ISSN 2278-3091
Volume 9, No.1, January – February 2020
International Journal of Advanced Trends in Computer Science and Engineering
Available Online at http://www.warse.org/IJATCSE/static/pdf/file/ijatcse81912020.pdf
https://doi.org/10.30534/ijatcse/2020/81912020

Traffic Light Control at Crossroad using Graph theory with Matlab

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ABSTRACT

Traffic light problem can be effectively solved by graph theory. In the present paper we have consider the cross road and did modelling of traffic flows in particular graph. The vertices are connected if they can be moving at the same time without dangerous consequences. Created the mathematical model affected by volume of the traffic flows and weight of traffic flows in the form of total time flows function by establishing required conditions, such as minimizing running time of each flow. The solution of this model is in the form of maximum total running time and is not unique because of volume and weight of traffic flow. We use MATLAB to solve the LPP.

Key words: Graph Theory, Traffic Control Problem, LPP, MATLAB.

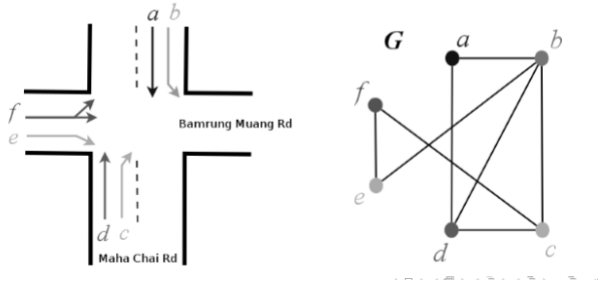
1. INTRODUCTION

Due to huge population and urbanization of small towns and cities, the increase in the number of vehicles led to the increase in time losses of traffic participants, the increase of environmental and noise pollution leads to the increasing number of traffic accidents. The major obstacle for the development of many urban areas is the traffic congestion which is also affecting millions of people. The construction of new roads may improve the situation, but it is very costly and, in many cases, it is impossible due to the existing structures. Instead of constructing the new roads, the other way to control the traffic flow in such a situation is to use the current road network in an efficient way. A methodology of handling city traffic in a very efficient way by proper traffic management instead of modifying the road infrastructure was studied by Dinas *et.al*. [2]. This paper presents the applications of vertex connectivity and edge connectivity in traffic control problems at an intersection so as to minimize the waiting time of the traffic participants Budayasa, I. K *et.al*. [1] .

Traffic management is important in order to avoid collisions, consequently we need a system to regulate the flow of traffic. One of the systems that regulate the flow of traffic is traffic lights. As the city equipment, traffic lights play the most important role on the impact of traffic. If the traffic arrangements are not optimal, then it will not only affect traffic order, but also lead to an accident. The traffic lights are lights that control the flow of traffic and attach at a crossroads, pedestrian crossings (zebra crossing), and another traffic flow places. These lights indicate when the vehicles have to continue or stop driving alternately from different directions. The setting of traffic lights at the crossroads is intended as vehicle's movement regulation in each group of movements, so that vehicles will not interfere the existing flow. However, in reality shows that there are more solid volume in the specific crossroads rather than congested crossroads. This situation happens because the traffic control system is less effective and efficient Varun Chand [4] . To represent whether or not the flow of traffic be effective, we can view from its direction. If there are two different directions that can move jointly and efficiently, i.e. with total time flows (when light is green) are maximum, then it can be transformed into one of the branches of mathematics: graph theory. In this graph, the dots show the objects that will be set, and the sides indicate the compatible object. Particular traffic flows can be called compatible if two flows will not result in an accident caused by vehicles moving on multiple flows simultaneously (Hosseini & Orooji, 2009)[3]. By using compatible graph Wang, Qiang et.al.[5] , optimal waiting time at the crossroads can be determined. In this article, the authors make the traffic control systems work effectively and efficiently according to traffic rules. The system is not synchronized with other traffic controller, but with cascading vehicle volume data from the main or other direction. Although there are changes in the volume of arrival vehicles from various directions, with this system, the expected duration of the maximum flow of vehicles can be made especially for the main direction, in this case the author mentions optimal. The application of graph theory in Traffic are flow and shortest path Ahmad Tayyar [6].

Definition 1.1: Two traffic streams are **compatible** with each other if they can be moving at the same time without dangerous consequences.

