animal demonstrating extremely complex, cooperative behavior at the colony level. The colony works together to not only gather food and building materials with size dramatically exceeding their individual bodies, but to intuitively find the shortest path to food sources. Biologists have well established that ants use pheromones to exchange information and cooperate across the colony. Ants follow the pheromone concentration in selecting new paths and assigning them probability. Pheromones evaporate over time, leaving less of these signals over less optimal paths to guide the colony together towards the most efficient and effective path. Ants looking for a new food source do not yet have pheromone guidelines, so they undergo a completely ran- dom search in which all paths are given equal probability.

Optimal paths are slowly introduced to the whole colony via the pheromones described above; longer or otherwise unde- sirable paths are gradually abandoned, while better, more heavily traversed paths are lined with pheromones to make them clearer to new ants entering the search process. This forms a positive feedback loop through which all the ants in the colony ultimately follow the optimal path to the food source.

We focused on single scenic areas comprised of numerous Panoramic spots. The scenic area graph is a connected graph consisting of entrances and exits, internal scenic spots, public service points, road fork points, and paths between them. Any two points are connected, but not necessarily directly. The path planning problem through the Panoramic area involves finding the optimal path to satisfy the touristâĂŹs dynamic needs, for example, visiting specific scenic spots while avoiding certain paths. It is also assumed that the travel path loops back to the starting point

In panoramic area,most of path are plane,few paths are steep. When the typical ant colony algorithm is used to solve the TSP problem, premature convergence will appear. There are two effective policies to remedy this. The first policy is focused on the ant colony algorithm itself, for example, redefining the transfer probability and establishing a new pheromone-updating method. The second policy is to combine the traditional ant colony algorithm with other intelligent algorithms. For example, the genetic algorithm can be used to obtain initial solutions based on which the ant colony algorithm performs optimization. These policies can resolve the premature convergence problem to a certain extent, but the latter requires more spatial and time complexity. We apply the first policy in the proposed algorithm.

In this algorithm the initialization method of pheromone and path search policy are improved. So this algorithm effectively overcomes the path dead lock problem and promotes the feasibility of the paths. For the local pheromone diffusion is introduced, the antsâĂŹ search space is enlarged and the ability of global search is enhanced. Compared with our proposed improved ant colony algorithm, We redefine the path planning of scenic area as a partial node traversal problem in a weakly connected graph to better reflect the dynamic behavior of individual tourists firstly. Secondly, the partial nodes traversal problem in the weakly connected graph is resolved through a temporary weight matrix and a shortest path matrix. Finally, we improved the initial pheromone values, establish mas-min ant system and optimize the transfer probability parameters.

The improved ant colony algorithm has a smaller total weight of paths than the traditional ant colony algorithm. Thus, the proposed algorithm allows the tourist to avoid steep or crowded paths by assigning them larger weights. The greater the number of nodes is, the larger the total path weight value. When the number of nodes is similar, the proposed algorithm has smaller total path weight than the traditional ant colony algorithm. The simulation results show that our proposed improved ant colony algorithm is more suitable to solve path planning problem in the circumstance in one scenic area with many spots than the enhanced ant colony algorithm and the traditional ant colony algorithm.

1.3 Literature Review

It has proposed a type of swarm intelligence optimization for handling the problem of path planning of auto driver ground vehicle for which it has focus on determining a prediction model that predict the power consumed by the vehicle and even try to minimize it and it reach to its destination through collision free shortest path. approach is not proper when used in dynamic environment,therefore it is not appropriate for determining turism spot as it is highly dynamic based on various factor. [1]

The proposed algorithm modifies the ants ending tour to achieve partial point traversal of the connected graph by eliminating the restriction of the ant colony algorithm taboo table. A temporary weight matrix is introduced so that the algorithm avoids the repeated selection of smaller-weight paths, improving its overall efficiency.The algo- rithm was designed to be intuitive and convenient in addition to being effective; it provides rapid response time without consuming excess system resources, making it well-suited to mobile devices.[2]

An auto controlled ant colony optimization algorithm controls the behavior of the ant colony algorithm automatically based on a priori heuristic.Performance study reveals the efficacy and the efficiency achieved by the proposed algorithm. A compar- ative study of the proposed method with some other recent meta-heuristics such as auto controlled ant colony optimization algorithm.It also fully exploits the possibility of obtaining good solu- tion through the inclusion of lazy ants before moving to the next generation.[3]

The probable origin of an attack is commonly investigated using some form of ant colony system algorithms.The ability of the ants to search all feasible attack paths was enhanced using a global heuristic mechanism in which the ant colony was partitioned into multiple subgroups, with each subgroup having its own pheromone updating rule.The results showed that the proposed scheme has a slightly slower convergence speed than does the conventional algorithm,this may not be possible in a real-world spoofed IP attack.Thus, a deception test subject to shared collective intelligence in a spoofed IP attack will be used in future studies.[4]

The ACS algorithm is extended to model the use of multi-compartment vehicles with kerbside sorting of waste into separate compartments for glass, paper, etc. The algorithm produces high-quality solutions for two-compartment test problems. Further improvement could be made by including other constructive heuristics such as the Clarke and Wright algorithm.[5]

Inspired by the promising performance of heuristic algorithms to solve combinatorial problems, this paper proposes an improved quantum ant colony algorithm for exhaustive optimization of the evacuation path that people can evacuate from hazardous areas to safe areas.Relevant context variables affecting the evacuation pro- cess should be taken into account. Factors like network dynamics and human behaviors have significant effects on evacuation opti- mization and should be considered.[6]

Ant colony optimization is a metaheuristic for combinatorial optimization problems. In this paper we report on its successful application to the vehicle routing problem.In this paper we have described how the ant colony optimization metaheuristic can be successfully used to solve a number of variants of the basic vehicle routing problem.In conclusion, after more than ten years of research, has been shown to be one of the most successful metaheuristics for the VRP and its application to real world problems demonstrates that it has now become a fundamental tool in applied operations research.[7]

In the Motion Planning research field, heuristic methods have demonstrated to outperform classical approaches gaining popularity in the last 35 years. Several ideas have been proposed to overcome the complex nature of this NP-Complete problem. Ant Colony Optimization algorithms are heuristic methods that have been successfully used to deal with this kind of problems.The proposed method seems to be a promising path planning system for autonomous mobile robot navigation since the given solutions are not only paths, but the optimal ones.[8]

1.4 Key Related Research

In this paper,the ant colony methodology used to find the vehicle route with minimum cost and minimum number of vehicles. In this ACO is use for shortest route and k mean clustering uses to improve the efficiency of the solution. Uses subtour for efficient unloading. We can not pridict how much amount of waste in the recycle box set out by households. [5]

In this paper,ACS is to find the origin of attack in networks environment. In this, the rate of pheromone accumulation is reduced to increase the likelihood of the solution procedure covering to the attack path. To reduce the rate of most probable path and improve the global optimality of final solution we make partitioning of ant colony in subgroups. This scheme has slightly slower convergence speed then does the conventional algorithm but yield a more globally optimal solution for the attack path particularly in large scale network topology[4]

