



Application of genetic programming clustering in defining LOS criteria of urban street in Indian context



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ABSTRACT

India is a highly populated country having second largest road network in the world. Owing to boastfully population, the congestion is growing rapidly on the urban road networks. The level of service (LOS) is not substantially defined for heterogeneous traffic flow with different operational characteristics. Defining LOS is essentially a classification problem. The application of cluster analysis is the worthiest proficiency to solve such problem for which genetic programming (GP) clustering, an evolutionary algorithm is used in this study. Five cluster validation parameters are utilized to examine the optimal number of clusters. The cluster validation parameters are used to obtain the number of categories of urban street classes. After acquiring optimal number of clusters, GP clustering is implemented to the free flow speed (FFS) data to get ranges of different urban street classes. Again, GP clustering is enforced on average travel speeds of street segments to specify the ranges of different LOS categories. Speed data used in this study are collected using Trimble GeoXT GPS receivers fitted on mid-sized vehicles for five major urban corridors comprising of 100 street segments of Greater Mumbai region. Result shows that FFS of urban street classes and average travel speed of LOS categories are lower than that mentioned in Highway Capacity Manual (HCM 2000) on account of physical and surrounding environmental characteristics. Also, average travel speed of LOS categories expressed in terms percentage of FFS of urban street classes found to be different from that mentioned in HCM 2010.

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1. Introduction

An urban area are those locations where there is an opportunity for a diversified living environment, diverse lifestyle, people live, work, enjoy themselves in social and cultural relationships provided by these proximities of an urban area. After independence, India's growth was based to assist the urban area by introducing the industrialization and urban infrastructure. Urban agglomeration in India is the set of large urban clusters where the built up zones of influence the distinct cities or towns are connected by a continuous built-up developments. The level of service (LOS) analysis of urban roads in India is not decently defined for majorly heterogeneous traffic flow. Subsequently India is a populated country, therefore heterogeneous traffic flow occurs on urban roads. The LOS defined for urban roads in India by HCM 2000, which is most suitable for homogeneous traffic flow. In reality, homogeneous traffic flow is outlined as a region of high density and low average velocity of cars. In India, heterogeneous

traffic flow occurs with different operational characteristics. The researchers have given many approaches about the conventional analysis that defines roadway expansion as a transport system improvement. But none of them defined clearly about the LOS criteria of urban roads in Indian context. Thus an endeavor has been made to specify the level of service (LOS) criteria for India in this study.

The speed data were accumulated by Trimble Geo XT receiver, where the Global Positioning System (GPS) receiver mounted on a vehicle and automatically records location of urban corridors and speed at regular sampling interval. The development of information technology and advancement of GPS has largely overcome the data quality and quantity shortcomings of the manual and Distance Measuring Instrument (DMI) methods of accumulating travel time data become one of the alternatives to the moving car observer method for the field data collection. DMI measures the speed distance using pulses from a sensor attached to the test vehicle's transmission. This method also has some limitations like very complicated wiring is required to install a DMI unit to a vehicle. Frequent calibration and verification factors unrelated to the unit are necessary to store making the data file large and which leads to a data storage problem. The automated procedure provides

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convenience, consistency, finer precision and accuracy than the conventional procedure.

Reviews of literature suggest that cluster analysis is the suitable technique applied to the classification of the large amount of speed data collected using a GPS receiver. Genetic programming clustering is an evolutionary algorithm based methodology is employed for clustering purpose in the study. The optimal numbers of clusters were found out by applying five validation parameters on FFS data. The optimal number of clusters helps in deciding the classification of urban streets into a suitable number of classes. Once the numbers of street classes is finalized, GP clustering is used on FFS to find FFS ranges of urban street classes. Thereafter average travel speed in street segments are used by GP Clustering to find the speed ranges of six LOS categories. The methodology applied in developed country like India in which the LOS categories for different urban street classes are similar to HCM 2000 values for comparison. The coherence of the clustering result of compartmentalization of urban streets and LOS categories were assured by checking the geometric and surrounding environment features of street segments. The overall model of this study is as shown in the Fig. 1.

