Optimization of Road Width

Mohd Vaseem , Shaksi Jain, Ankit Saini
Quantum Global Campus Roorkee
qv1990@gmail.com, sakshijain333@gmail.com, hbti.ankit11@gmail.com

ABSTRACT
This paper presents an attempt to optimize the highway road width at the locations where there is problem of traffic jam and rush. As we know that the highway width is made uniform all along the way, but there occurs the problem of traffic jam at the crowded areas and junction points, so in this project first the simulation is done in MATLAB and then the problem is formulated as an optimization problem. The results of simulation are used in optimization. Finally the problem is solved in Genetic Algorithm using as an optimization tool. In this project a national highway (NH 73) is taken to optimize road width and the results are obtained. This project can be applied on any national highway.
Keywords: GA (Genetic algorithms), optimization, Simulation

1. INTRODUCTION

Optimization is the process by which we can obtain the best result under the given circumstances. In design, construction, maintenance, decisions are taken either to minimize effort or maximize benefit, and these efforts or benefit are usually expressed as a function of certain design variables. Hence, optimization is the process of finding the conditions that give the maximum or the minimum value of a function. An optimization problem consists of three factors: An objective function, set of variables and number of constraints. On the basis of these factors optimization problem can be defined as finding values of the variables that minimize or maximize the objective function while satisfying the constraints.

2. LITERATRE RIVEW

According to "Promothes Saha"[1] Traffic Safety Management System (TSMS) is a strategic and systematic process to improve safety of roadway network. The factors included in the proposed optimization model are annual safety budget, roadway inventory, roadway functional classification, historical crashes, safety improvement counter measures, cost and crash reduction factors (CRFs) associated with safety improvement counter measures, and average daily traffics (ADTs).According to "Mark Koryagin"[2]the municipal authorities have to optimize road width and public transport frequency. The car travel time depends on the number of road lanes and passengers choice of travel mode. The conflict between municipal authorities and the passengers is described as a game theoretical model. The existence of Nash equilibrium in the model is proved.According to Mark Koryagin[3] **,** consideration was given to the problem of making decisions on public transport management. Three parties making decisions were marked out: passenger flow, transport operator and municipal authorities. Passengers choose between public and private transport evaluating the value of time. The value of time is modeled by uniform distribution.According to Ashfaq H. Farooqi[4] the optimization of the road model is done by properly allocating the time to traffic signals. They have proposed different simulation models and used various approaches to optimize the traffic light signals. In this paper they have provided information about the traffic light simulator that is implemented using Visual Studio 2008. They have also illustrated the genetic algorithm (GA) approach that has been used to optimize the traffic light signals using the simulator. The manual provided by K.Dixon[5], aid in implementing the AASTHO (American Association of State Highway and Transportation Officials) highway safety manual. It is a science based safety assessment approach that can be used to help transportation professional identity as how to best enhance safety for their managed facilities. According toKenneth John Button[6], the evolution of micro economic models for the analysis of public transport services with parametric demand is developed , leading towards a more comprehensive one. The treatment emphasizes both on the treatment of variables and the form of the results mostly in terms of frequency and fleet size. According to Steven Chien[7] ,The problem of determining an optimal feeder bus route, feeding a major inter modal transfer station (or a central business district), in a service area is considered. Subject to geographic, capacity, and budget constraints, a total cost function, consisting of user and supplier costs, is developed for determining the optimal bus route location and its headway considering intersection delays, irregular grid street patterns, heterogeneous demand distributions, and realistically geographic variations.

3. PROBLEM FORMULATION

In this research survey on the National highway (NH 73) (Deheradun-Roorkee) is performed. Data is taken at various locations and optimization simulation is performed.

Table no. 4.1: Results obtained from the optimization

Optimal Road Width	Width in (meter)	Recommended width (m)
At Biharigarh	3.49	3.5
Biharigarh to Chutmalpur	2.99	3
At Chutmalpur	3.48	3.5
Chutmalpur to Bhagwanpur	3	3
At Bhagwanpur	3.49	3.5
Bhagwanpur to Roorkee	3	3

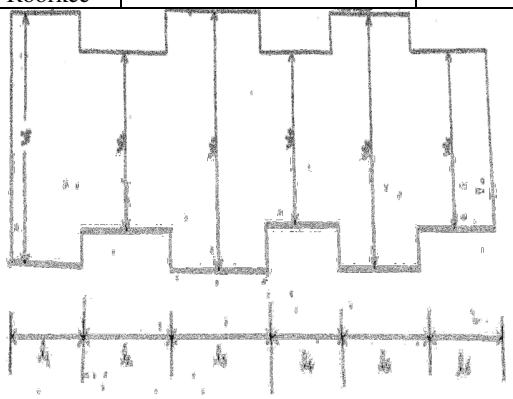

Figure 3.1: optimized model of road

i) An objective function

Minimize Road area = $\{w_1l_1 + w_2l_2 + w_3l_3 + w_4l_4 + w_5l_5 + w_6l_6\}$

$w_1, w_2, w_3, w_4, w_5, w_6$= width of the road (to be optimized)

$l_1, l_2, l_3, l_4, l_5, l_6$ = length at various locations (already known)

ii) A set of unknowns or Variables

Width at various locations $\{w_1, w_2, w_3, w_4, w_5\}$

iii) A set of constraints

TIME :

$$\frac{l_1}{v_1} \times \frac{w_1'}{w_1} \leq t_1$$

$$\frac{l_2}{v_2} \times \frac{w_2'}{w_2} \leq t_2$$

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$$\frac{l_6}{v_6} \times \frac{w_6'}{w_6} \leq t_6$$