In this paper, green ant methodology uses to find the collision free shortest free path with lower energy consumption by unmanned ground vehicles. It comprise four phase,Prepration,Map Exploration Energy consumption calculation, Path planning It uses two concept,Reinforcement and pheromone evaporation. It is suitable for static environment not fit for dynamic environment.[1]

In this paper,methodology used to find the shortest tour in one scenic area with many spot.This tour must be as tourist requirements. In it, weakly connected graph used in place of complete graph to efficient configuration of multiple spots. For best path consideration,not always select short distance path because of tourist requirement i.e some path may be steep or crowded, not suitable for the children and the aged. In this if any path which is steep or crowded but shortest,not taken consideration. To avoiding always a steep or crowded path is not satisfactory solution because some steep or crowded path might be suitable for tourist.[2]

1.5 Motivation

As I am doing M.Tech specialization with Information Security it motivates me to work in the field of information security as well as the area of soft computing and Robotics because of my childhood interest in mathematics and machine learning based on purely mathematics so i decided to work on something which related to both security as well as machine learning.

As we have an idea that traditional path planning algorithm is usually based on complex mathematical problem that we cannot find quick algorithm at this stage ,when i studied, i found these traditional algorithms telling only optimal path selection,in other words these algorithm always choose best path whether it steep or crowded road.In general at a particular panoramic spot there are many steep roads present so these steep road are not suitable for children and old age and also not best for any vehicle.

This is the time when day by day the new path planning algorithm are introduced with great convergence rate and shortest path but these algorithm focused only best path , they not focuses optimal path,here optimal path means choose such path which is shortest as well as satisfy tourist need that is why traditional path planning algorithm are not suitable in future.Path planning algorithm with steep probability based methodology may be prominent solution to this problem thus it motivates me to turn my work in this area.Path planning with steep probability provides a Pheromone updating function which is based on cost of link and steep probability of the link.In panoramic spot ,there are tow type steep road,upward steep and downward steep road.This proposed methodology is best for optimal path cost as well as Tour aspect.

1.6 Research Gap

In this thesis we are focusing on steep probability, because steep angle of particular link is directly proportional to the energy consume by the tourist vehicle and these steep angle is also not best for tourist need because it create hurdle for children and the age.Our methodology based on cost as well steep angle of the link which is modification in traditional thoughts because traditional thoughts focus either best tour or steep road but .

1.7 Research Objective

The objective of this research is

- To develop an improved ant colony algorithm for shortest tour planning which is based on link cost and link steep probability,that always give optimal solution and satisfy tourist requirements.
- To reduce the path length of total tour so that it will be accept by tourist vehicles and also satisfy the tourist requirements.

1.8 Thesis Layout

Rest of the content of thesis is organized as follow: Chapter 2 includes include literature review and motivation, objective ,key related search . Chapter 3 shows the statement of problem definition and proposed methodology . Chapter 4 concludes all results aspect.Chapter 5 shows conclusion ,limitation ,future work.

CHAPTER 2

Statement of Problem and proposed Methodology

2.1 Model Description

In our methodology,first of all i am giving pictorial representation of our model. Our model is based on complete graph because in general most of panoramic area look like complete graph, where every node belong to particular panoramic site and every link belong to path of link (i,j). In general there are many fork and turn present in actual panoramic area but for convenience we are taking only node which will work for both panoramic site and fork or turn also. In real most of panoramic sites have different structure, means some of them are plane road look like weakly connected graph and have many fork, turn and other have many steep or crowded roads. If there are many crowded roads then it may be the case that it is not suitable for children and old aged and also not good for vehicle,because these road consume huge energy of vehicle.

To develop an improved ant colony algorithm for shortest tour planning which is based on link cost and link steep probability, always give optimal solution and satisfy tourist requirements.As we know very well that in a particular panoramic spot,there are two type of roads, plane roads and other is steep roads,these steep roads some time are not suitable for children or the aged and also consume huge energy by tourist vehicle. There are two type steep roads,steep road with upward direction and steep road in downward direction.For upward,we will take positive steep angle and for downward we will take negative angle.

The fig.2.1 shows upward steep angle,these steep angles look like stare case in upward direction,it may be possible that any steep road look like right angle steep road but right angle steep road normally consider worst road because these roads not for travelling. In actual panoramic area most of roads are normal but these normal roads should be steep up to some level of inclination,the problem here how to set that any steep road will be suitable for travelling.For general consideration we will consider that steep roads are suitable if the contain steep angle in range -45 degree to 45 degree. Steep road with 90 degree steep angle is worst

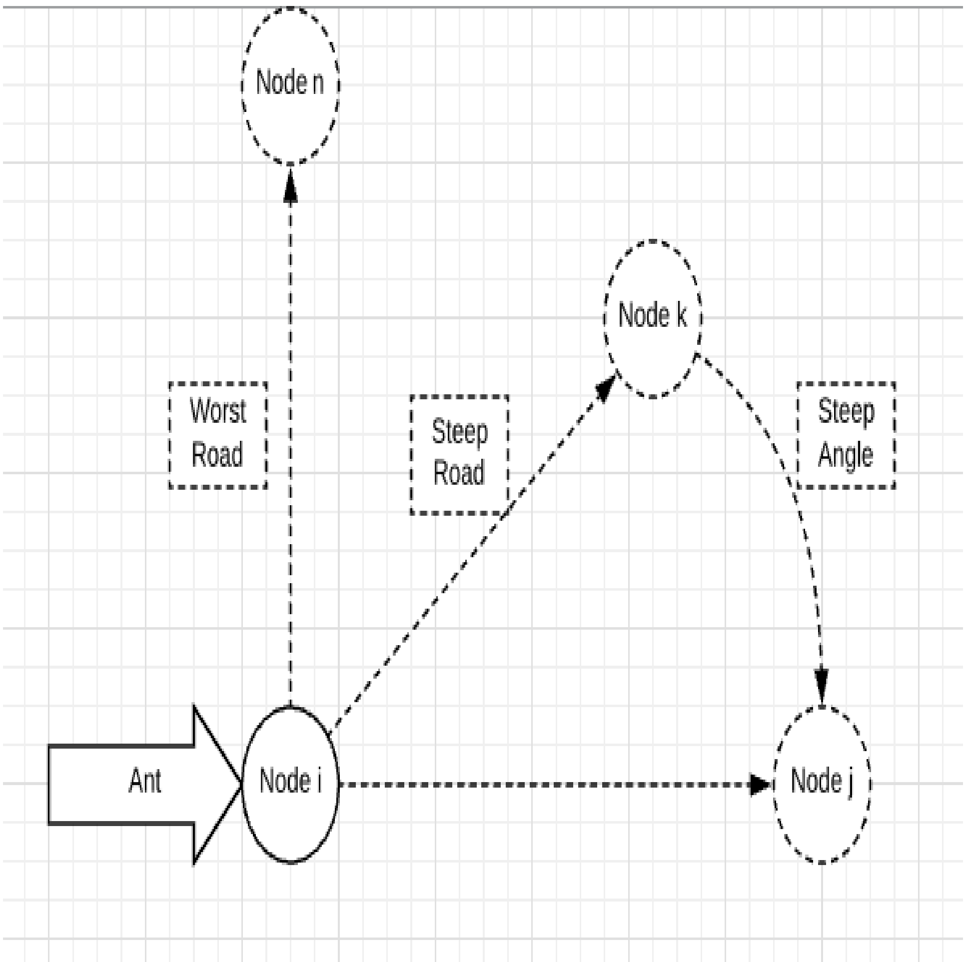

Figure 2.1: Graphical representation of upward steep angle.

