# Update Vehicle Traffic Routing Using Ant Colony Optimization Algorithm

Mohammad Jamal Hossain, Golam Md. Muradul Bashir
Computer Science and Engineering Faculty
Patuakhali Science and Technology University
Patuakhali, Bangladesh
jamalpstu07@yahoo.com, murad98csekuet@yahoo.com

Md. Rejaul Karim
Assistant Director: Bangladesh Bank
Dhaka, Bangladesh
karimrejabd@yahoo.com

Md. Mehedi Hasan
Lecturer: Department of Language and Communication
Patuakhali Science and Technology University
Patuakhali, Bangladesh
mh_sust@yahoo.com

***Abstract*— In this paper, the authors want to implement the solution of combinatorial problem, based on the heuristic behavior of ant. This paper focuses on a highly developed solution procedure using ACO algorithm. This helps to solve routing problems easily. It also reflects the method considering flow, distance, cost, and emergency etc. Here, a new algorithm named UVTR (Update Vehicle Traffic Routing) is represented to overcome the complexity of the previous algorithm. It yields the typical process for removing traffic problems in case of flow, distance, cost etc. This formulation is represented with systematic rules based case study for the Dhaka City.**

Keywords- ***ACO; UVTR; Traffic Network; Flow; Distance***

## I. INTRODUCTION *(HEADING 1)*

Ants are social insect, who are one of the animals living together. Their behavior for survival is the best way of finding shortest path. The goal of Ant Traffic Control System algorithm is to dynamically control the traffic network equilibrium [1] such that traffic flow in the network is optimized [2-3]. The authors introduce a novel Ant Traffic Control System algorithm, derived from the existing class of Ant Colony Optimization (ACO) algorithms. For transporting all car drivers without delay, the capacity of the highways is insufficient. Especially in the busy times there are enormous traffic jams. Traffic jam occurs due to ecological, financial or political reasons [4], hence the losses in time and money are excessive. But causes and results are not fact; the actual fact is to find the minimization of traffic problem. In case one route is blocked or delayed, car drivers should be informed about alternative routes. Nowadays, information about traffic jams is telecast through news on radio and TV, or via mobile phones, but generally mere overcrowded is reported and no alternative routes are suggested [3]. The existing routing systems are so expensive and very time consuming. These traditional systems will not afford to be suitable in future situation. In this paper, the authors will represent Ant Traffic Control System using Sensor with Voice Synthesizers that will effective in all situations. The outline of the paper is as follows. In the next section the authors present and discuss related work. In Section III is presented the Update Vehicle Traffic Routing Algorithm. In section IV ACO based UVTR Algorithm. The experiments and results are described in Section V. The authors end the paper in a conclusion.

## II. ANT COLONY OPTIMIZATION AND ITS RELATED WORK

### 2.1 ACO Meta-Heuristic

The behavior of single agent, called artificial ant forms multi agent system of ant algorithm. This is encouraged by the real ant. A meta-heuristic is a set of algorithmic concepts that can be used to define heuristic methods applicable to a wide set of different problems. The use of meta-heuristics has significantly increased the ability of finding very high quality solutions to hard, practically relevant combinatorial optimization problems in a reasonable time. A particularly successful meta-heuristic is inspired by the behavior of real ants

[5-6]. Starting with ant system, a number of algorithmic approaches based on the very same ideas were developed and applied with considerable success to a variety of combinatorial optimization problems from academic as well as from real-world applications.

### 2.2 ACO Algorithm

An ACO algorithm consists of two main parts: initialization and a main loop. These are described below:

**Initialize:**

. Set initial parameters of the system: Variable, states, function, input, output, input trajectory, output trajectory

. Set initial pheromone trails value

**While termination conditions not meet do:**

. Construct ant solution

. Apply local search.

. Best tour check

. Update trails

**End while**

### 2.3 Related Work

The A* algorithm (Chabini and Lan 2002), which is widely used in vehicle navigation, is an improved version of the Dijkstras algorithm. It makes use of an appropriate heuristic function to search the most promising nodes first thereby reducing the computation time. To minimize the traveling time the authors need a decentralized routing algorithm which is able to adapt to the dynamic changes that take place in the traffic network. Ant colony optimization was applied to the vehicle routing problems with time-dependent travel times [7]. In (Tatomir and Rothkrantz 2004) a dynamic vehicle routing system was introduced which uses the Ant Based Control algorithm (ABC-algorithm) for car navigation in a city. But the algorithm is proved to be suitable for small networks and showed scalability problems on big networks as the one of the streets of a city.

