International Journal For Technological Research In Engineering
Volume 3, Issue 8, April-2016 ISSN (Online): 2347 - 4718

DYNAMIC PROGRAMMING APPROACH FOR TRAFFIC INTERSECTION TIMING OPTIMIZATION

Ms. Nivya K Suresh
PG Student, ME-Embedded System Technologies
Sun College of Engineering and Technology, Sun Nagar, Nagercoil, Tamil Nadu, India

Abstract: Increase of population in cities often makes the traffic problems more serious. Finding an optimal solution for traffic signal control duration is an intensive task. A classical traffic control problem is finding the optimal traffic phase duration for an intersection. A classical algorithm for handling this problem is Controlled Optimization of an Intersection algorithm. The existing algorithm achieves a time complexity of O(T2) and space complexity of O(T3) where T is the time interval. A novel algorithm is proposed that tackles the same problem while reducing the time and space complexities into O(T).The algorithm uses an efficient dynamic programming formulation of the traffic problem. The formulation exploits a phase rather than the time interval. The outcome of this paper is to reduce the cost function i.e. the waiting time of the vehicle, using an optimized timing plan. The model is developed using dynamic algorithm and it is simulated in MATLAB.

Index Terms: Dynamic programming, traffic signal, Optimization, Phase transition, Traffic control

I. INTRODUCTION

In modem life we have to confront with many problems one of which is traffic congestion. When vehicles are fully stopped for a period of time, this is colloquially known as traffic jam. The high volume of vehicles, the inadequate infrastructure and the irrational infrastructure are main reasons for increasing traffic jam. Some congestion can be caused when the interaction between vehicles slows the speed of the traffic flow. The slower speeds, longer trip times and increased vehicular queuing will characterize the traffic congestion. The accumulation of vehicles is a severe problem at an intersection in urban areas causing many critical problems. The congestion of vehicle is also a challenge in major and most populated cities around the world. Really, signal timing is the technique to appropriately decide the signal cycle and effective green time, with respect to various intersections, phases, traffic flows and others. The conventional signal timing model uses fixed cycle and fixed split algorithm which is less efficiencies and it cause congestion problem. Therefore, to improve the service function of road, the design of real-time signal timing model is important. The proposed model of signal timing is constructed with respect to minimization of vehicle average waiting time and number of stops at an intersection.

II. RELATED WORKS

The strategies used to solve the traffic control problem efficiently are different. Authors in [1] review these strategies. These include neural networks [2], multiagent systems [3], petri nets [4], genetic algorithm [5] and fuzzy control [6]. The strategies can be distinguished by the number of considered traffic intersections, and how they model the traffic demand and response [7]. The traffic demand can be statically determined using off-line demands, and it is used to create fixed-time traffic-control response strategies. The demand can be dynamically determined using real-time measurements to generate adaptive traffic response strategies.

III. PROPOSED ALGORITHM

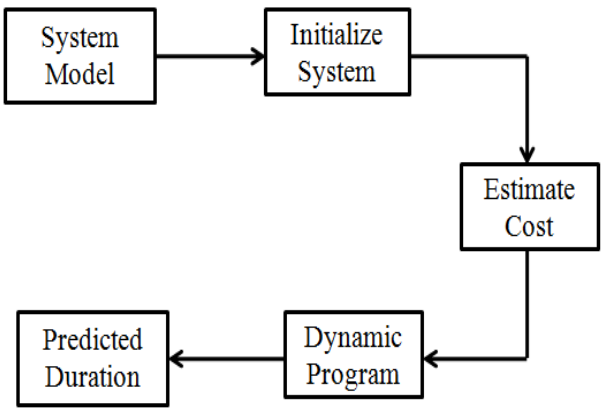

Fig. 1. Building blocks of dynamic programming formulation

The fig 1 illustrates an efficient dynamic programming formulation and the blocks are explained as follows
System Model: A road intersection can be considered a limited resource. One of the traffic control problem at the intersection is assigning time for each traffic-flow direction to optimize a performance metric and maintaining a safe passage of vehicles over a time horizon T. The Fig 2 shows an example for a traffic intersection. The intersection is composed of two crossing roads having eight possible directions, reckoned from 1 to 8. The phases are the combinations of non conflicting directions. For instance, directions 2 and 6 construct a phase, that gives safe passage to the vehicles simultaneously without breaking safety. The directions 2 and 6 are phase A, directions 1 and 5 are phase B, directions 3 and 7 are phase C, directions 4 and 8 are phase D Generally, the set of all possible phases are referred a P and number of phases as |P|.