road,the range of worst road lie between 46 to 90 degree because it create much energy by tourist vehicle and also not suitable for children and old age person.

fig 2.2 shows steep angle but downward direction,any steep road is as better as it contain steep angle as much downward but these downward steep angle should be up to -45 degree after that it will become worst because if downward steep angle is more then it may be chance to out of control tourist vehicle but downward steep angle with -45 is top best because it consume very less energy by tourist vehicle. In actual panoramic area most of roads are normal but these normal roads should be steep up to some level of inclination,the problem here how to set that any steep road will be suitable for travelling.For general consideration we will consider that steep roads are suitable Steep road with -90 degree steep angle is worst road,the range of

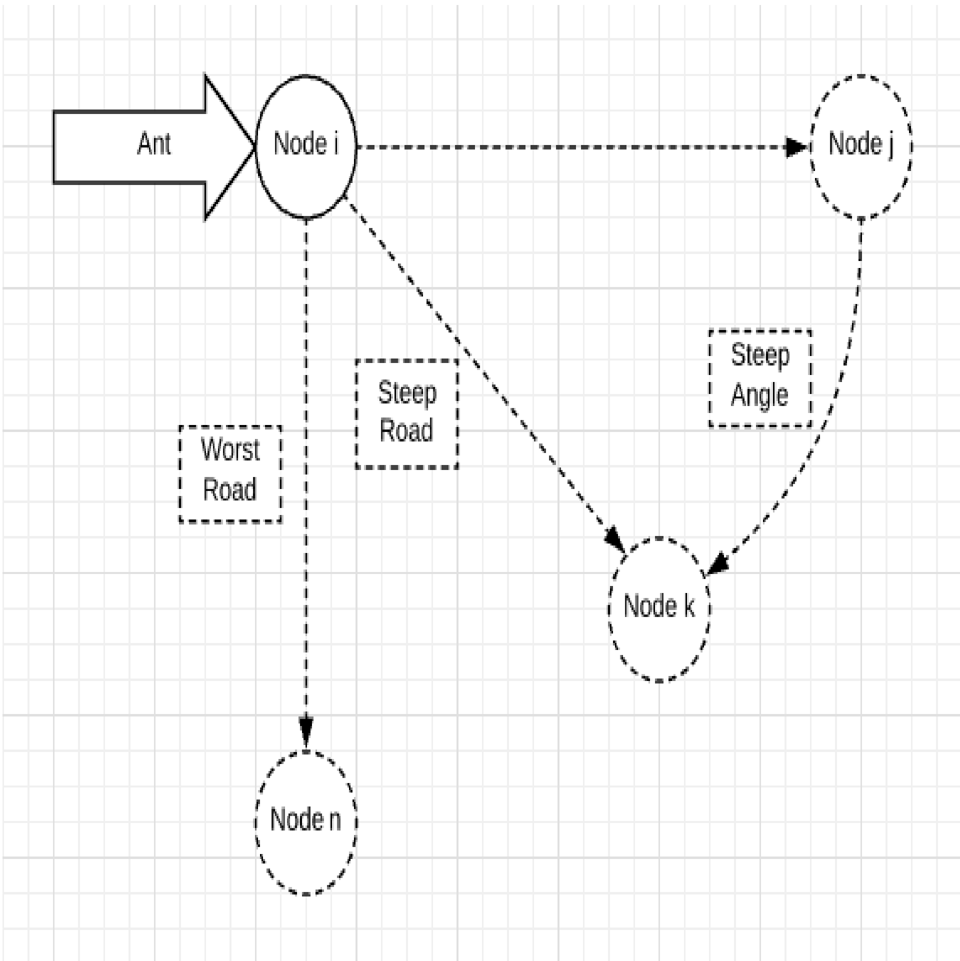

Figure 2.2: Graphical representation of downward steep angle.

worst road lie between -46 to -90 degree because it is not suitable for tourist vehicle. In this range of steep angle, vehicle may be out of control.

fig.2.3 shows the complete view of panoramic area with both steep angles,here we are talking about favourable area,favourable area is nothing but area between -45 degree to 45 degree.this area is better for tourist vehicle ,tourist vehicle can travel in this area range but out side this is unfavourable area, this unfavourable for tourist vehicle.Probability for any road is how much steep lie between -0.5 to 0.5,this is for favourable area,for unfavourable area steep probability lie between 0.5 to 1 or -0.5 to -1.