## III. UVTR ALGORITHM

### 3.1 Concept of the Complexity

The aim of this paper is to develop an ACO-based traffic algorithm. In order to determine the "optimal" routes, a cost has to be assigned to a given route. There are several ways to express travel costs for a route, the travel time, length of the route, the traffic density on the route, flow of the route, emergency etc. or a weighted combination of other sample. In this paper, the authors focus on the travel time as the main component of the travel cost. The method can easily be applied to other cost measures. The traffic network efficiency depends on not only flow but also other factors such as distance, emergency which are based on some criteria.
**Flow:** The flow will be incremented with respect to increasing the number of vehicle per hour.

**Distance:** Flow will decrease when distance increases and vice-versa.

**Emergency:** Vehicles choose route depending on the emergency case following shortest path without considering cost, flow and distance**.**

### 3.2 UVTR based virtual pheromone

The authors developed the notion of a "virtual pheromone" inspired by the chemical markers used by ants and termites for communication and coordination. It is implemented by messages relayed from central traffic control to Sensor with Voice Synthesizer [8]. Virtual pheromones includes following properties: Without specifying a recipient, obviating the need for unique identities that are impractical in large groups Pheromones are locally transmitted. The authors get essential navigational clues from pheromone diffusion gradients. Pheromone evaporates with increasing time, decreasing for error or garbage information [9]. A pictorial representation of ant based traffic control system has been shown below (Fig. 1). Central traffic control (CTC) is bi-directional communication in Sensor with Voice Synthesizer and update road information getting on CTC via traffic signaling element.

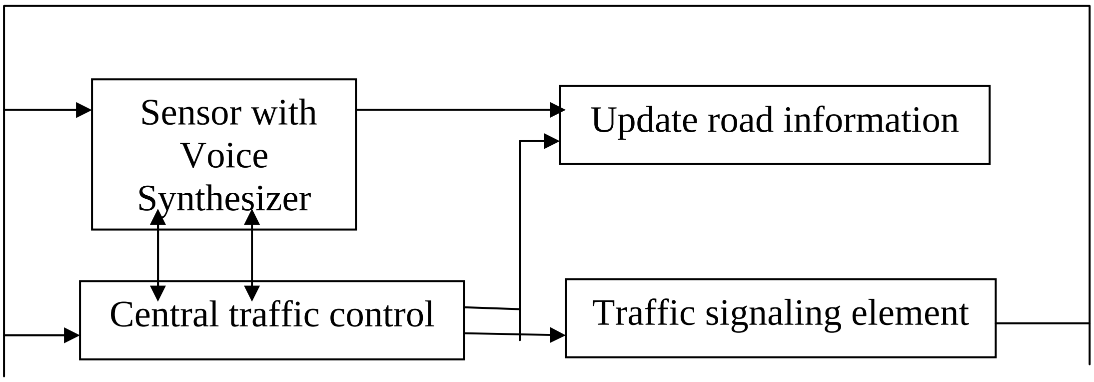


Figure 1: Pictorial representation of ant based traffic control.

### 3.3 Calculating Time Value Cost

The travel time cost **β** is the time it takes to travel a stretch of road r and considering static case is calculated by dividing the distance of the road by the average speed of the vehicles on the road.

$$(\beta) = \mathbf{D} / S_{road} \quad \textbf{(1)}$$

Where **D** is the total length of road *r* and S***road*** is the relation of the fundamental diagram that gives the equilibrium speed S***road.***

### 3.4 Efficient way calculating

Efficient way η is inverse proportional to the distance and flow and the value of η is measured by percentage(%).

$$\eta = \{1/(D * F)\} * 100\% \quad (2)$$

here, η is the efficiency, D is the distance and F is the flow of the road
The maximum value of the efficient way is the best optimum way

$$\eta op = \max \{1/(D * F)\} * 100\% \quad (3)$$

## IV. ACO Based Update Vehicle Traffic Routing

### 4.1 Main UVTR Algorithm

The VRT algorithm consists of two crucial parts i.e. (1) sensing element or Sensor with Voice Synthesizer, (2) central traffic control (CTC). Every car includes Sensor with Voice Synthesizer which is connected to CTC from which update information may be achieved. Each Sensor with Voice Synthesizer can process and store data. A distinct server provides supporting element to its central control.