2. Literature review

The concept of “practical capacity” presented in the 1950 HCM (TRB, 1950) HCM (1950) gave rise to the conception of LOS. In the dynamicity of time the conception has been altered and made more practical in the 1965 HCM (TRB, 1965) HCM (1965) and 1985 HCM (TRB, 1985) HCM (1985). The current definition of LOS being accompanied is that defined in 2000 HCM (TRB, 2000). Level of service in the Highway Capacity Manual (HCM, 2000) defined as “a quality measure describing operational conditions within a traffic stream, generally in terms of service measures such as speed and travel time, freedom to maneuver, traffic interruptions, comfort and convenience”. The current HCM methodologies is ensued from a combination of consulting studies, research and the discussions of Highway Capacity and Quality of Service committee (Pecheux et al., 2000). The HCM 2000 also designates six levels of service for each type of facility, from “A” to “F,” with LOS “A” representing the best operating conditions and LOS “F” the worst.

In the latest years, various methods have been proposed for defining and developing the LOS. The HCM 2010 has been signifi-

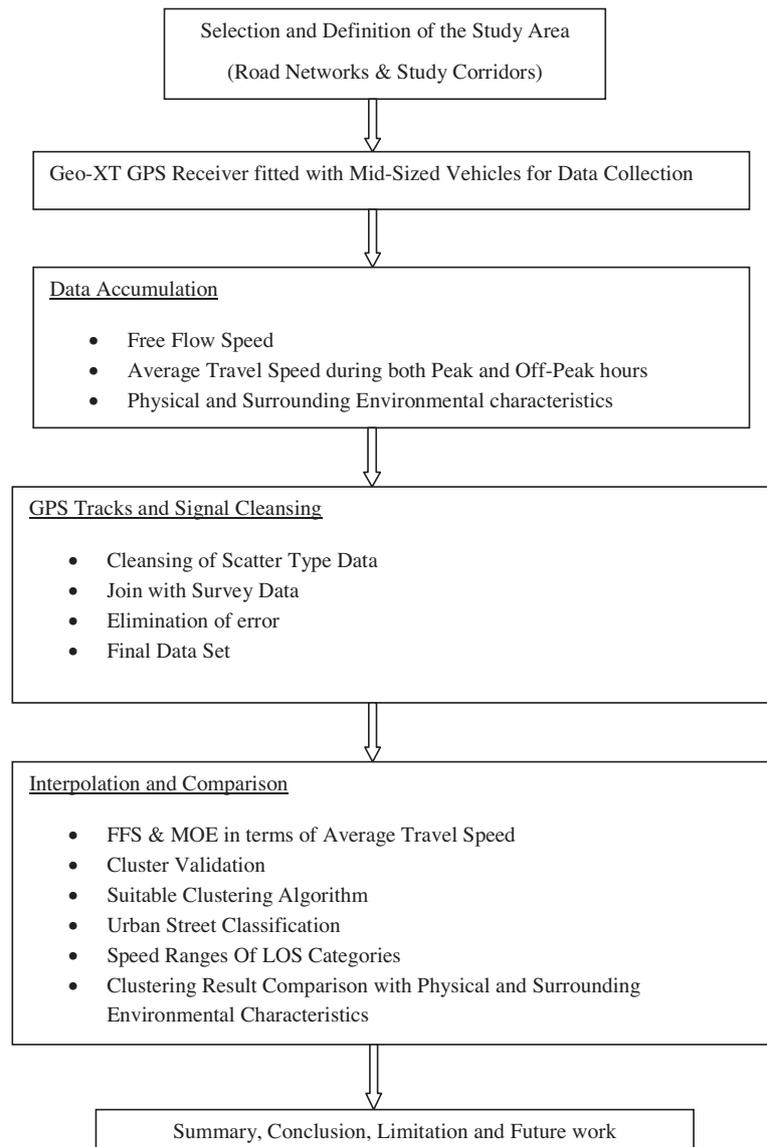


Fig. 1. Overall framework of the study.

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