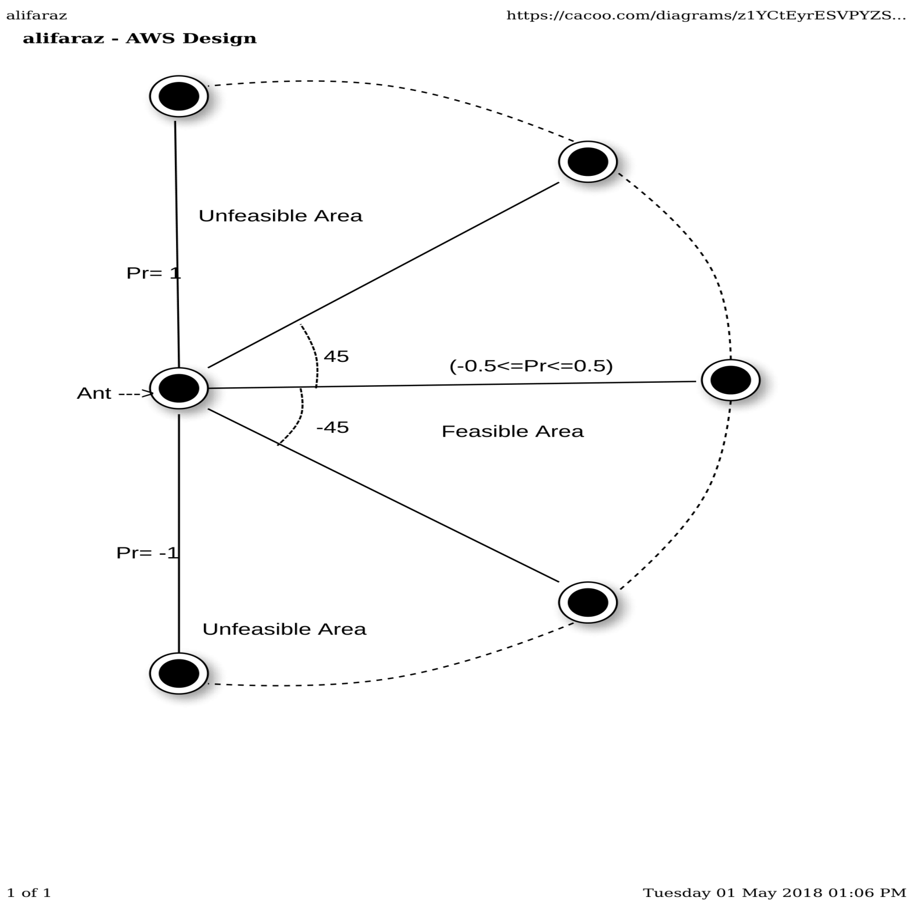

Figure 2.3: Graphical representation steep angle with steep probability.

2.1.1 Proposed methodilogy

The concentration of pheromones on path (i,j) is updated as follows-

$$\tau_{ij}(t+T) = (1-\rho)\tau_{ij}(t) + \sum_{k=1}^{m} \Delta\tau_{ij}^{k}(t, t+T)$$

where $\Delta\tau_{ij}^{k}$ represent the released pheromone of ant k on the path (i,j) .

$$\Delta\tau_{ij}^{k} = \begin{cases} \frac{Q}{L_k}, & (i,j) \in \text{T} \\ 0, & \text{otherwise} \end{cases}$$

In following equitation,we will calculate the Pheromone updating function which is based on steep probability and link cost.If Ant has reached to node i and from node i Ant want to go node j but from node i to j,there are n-1 nodes then the problem is that how can Ant go to node j.Solution of this problem is that calculate the values of steep cost and steep probability of all nodes which is adjacent to node i then add these cost and probability values to the cost which is travel by ant k, from source node to node i.After that compare from all values,the value which has less cost from others should be taken into account, this minimum value path should be taken by ant k and Pheromone concentration will increase and others paths pheromone concentration will be reduce by some pheromone rate factor ρ .

Here we are consider two parameters time d_{ij}^{k} and steep road probability $P_{sr}^{k}(ij)$ in place of path-length L_k in above pheromones concentration function which is expressed as follows-

$$\Delta\tau_{ij}^{k} = \begin{cases} \frac{1}{D_{ij}^{k}}, & \text{if the link (i,j) passed by ant k} \\ 0, & \text{otherwise} \end{cases}$$

where D_{ij}^{k} is distance and probability function.

$$D_{ij}^{k} = \begin{cases} d_{is}^{k}\} * P_{sr}^{k}(is) \\ \text{s} \subset \{\text{All adjacent nodes of i}\}, \end{cases}$$

where d_{ik}^{k} is the distance travel by ant on path (i,s)and $P_{sr}^{k}(ij)$ is steep probability of path (i,j). we calculate the steep probability $P_{sr}^{k}(is)$ as follows -

$$P_{sr}^{k}(is) = |\frac{\theta_{is}}{90}|$$

where θ_{is} is the angle of steeping road.

In above equation,if ant will go upward then probability of steep road will be positive but if ant will go downward then probability of steep road will become negative, so this is a big problem because cost and steep probability value also will become negative then this negative value will be select minimum from all others values.To overcome from yhis problem we will take absolute value of steep angle which will give always positive values.

The current methodology based on two considerations of tourists' demands: (1) Avoiding steep paths and (2) avoiding crowded paths. This involves recalculating the weight ω_{ij} in the initial weight matrix according to equation.

$$\omega_{ij} = d_{ij} + d_{max}(d_y + d_d)$$

when
d_y=1 *or* d_d=1 $avoid the path selection.$
d_y=0 *and* d_d=0 $select the path.$

$Our proposed methodology for calculating the weight matrix -$

$$\omega_{ij} = \begin{cases} \text{d\_ij}, & \text{if } P_{sr} \leq X \\ d_{ij} + d_{max}, & \text{otherwise} \end{cases}$$

where P_{sr} is probability of being steep road.
X is max set probability for travelling in the steep path.

CHAPTER 3

Results and Discussions

In this section,first of all we will set the variable values for initialization and we will show different type results .First we will show the actual execution of our algorithm with normal condition after that we will show the result of steep road with high steep probability.In the next section we will depict two diagram,out of two first shows actual flow of algorithm with normal condition and second shows actual flow of algorithm with one path of high steep probability.

3.1 Variables Settings

In the following table, we have fixed the variables values which is use in our algorithm.

Table 3.1: Variables settings

Variables	:	Setting
Max Ants	:	15
Max cities	:	20
Maximum Cost	:	32765
Alpha	:	-1.5
Beta	:	1.1
Pheromone_Decay_Factor	:	0.1
Pheromone_Bonus_Factor	:	0.15

3.2 Result phase I

Figure 3.1 shows graphical view of panoramic area with many spots as earlier we talk about complete description of panoramic area where node represent panoramic spot and edges represent links among panoramic spots.Each link associated steep cost and steep probability which is the measure of path selection.