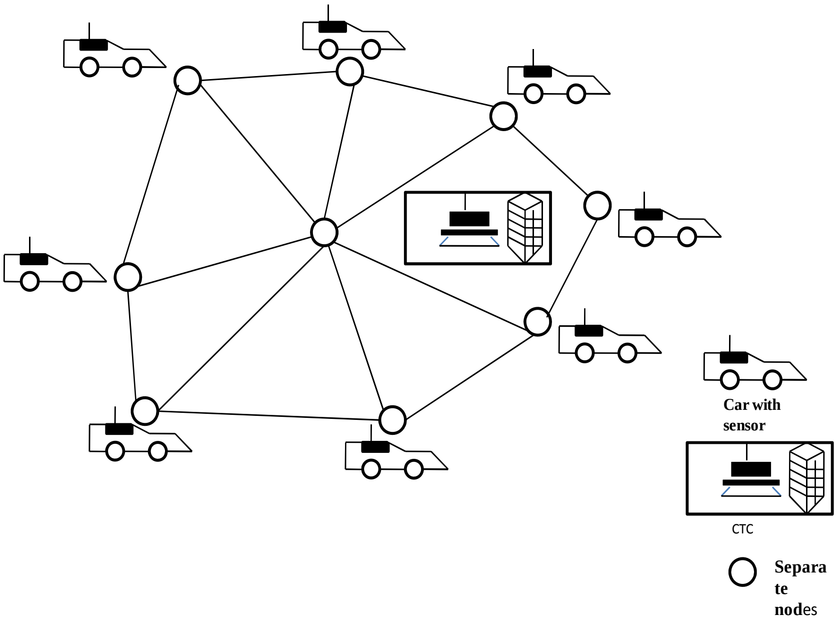


**Figure 2**: Transferring update information CTC to Sensor with Voice Synthesizer.

### 4.2 Algorithm Optimum Route(D, v*r*, **β**, F)

*{D - the distance of route or node}*

*{ti- required time}*

*{vr- speed of vehicles}*

*{β-cost value with respect to distance and speed}*

*{F-flow of vehicles per hours}*

*P ← D (i,j) {d(i , j) - distance between two nodes}*

*q←0*

**while** P>0 **do**

**if** *P*>v*r* **then**

**β**i,j← *P/* v*r(i , j)*

**if β**i, j > *Fi , j* **then**

E i, j={1/( *P* * *Fi , j*)}*100%

*P←0*

**end if**

**end if**

*q ←q+1*

**end while**

### 4.3 Iterative Process of UVTR Algorithm

UVTR works processing steps that is vehicle moves at Sensor with Voice Synthesizer decision. It towards proper way face busy medium then take decision what should done. The original version of ACO only optimizes the path length, but in this problem it is required to optimize at least two parameters of path length and path traffic. The authors used dynamic traffic signaling element which can provides up-to-date signal to communicate Sensor with Voice Synthesizer and CTC. It is iteration process finding optimum solution in each step.