Where,

$w_1', w_2', w_3', \ldots\ldots\ldots\ldots w_n'$ = simulated width

$w_1, w_2, w_3, \ldots\ldots\ldots\ldots\ldots w_n$ = optimized width

$l_1, l_2, l_3, \ldots\ldots\ldots\ldots\ldots\ldots\ldots l_n$ = lengths at various locations

Table no. 3.1: Value of time, velocity, length and simulated width at different locations

S. No	Road Route	Time(min)	Length (km)	Velocity(m/s	Simulated width(m)
1.	At Biharigarh	05	01	20	03
2.	Biharigarh to chutmalpur	15	10	45	2.5
3.	At Chutmalpur	05	01	20	3.4
4.	Chutmalpur to bhagwanpur	15	12	45	2.5
5.	At bhagwanpur	05	01	20	3.7
6.	Bhagwanpur to roorkee	20	13	45	3

4 METHODOLOGY SURVEY AND OPTIMIZATION

In this paper, the survey is done on national highway for the simulated width and the result of the survey is used in optimization as given below. Genetic algorithms are used as an optimizing tool for the optimization. Genetic algorithm (GAs) is the optimization technique and the heuristic search that mimic the process of natural evolution. Genetic algorithm (GAs) is inspired by the Darwin's theory about evolution- "the survival of the fittest".

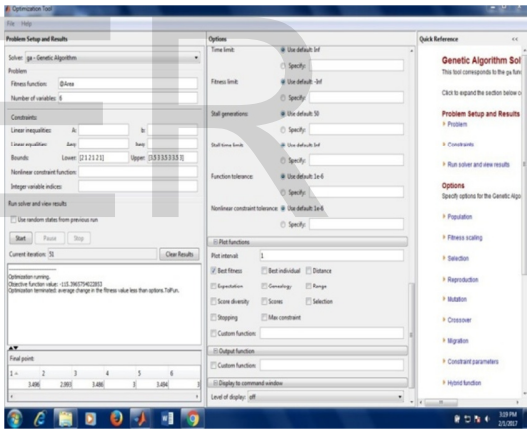

Figure no. 3.2: Results in GA window

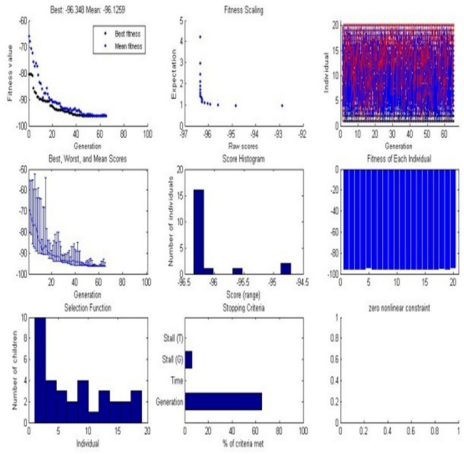

Figure no. 3.3: Objective function graphs

5 RESULTS AND DISCUSSION

The optimization is done in MATLAB using the tool Genetic Algorithm

6 CONCLUSION

Various social and economic changes in the developing countries lead to the transportation problem which create traffic problems on the highways. At present the highways road width is made uniform all along the way but it creates problem of road blockage at crowded areas. So in order to avoid this problem a model of road width is proposed which can decrease the traffic blockage at these areas. In this model the width of the road at crowded areas are optimized by using Genetic Algorithms in MATLAB. Data is taken at different locations on the Deheradun – Roorkee (NH 73) highway from Biharigarh to Roorkee and the width at different locations are optimized. This model of road width can also be applied on other highways of other states. Applications of the proposed model: i) National Highway Design ii) NHDP (National highway development programed)

REFERENCES

[1]Saha, P., & Ksaibati, K. (2016). "An Optimization Model for Improving Highway Safety". *Journal of Traffic and Transportation Engineering (English Edition)*.

[2]E Koryagin, M. (2015). "An Agent-Based Model for Optimization of Road Width and Public Transport Frequency". *PROMET-Traffic &Transportation*, *27*(2), 147-153

[3]Koryagin, M. (2014). "Game Theory Approach to Optimizing of Public Transport Traffic under Conditions of Travel Mode Choice by Passengers". *Transport Problems*, *9*(3), 117-124.

[4]Ezzat, A. A., Farouk, H. A., El-Kilany, K. S., & Abdelmoneim, A. F. (2014, January). "Development of a Stochastic Genetic Algorithm for Traffic Signal Timings Optimization". *IIE Annual Conference. Proceedings* (p. 1740). Institute of Industrial Engineers-Publisher.

[5]Dixon, K. (2012). "*Highway Safety Manual Training Materials"*. Transportation Research Board.(Vol. 715).

[6]Jara-Díaz, S., & Gschwender, A."Towards a General Microeconomic Model for the Operation of Public Transport". *Transport Reviews*,(2003). *23*(4), 453-469.

[7]Chien, S., Yang, Z., & Hou, E. (2001). Genetic Algorithm Approach for Transit Route Planning and Design", *Journal of Transportation Engineering*, *127*(3), 200-207.

[8]Holland, J. H., & Goldberg, D. (1989),"Genetic Algorithms in Search, Optimization and Machine Learning". *Ed: Addison-Wesley, Reading, MA*.