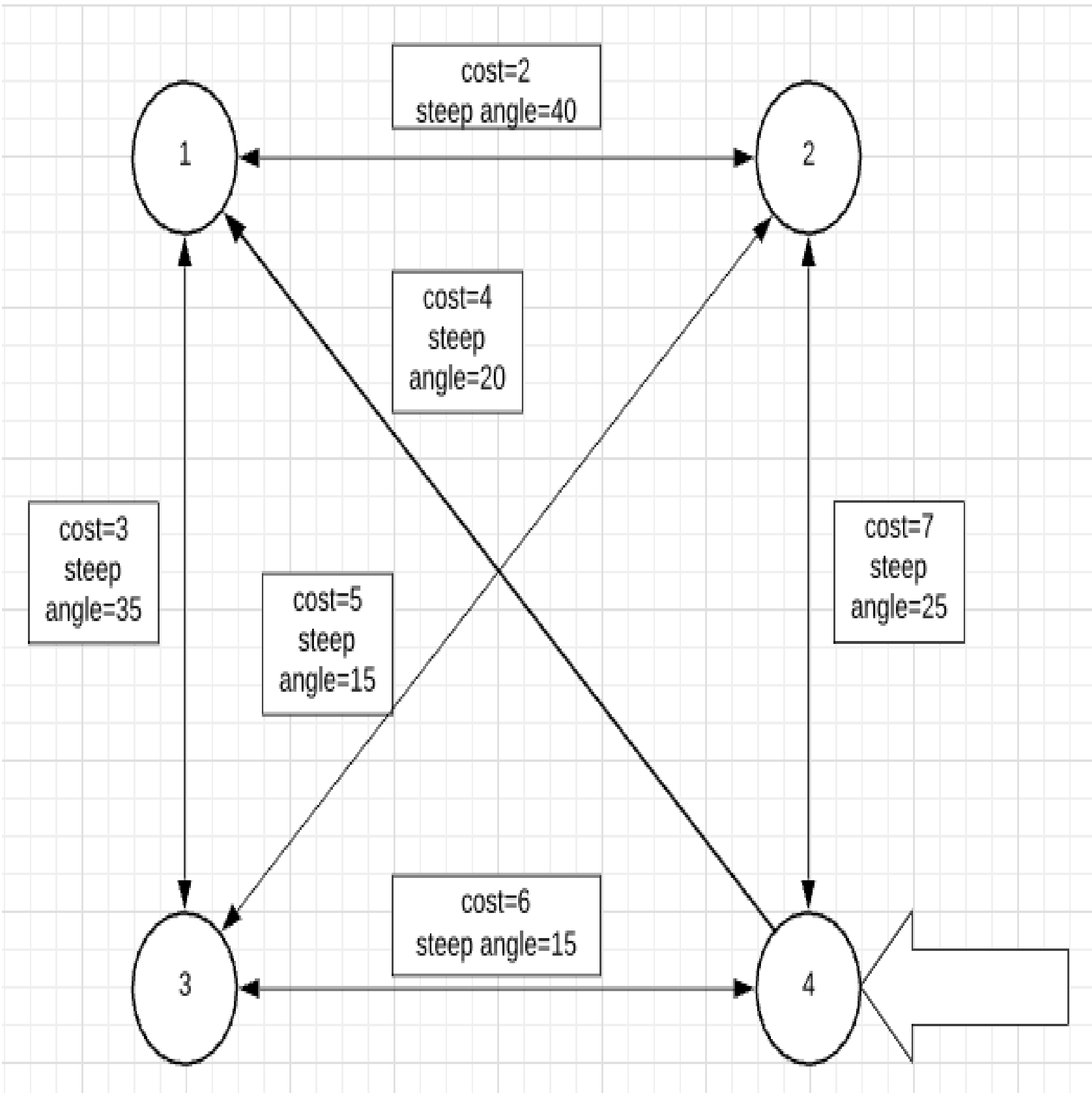

Figure 3.1: Graphical view of Panoramic Area.

Figure 3.2 shows experimental result of proposed algorithm,this show best path tour and best best path length. For N panoramic spots it inputs N*(N-1)/2 values of steep angle and link cost and after finite computation it will give the outcome. Following figure also shows final pheromone table and final steep or crowded path probability table.

```
C:\Users\Prashant\Desktop\ali\mtp4\mtech1.exe
Enter No. of Cities: 4
Enter Cost & steap angle of path:(1)-------------(2) : 2
40
Enter Cost & steap angle of path:(1)-------------(3) : 3
35
Enter Cost & steap angle of path:(1)-------------(4) : 4
20
Enter Cost & steap angle of path:(2)-------------(3) : 5
15
Enter Cost & steap angle of path:(2)-------------(4) : 7
25
Enter Cost & steap angle of path:(3)-------------(4) : 6
15
@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@
Best Path is:-  3-> 0-> 1-> 2-> 3->
Tour value is:- 17
@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@
Final Pheromone Table is:
0.2059 6.3681 0.2631 0.2059
0.2631 0.2059 6.3681 0.2059
0.2059 0.2059 0.2059 0.2631
6.3681 0.2059 0.2059 0.2059

Final Steep or Crowded path probability Table is:
***************************************************
0.0000 0.4444 0.3889 0.2222
0.4444 0.0000 0.1667 0.2778
0.3889 0.1667 0.0000 0.1667
0.2222 0.2778 0.1667 0.0000
***************************************************
```

Figure 3.2: Result I of proposed algorithm..

Figure 3.3 shows graphical view of result phase I.In following figure Ant start her journey from node 4 ,after comparing the value of steep angle and steep probability from three link she found that link (4,1) is best link. After reaching node 1 she will find that node (1,2) is best and carry forward then at node 4 ,she will find that link (2,3) is best,at node 3 she will that link (3,4) is best link,so she will travel on 4-1-2-3-4 tour and tour length will be 17.