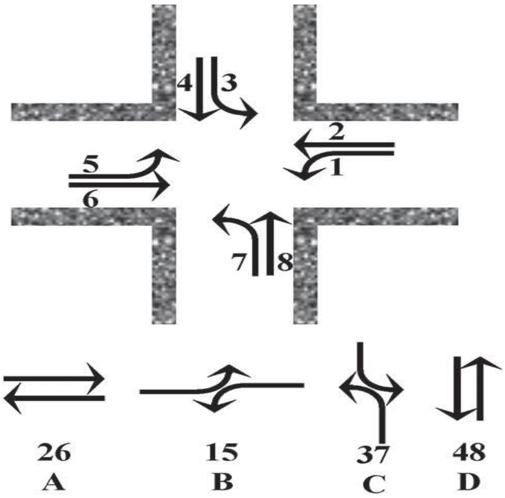

Fig. 2. Phases at a traffic single intersection

Initialize System: A solution for the traffic control problem is a sequence of phases with a time duration assigned to each phase. It will maximize certain performance parameter by assigning a minimum duration, γ, for each phase. This series is called the signal time plan.

Table 1 Example of a traffic signal time plan

Phases	A	B	C	D	B	D
Duration	3	5	4	6	3	5

Table 1 shows one example of a traffic signal time plan after assigning symbols to each phase. Additionally, after the change of each phase, a clearance interval r will be assigned so that it gives a safe passage chance to the vehicles already crossing the intersection itself.

Estimate Cost: V (Ω) be the cost function of timing plan Ω. The optimization can be stated as MinimizeV (Ω). The timing plan Ω is calculated that gives the minimum cost function V( ). Computing cost function requires scanning all phases.

Dynamic Program: The dynamic programming (pi, ti) formulation is used to find an optimal timing plan Ω. Dynamic programming proceeds in serial stages corresponding to successive values of time t. Thus, at stage t, we compute V (p, t) for all possible phases p. The S( )values for the direct previous stage only considered and neglect the other stages due to the inherent serial nature of the dynamic programming formulation. Therefore, only need the O (|P|2) space to keep the values of S( ). The dynamic programming thus requires visiting every phase at each time unit, computing the associated cost, and storing the minimum cost.

Predicted Duration: In the heavy traffic load, the average junction waiting time of the algorithm is better. Typical optimization metrics include the total number of stops, the waiting time, and queue lengths.

IV. RESULTS

The queue length, arrival rate, flow rate are calculated for phase A, phase B, phase C and phase D which is represented by blue, green, red and turquoise blue respectively. The Fig 3 shows the queue length and it is defined as the number of vehicles stopped in the lane behind the stop line. The Fig 4 shows the arrival rate and it is the number of arrivals per unit time. The flow rate is the number of vehicles passing on the roadway during a specified time period. The Fig 5 shows the cost function of each phases and it is determined with the values of queue length, arrival rate and the flow rate. The fig 6 shows the best timing plan in which the cost function of each phase will be iterated to find the minimum cost.

