Development of an Economical Level of Service Estimation Model using GPS Data in a Mixed Traffic Condition

Sankha Jayawardhana[1] and Loshaka Perera[2]

Abstract

This research presents the development of an economical Level-of-Service (LOS) estimation model using GPS data in a mixed traffic condition, with a specific focus on defining clusters based on the categories within the existing Highway Capacity Manual (HCM) definitions of motorized LOS for practical application. The study aims to enhance the representation of Sri Lankan traffic conditions, predominantly observed on 2-lane roads, particularly within the LOS D and E categories where the majority of typical Sri Lankan traffic situations occur. The data collection scope encompasses the entirety of Sri Lanka to ensure the generation of more representative values for the defined clusters. As clusterization parameters, Average Travel Speed, which is a reflection of mobility, Percentage Time Spent Following another vehicle and the Percentage Free Flow Speed, which is a ratio of current speed to the posted speed limit, were used in the same manner as HCM 2016 - 15-2. The deviations observed in the study from the classical Level of Service (LOS) approach, which traditionally relies on the volume/capacity ratio, are intentional and rooted in the need to better capture the nuances of Sri Lankan traffic conditions. Unlike the conventional focus on volume-related metrics, this methodology incorporates the aforementioned parameters and factors in road class-specific considerations. It showcases the utilization of two CNN-based image processing models developed, one for assessing the ‘following’ and ‘non-following’ states and the other to assess the types of road (road classes) using the Google Colaboratory platform for the analysis of geo-tagged video collected through the Transcend DrivePro 250 and their combination with 1 Hz GPS data collected by the Qtravel GPS device, which includes parameters such as speed, heading local date and time. The study's economic efficiency stems from the use of GPS data, replacing traditional video camera setups. This shift reduces costs and logistical complexities. Additionally, open-source software, specifically on Google Colaboratory, streamlines data analysis, emphasizing affordability. Additionally, the application of unsupervised KMeans clustering, which finds k centroids and then assigns each data point to the closest cluster while minimizing the size of the centroids to define clusters corresponding to the HCM definitions. This is particularly advantageous since it is possible to define the number of clusters required before hand and offers higher computational efficiency. The proposed methodology and model aim to provide an improved representation of LOS in Sri Lanka's traffic conditions, considering the unique characteristics of the road network and the predominant traffic scenarios observed in the country. The research findings produce a table containing parameters similar to HCM 15-2 (Motorized LOS parameters for 2-lane roads), meaning that the table has 5 clusters each for the three road classes under parameters relevant to each class as per the HCM guideline, but in a practical sense instead of a planning tool. Some notable deviations in the table produced include Percentage Free Flow Speed exceeding 100% due to speed limit choice (50 km/h) for class 03 roads and FCD noncompliance. Additionally, Cluster 5 needs to be checked against road capacity levels. Adjusting limits in the clustering model can eliminate any potential issues. However, the primary objective has been achieved for representative LOS clusterization from

GPS and geo-tagged video data. Possible future improvements to the model include the utilization of a bigger data pool of about 3 million data points and higher amounts of distinct training data for the image processing models to increase their accuracy.

Keywords: *Level of Service (LOS), Convolutional Neural Network (CNN), KMeans Clustering, GPS Data, Highway Capacity Manual (HCM)*

Authors Details;

1. Postgraduate Student, Department of Civil Engineering, University of Moratuwa, Sri Lanka. 180287h@uom.lk
2. Traffic Engineer, City of Rockingham, Australia. perera.loshaka@gmail.com