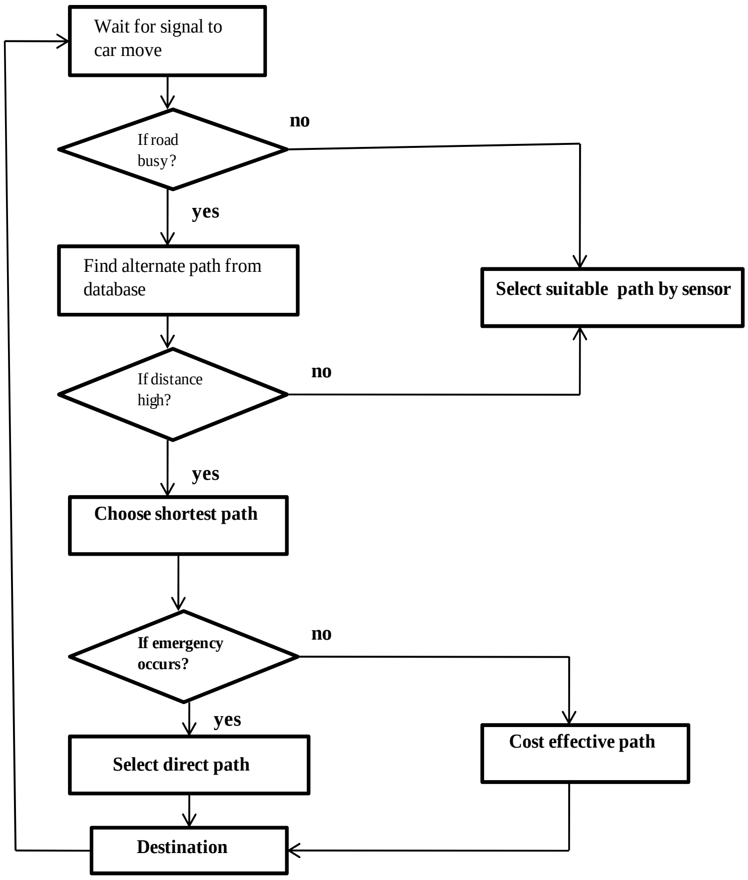


**Figure 3**: Flowchart of traffic flow based on AC

## V. EXPERIMENTAL DATA AND RESULT OF UVTR ALGORITHM

To perform experimental result the authors consider only one city traffic system and road description .The authors now pictorially (shown in Fig: 4) the UVTR algorithm on an experimental data and result involving the Dhaka City. The Dhaka City Traffic Network was selected with respect to its high and low density of highways. The authors built possible 8 nodes of highway intersections. There are several possible ways from each starting node to each destination node. Two specific period the morning period (9:00am-11:00am) and the evening period (6:00pm-9:00pm) the roads become more busy and these situation. The authors solve all traffic problems. The authors used three types of vehicles. One of emergency vehicles which is priority most and up-to date guided using the VTR Algorithm. 50% received traffic update information every 10 minutes in emergency vehicles. Then 35% of the VIP cars received traffic update every 20 minutes like a special traffic information service .Other 25% received traffic update every 15 minutes like the common car navigators are working. In busy hour, the authors update traffic information more or less 5-7 minutes. As a result road traffic will be minimized. In Fig: 4 there are 8 nodes connected in a common gate way which is central traffic control that is placed on Tejgaon other 2 to 8 nodes represent on Mirpur to Mohammadpur. Every two nodes connected in a subway. In our experimental data the authors consider node1 and node 7 that means Tejgaon to Dhanmondi. The shortest possible nodes 1, 6, 4, 8, 5.The shortest path node 1to7 are road 1 but high traffic network. Then possible shortest nodes 1 to 6 to7 road 2 next high traffic and as same as road 5.The driver take short decision by Sensor with Voice Synthesizer which road is preferable for him. It is dependent on road distance, vehicles speed, cost flow and emergency. This decision is different in different types of vehicles because all vehicles are not emergency, VIP, common in types. Other hand in case of incidents such as traffic accidents, it makes sense to choose another alternative route [9].