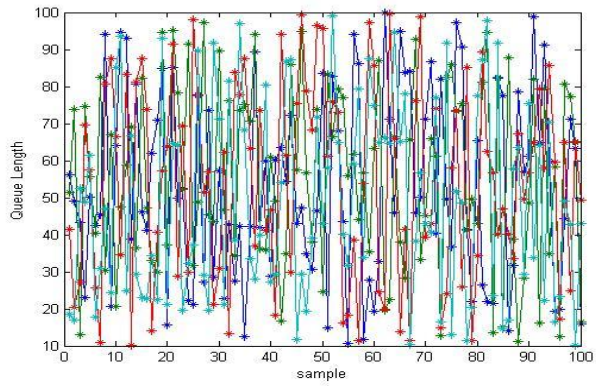

Fig. 3. Queue Length

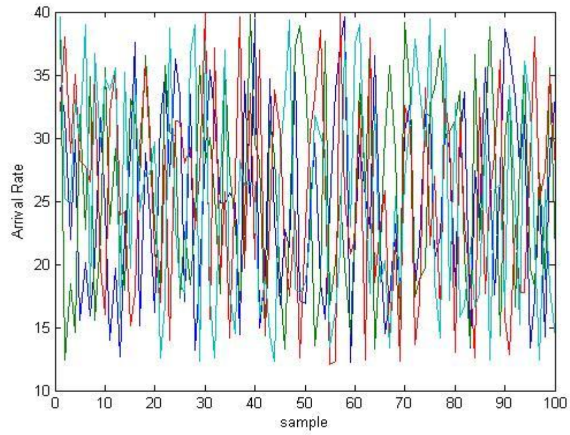

Fig. 4. Arrival Rate

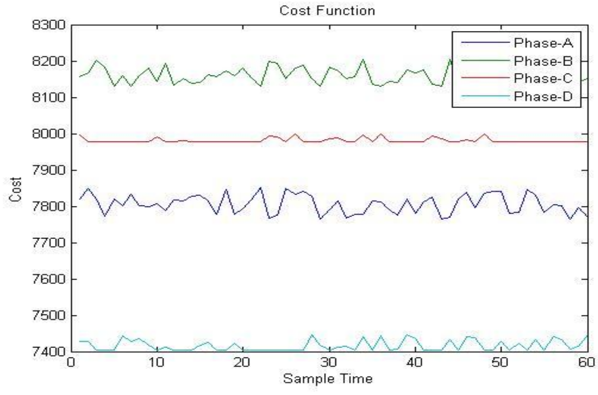

Fig. 5. Cost Function

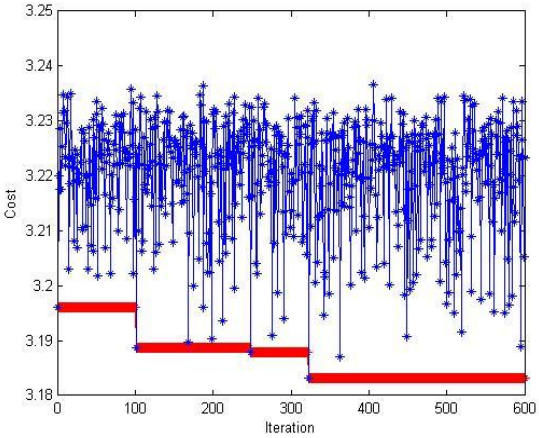

Fig. 6. Best Timing Plan

V. CONCLUSION

This paper presents a dynamic programming algorithm to find an optimal phase duration sequence for the traffic signal control problem at an intersection. The algorithm improves time and space complexities by not abiding with a strict (cyclic) phase order and by exploring the solution space in a time-oriented fashion, pruning many non optimal states early on.

REFERENCES

[1] R. Asthana, N. J. Ahuja, M. Darbari, and P. K. Shukla, “A critical review on the development of urban traffic models and control systems” Int. J. Sci. Eng. Res., vol. 3, no. 1, pp. 1–6, Jan. 2012.

[2] M. Saito and J. Fan, “Artificial neural network-based heuristic optimal traffic signal timing” Comput.-Aided Civil Infrastruct. Eng., vol. 15, no. 4, pp. 293–307, Jul. 2000.

[3] B. Chen and H. Cheng, “A review of the applications of agent technology in traffic and transportation systems” IEEE Trans. Intell. Transp. Syst., vol. 11, no. 2, pp. 485–497, Jun. 2010.

[4] Y. Huang and T. Chung, “Modeling and analysis of urban traffic lights control systems using timed CP-nets” J. Inf. Sci. Eng., vol. 24, no. 3, pp. 875–890, May 2008.

[5] H. Ceylan and M. G. Bell, “Traffic signal timing optimisation based on genetic algorithm approach, including drivers’ routing” Transp. Res. Part B, Methodological, vol. 38, no. 4, pp. 329–342, May 2004.

[6] M. Trabia, M. Kaseko, and M. Ande, “A two-stage fuzzy logic controller for traffic signals” Transp. Res. Part C, Emerging Technol., vol. 7, no. 6, pp. 353–367, Dec. 1999.

[7] M. Papageorgiou, C. Diakaki, V. Dinopoulou, A. Kotsialos, and Y. Wang, “Review of road traffic control strategies” Proc. IEEE, vol. 91, no. 12, pp. 2043–2067, Dec. 2003.