Example 1.2:



1.3 Characteristics of Traffic Flow

The characteristics of traffic flow are necessary to learn in order to analyze traffic flow Aaron Don M. Africa [7]. To be able to represent the traffic characteristics, there are three (3) main parameters that should be known where those parameters are mathematically interconnected, with each other. Those are as follows:

1. Volume of traffic flows is the number of vehicles that pass a certain point in a certain roads within a certain time unit, usually expressed in passenger car units per hour for short (smp / hour) .
2. Density of traffic flows is the number of vehicles that are within a certain unit of road length usually expressed in units of vehicles per km or abbreviated to (veh / km).
3. Density of traffic flows is a distance which can be reached within a certain time unit, usually expressed in units (km / hour)

Characteristics of traffic flow that will be used in this article is the volume.

2. RESULT

Theorem 2.1: Graph model and optimal solution of traffic light flow at cross road (Pari chowk , Greater Noida).

Proof: We have considered the very congested area Pari chowk in Greater Noida, the satellite graph is as under in *Figure 1*.

Figure 1: Satellite Map of Pari Chowk

Graph Model of The Traffic Problem at Pari-chowk is shown in *Figure 2*.

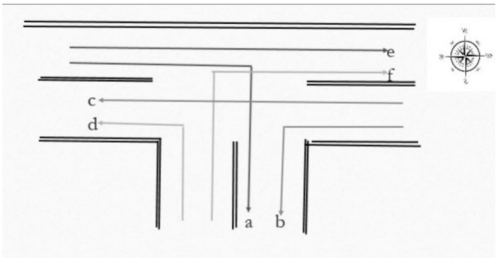


Figure 2: Traffic model of Pari Chowk

Compatibility

We already know that a graph is compatible in traffic when two routes will not cause a traffic jam or vehicles will not crush. So, here are the routes that will flow on the same time and will not cause any accidents.

- a is compatible with b, d, e
- b is compatible with a, c, d, e, f
- c is compatible with b, d, e
- d is compatible with a, b, c, e, f
- e is compatible with a, b, c, d, f
- f is compatible with e, b, d

According to Graph Theory the graphical representation of Compatibility is as shown in Figure 3:

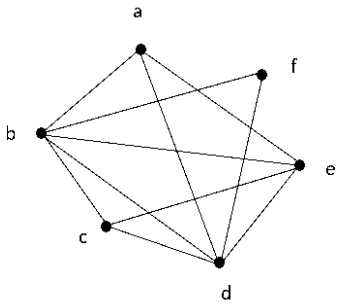


Figure 3: Graphical Representation of Compatibility

The cliques are $K_1 = \{a, b, d, e\}$
$K_2 = \{c, e, d, b\}$
$K_3 = \{b, d, f, e\}$
$K_4 = \{a, b, d, e\}$, Here $K_1 = K_4$

Assign a duration to each phase

$K_1 = \{a, b, d, e\} \rightarrow d_1$
$K_2 = \{c, e, b, d\} \rightarrow d_2$
$K_3 = \{b, d, f, e\} \rightarrow d_3$

The total red light time for all traffic streams

$$(d_2+d_3) + 0 + (d_1+d_3) + 0 + 0 + (d_1+d_2) = 2d_1+2d_2+2d_3$$

The minimum green light time for a stream = 20 seconds.
The total cycle = 120 seconds

$$Min \quad 2d1 + 2d2 + 2d3, d_i \geq 0$$

$$d_2 + d_3 \geq 20$$

$$d_1 + d_3 \geq 20$$

$$d_1 + d_2 \geq 20$$

Using Following Matlab File used for Solving the Equations:

```
f=input('Please enter the value of objective function');
A=input('Please enter the value of coefficient matrix');
b=input('Please enter the value of constant matrix');
% f should be in minimization condition and all inequalities are less
than
% equal to.
d=linprog(f,A,b);
disp('Time duration for closing the red light in sec.')
disp(d)
```

And the output we got 10 sec for closing the red light. Which is very Optimal Solution for the Concern Traffic Model.

3.CONCLUSION

In the present paper we have used graph theory in the most recent problem Traffic Flow , this very difficult problem for urban and developing city our problem will be the working model for any of the congested Red light. Lots of research is

possible in this field. Even the programming can be done using procedure.

ACKNOWLEDGEMENT

Author and co Author would like to thank guide Prof. S.K. Vaidya for his guidance.

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