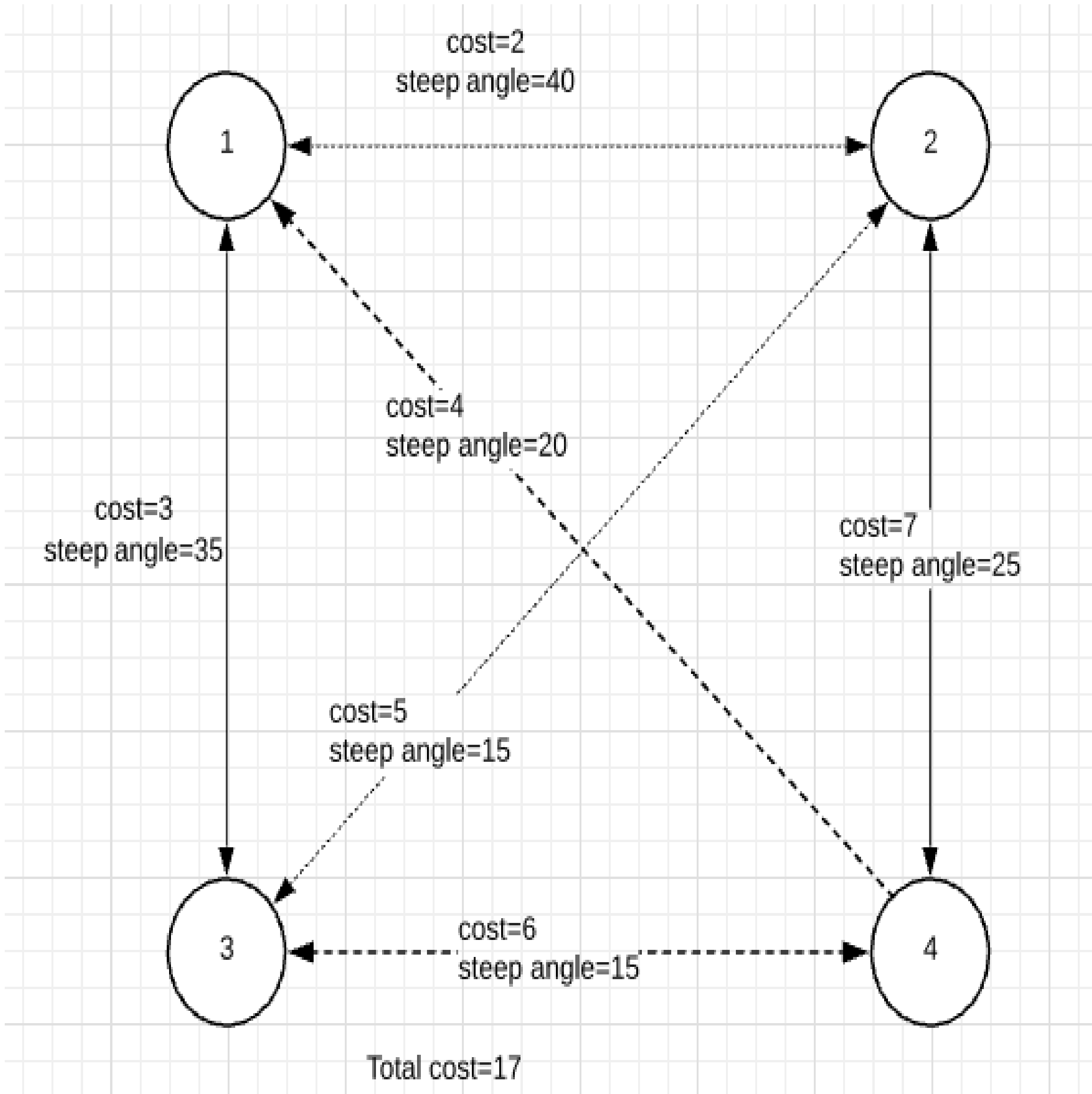

Figure 3.3: Graphical result of proposed algorithm.

3.3 Result phase II

Figure 3.4 shows experimental result of proposed algorithm,this show best path tour and best best path length. For N panoramic spots it inputs values of steep angle and link cost and after finite computation it will give the outcome. Following figure also shows final pheromone table and final steep or crowded path probability table.

```
Enter No. of Cities: 4
Enter Distance & steap angle of path:(1)-------------(2) : 2
80
Enter Distance & steap angle of path:(1)-------------(3) : 3
35
Enter Distance & steap angle of path:(1)-------------(4) : 4
20
Enter Distance & steap angle of path:(2)-------------(3) : 5
15
Enter Distance & steap angle of path:(2)-------------(4) : 7
25
Enter Distance & steap angle of path:(3)-------------(4) : 6
15
@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@
Best Path is:-  3-> 0-> 2-> 1-> 3->
Tour value is:- 19
@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@
Final Pheromone Table is:
0.2059 0.2059 8.1371 0.2059
0.2059 0.2059 0.2059 0.2059
0.2059 8.1371 0.2059 0.2059
8.1371 0.2059 0.2059 0.2059

Final Steep or Crowded path probability Table is:
***************************************************
0.0000 0.8889 0.3889 0.2222
0.8889 0.0000 0.1667 0.2778
0.3889 0.1667 0.0000 0.1667
```

Figure 3.4: Result II of proposed algorithm.

Figure 3.5 shows graphical view of result phase II.In following figure Ant start her Journey from node 4 ,after comparing the value of steep angle and steep probability from three link she found that link (4,1) is best link. After reaching node 1 she will find that link (1,2) is highly steep so it is not best but link (1,3) is best and carry forward then at node 3 ,she will find that link (3,2) is best,at node 2 she will that link (2,4) is best link,so she will travel on 4-1-3-2-4 tour and tour length will be 19,this cost is more as compare to previous so no problem because it gave optimal tour length and also worked according to tourist requirements.

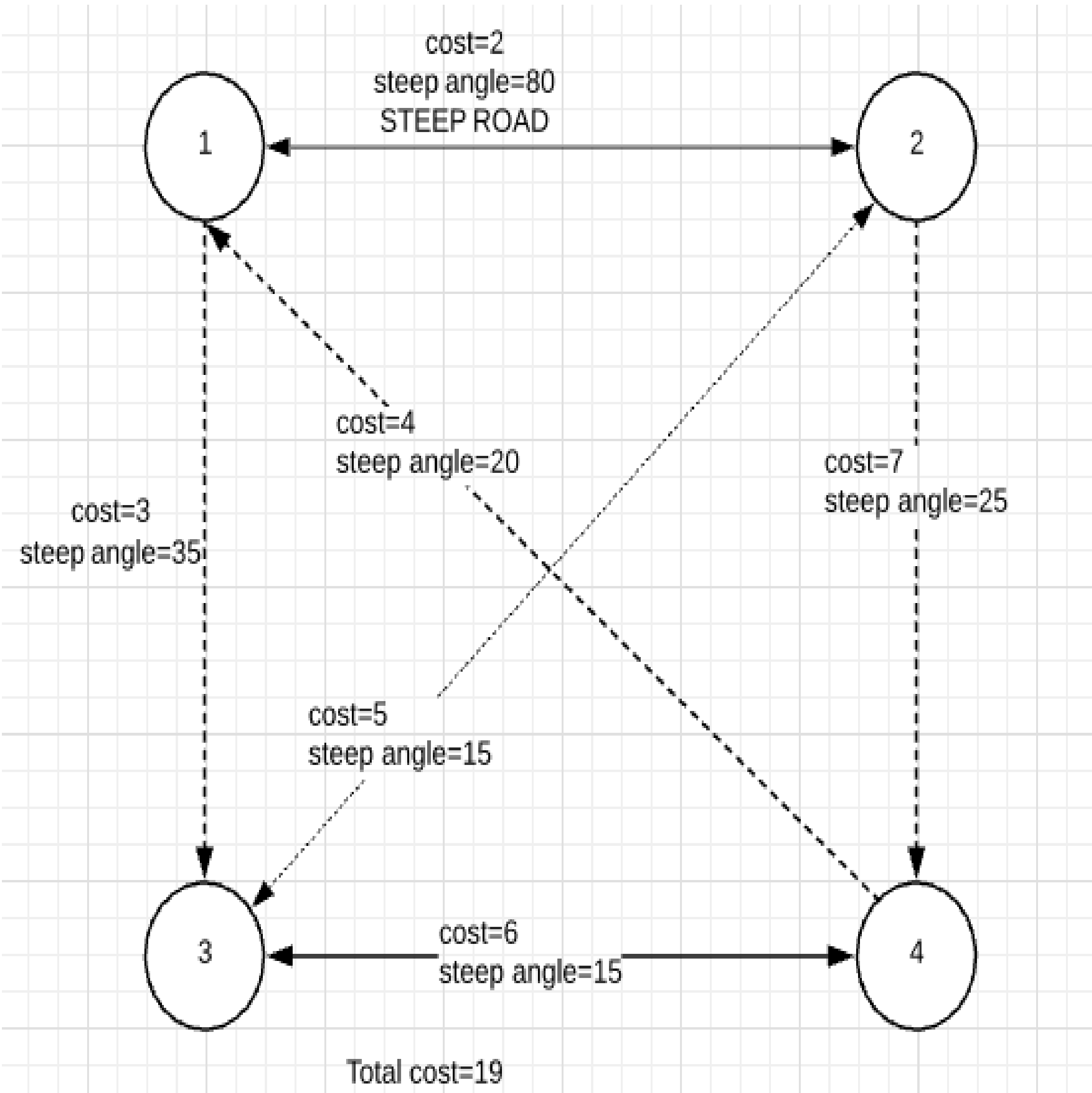

Figure 3.5: Graphical result of proposed algorithm..