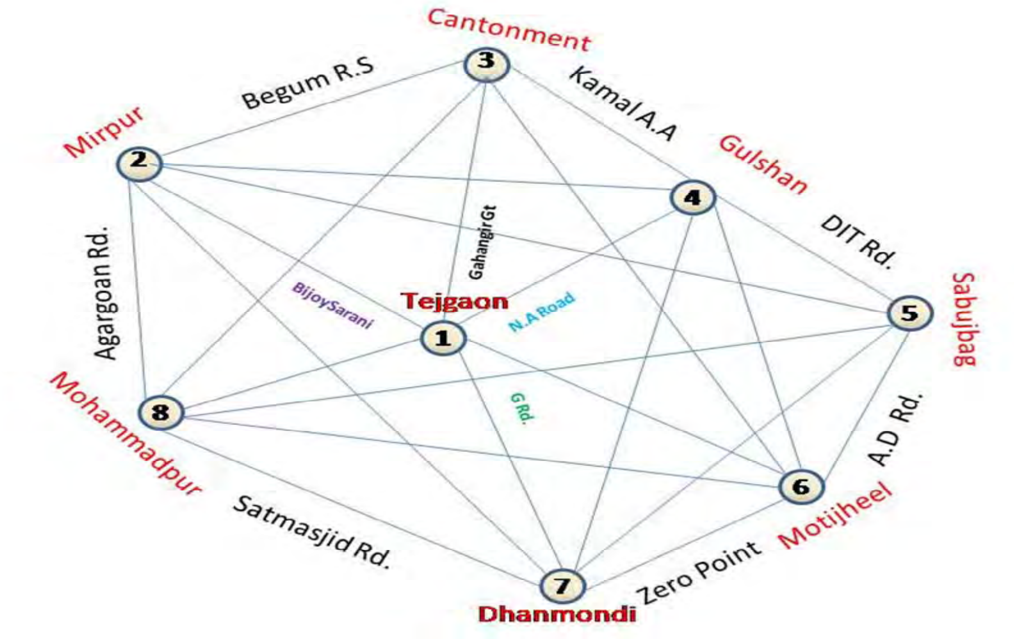


**Figure 4: Identification of location using connected node in Dhaka city**

The results of the guidance using the current traffic updates were somewhere in between. Increasing the frequency of receiving the traffic information from every 10 to 20 minutes, didn't show much difference. It can also be observed that for a while the morning period (9:00am-11:00am) and the evening period (6:00pm-9:00pm) solving techniques. That's why, the alternatives were calculated by using flow, distance, cost, emergency near future of the traffic jam was not considered. The authors previously discussed in detail about the node to node network. The shortest or optimum path **"road1"**according to its efficient way value which are affected to distance and flow. So, **"road1"**1 is optimum and other roads may be considered as vehicles traffic routing method in basis of cost, distance, flow, emergency function.

**TABLE I**: Dynamic database for central traffic control system in two example area

| Source | Destination | Possible way | Distance ( D km ) | speed ( dens-ity Vr | Cost value ( β)=D/ Vr | Flow (F) Veh/h | Efficient way E={1/( D *F)} *100% | Optimum route |
|---|---|---|---|---|---|---|---|---|
| Dhan-mondi | Tejgoan | Road 1 | 12 | 55 | .218 | 80 | .104 | **" Road 1"** |
| | | Road 2 | 0 6 | 45 | .133 | 150 | .111 | |
| | | Road 3 | 04 | 40 | .10 0 | 180 | .139 | |
| | | Road 4 | 09 | 50 | .180 | 90 | .123 | |
| | | Road 5 | 15 | 60 | .250 | 50 | .133 | |

## VI. CONCLUSION

The authors have considered a perfect ant-based vehicles traffic routing algorithm to solve the traffic problem. In this paper, the authors have also discussed the techniques of choosing road in busy hour getting up-to-date update traffic information in particular vehicles. This model-based VTR algorithm was designed to solve the traffic network problem. The authors also introduce four factor effecting function cost, distance, flow, emergency which are value added parameter to reduce traffic shortest path. The algorithm shows experimental result in vehicles traffic network (VTN) involving the Dhaka City.

## REFERENCES

[1] J. Dong and J. Wu, "Urban traffic networks equilibrium status recognition with neural network," *Proceedings Intelligent Transportation Systems, 2003 IEEE*, vol. 2, pp. 1049–1053 vol.2, Oct. 2003.

[2] F. H. Knight, "Some fallacies in the interpretation of social cost," *The Quarterly Journal of Economics*, vol. 38, pp. 582–606, 1924.

[3] J. G. Wardrop, "Some theoretical aspects of road traffic research," *Proceedings, Institute of Civil Engineers, Part II*, vol. 1, pp. 325–378, 1952.

[4] Ichoua, S., M. Gendreau, and J. Potvin. 2003. Vehicle dispatching with time-dependent travel times. European Journal of Operational Research (144): 379–396.

[5] M. Middendorf, F. Reischle and H. Schmeck (2002) Multi colony ant algorithms.*Journal of Heuristics,* (in press). *Journal of Heuristics,* (in press).

[6] M. Dorigo, Online website. Available: www.aco-metaheuristic.org.

[7] [Di Caro, G., F. Ducatelle, and L. M. Gambardella. 2005. Anthocnet: An adaptive nature-inspired algorithm for routing in mobile ad hoc networks. European Transactions on Telecommunications, Special Issue on Self-organization in Mobile Networking 16 (5).

[8] Gianni Di Caro, "Ant Colony Optimization and its Application to Adaptive Routing in Telecommunication."

[9] Tatomir, B., and L. Rothkrantz. 2004. Dynamic traffic routing using ant based control. International Conference on Systems, Man and Cybernetics IEEE SMC: 3970–3975.