3.4 Result III

Figure 3.6 shows performance of the algorithm and also showing graphical view of Ant tour. For best tour outcome we have to set the parameter values which will constant through out the execution,these values are number of ant ,number of cities,maximum test values,alpha , beta and evaporation rate value.

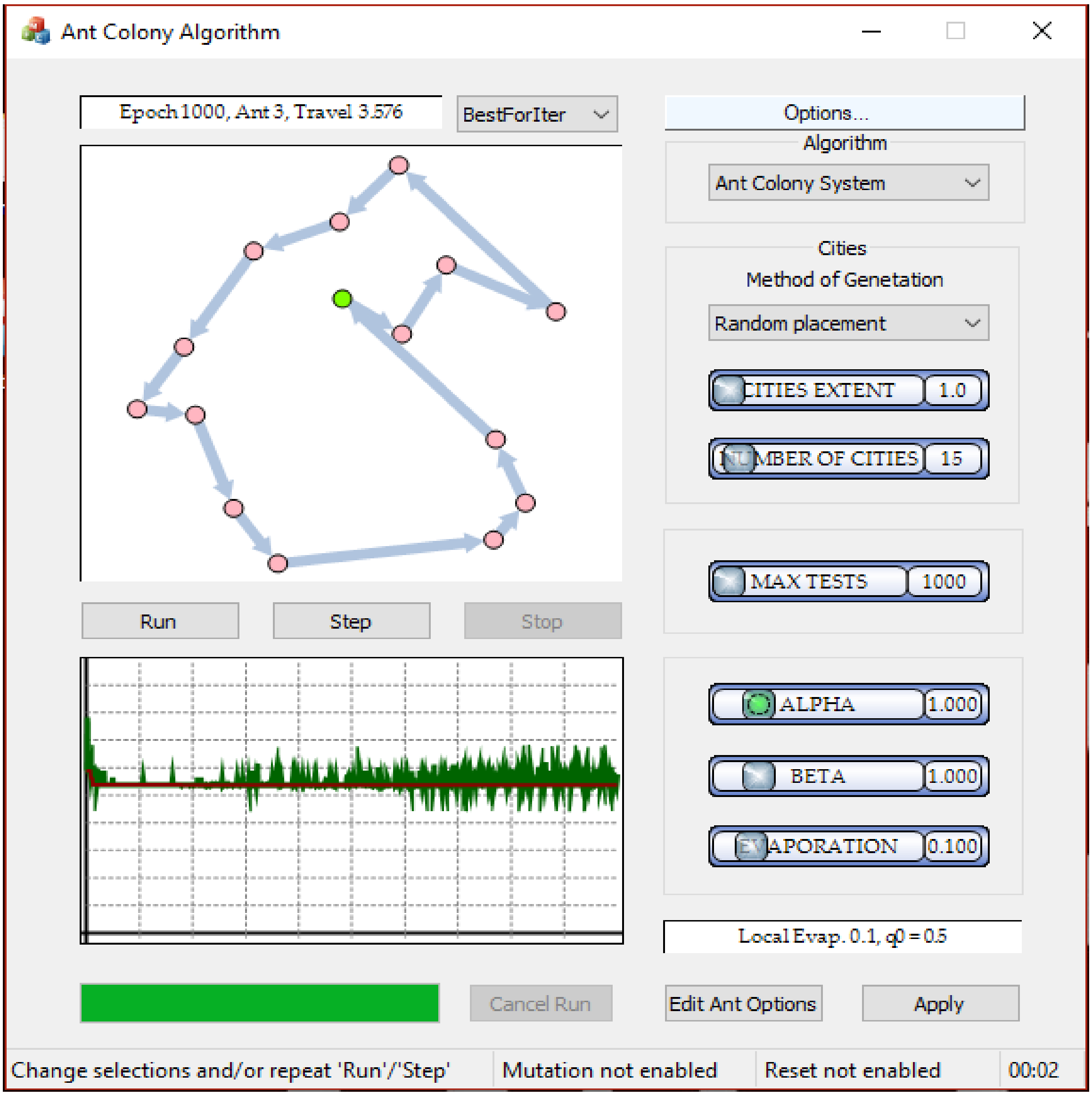

Figure 3.6: Graphical view of result III.

Figure 3.7 shows performance of the algorithm and also showing graphical view of Ant tour. In the following figure we slightly increase the value of all parameters,through which outcome of the algorithm will also changed.

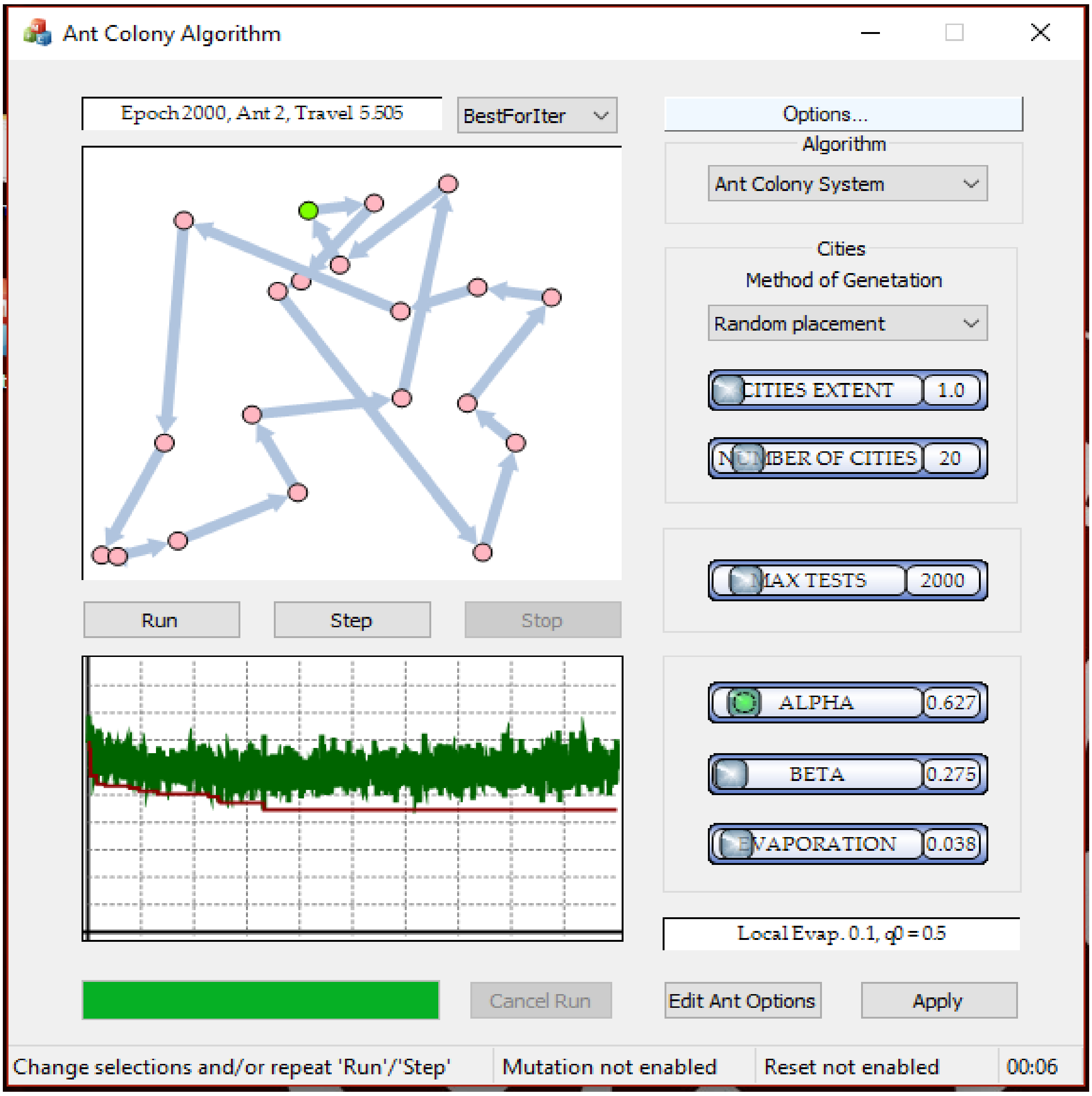

Figure 3.7: Graphical view of result III with increase all variables values.

Figure 3.8 shows performance of the algorithms,if we talk about traditional algorithms then by increasing the number of node, path length also increase.but if we compare result of traditional algorithm and result of improved ant colony algorithm then we will find that by increasing the number of node, path length of tour are still less as compare to traditional and enhance ant colony algorithm.

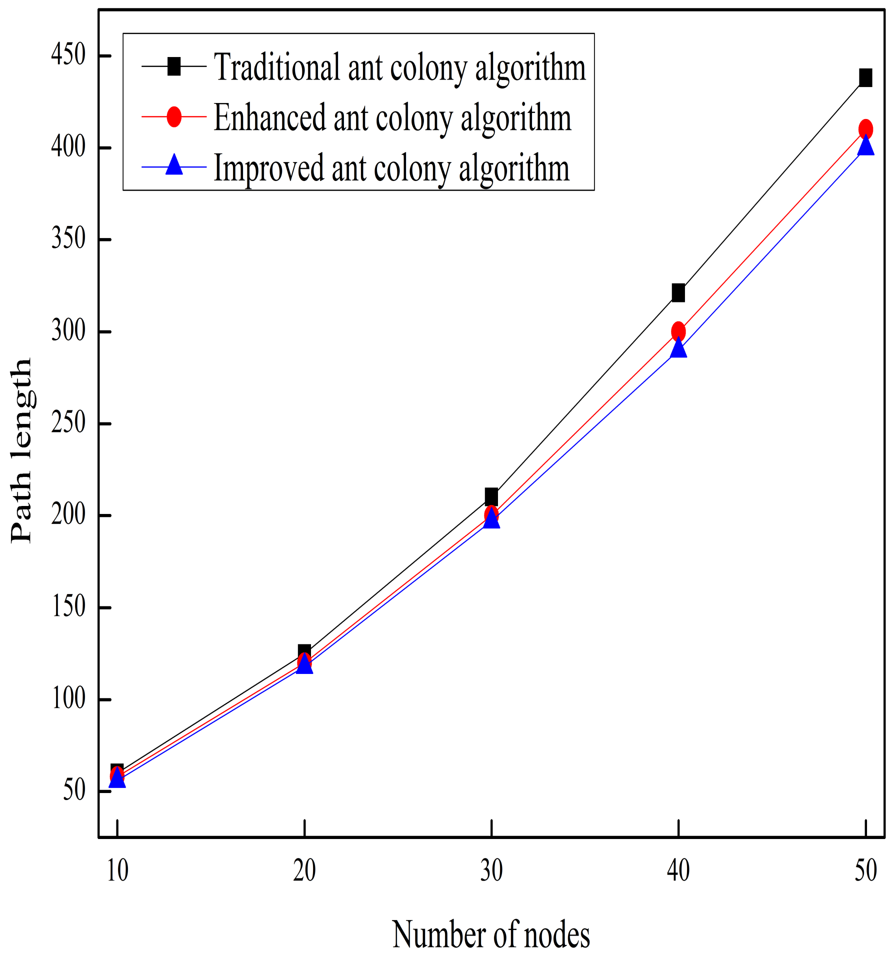

Figure 3.8: Performance Comparision among algorithm.

CHAPTER 4

Conclusion and Future Scope

In this final chapter, section 4.1 concludes the thesis by explaining the outcome. Section 4.2 mentions some of the assumptions and limitations of the research work. Section 4.3 gives direction in which the present thesis work can be taken further on.

4.1 Conclusion

This thesis proposes an intelligent, ant colony based path planning algorithm with built in function to avoid steep path through panoramic sites.This function will drop the Pheromone value on path according to the minimum value of steep angle and steep cost. The algorithm was designed to be intuitive and convenient in addition to being effective; it provides rapid response time without consuming excess system resources. Simulation results also showed that the proposed algorithm outperforms the traditional ant colony algorithm in regards to convergence speed and search range.Most important thing in this proposed algorithm is that it is best for both purpose means it is best for optimal path as well as tourist requirement. we will define a function for pheromone updation which is based on time and energy consumed by tourist vehicle .This pheromone updation function perform better if path distance is shortest and energy consumed by vehicle is less. Traditional path planning algorithm focus on shortest path but they did not focus on tourist demand,it means former methodology based on best strategy instead of optimal. In formal methodology,if any path is best path but this path is slightly steep then they blindly reject these path with out think that this path how much steep. This modification in previous methodology will surely increase the performance of our algorithm ,hence this algorithm will give better route for tourist with less time, cost and energy consumption as well as tourist requirement.

4.2 Limitations

Our methodology is based on steep road probability and road cost. If path has proper inclination then it will work properly .But it may be the case that paths are curve shape and in between path there are lot of digs then our methodology may be unsatisfactory because we consider that path should be properly inclind and roads are plane.

4.3 Future Scope

For future, it would interest a researcher to further make refinements over the model and include the new factor like vehicle efficiency(engine power in cc) so that whenever any vehicle have that much power then it can travel otherwise it choose other link for travel,we can say in other words if angle of steep road is very high cause probability of steep road also very high then pheromone drop rate of this link should be very low but if the vehicle who want to travel on that path has high efficiency then it may be a chance that it can travel and drop the pheromone on that path.

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