Abstract

Urban areas are the hubs of growth and economic development for nations. However, mismatched demand and supply for infrastructure and access to facilities plague these vital centers leading to a deterioration in the quality of life of its inhabitants. Traffic congestion is one of the serious issues that arise due to this supply-demand imbalance of infrastructure and leads to high economic and social costs that economies, like India, could do without. One effective strategy to combat traffic congestion is the use of well-designed traffic control measures such as traffic signals and existing real-time traffic signal control systems have proven their effectiveness in combating congestion. However, these systems consider homogeneous traffic conditions with CoSiCoSt being the only successfully field implemented system that considers mixed traffic conditions as seen in India. Additionally, recent years have seen progressive interest in distributed and decentralized systems over centralized signal control systems. This is due to the increased computational complexity of centralized systems for larger networks even though they obtain system optimal solutions. However, with the advancements in computational intelligence, it is worth revisiting the design of centralized traffic signal control systems for urban areas and to specifically cater for mixed traffic. The present work aims synthesize this with simultaneous optimization of phase plans, green times, and offsets across intersections. The simultaneous optimization of variables in real-time for centralized signal control systems becomes feasible with the adoption of modified two-dimensional genetic algorithm with a strategic initial gene. The study evaluates the performance of the system for varying volume levels as well as reduced number of data input sources. Further, the study also investigates the resilience of the proposed system to errors in data inputs from the traffic network. Comparison of the developed system with existing fixed time plan and the popular Maxpressure based decentralized system indicates reduced travel times and faster queue dissipation especially for routes with high

traffic demand. The modified two-dimensional algorithm aids in determining feasible solutions with computation times that are comparable to decentralized Maxpressure based systems. The study findings also provide evidence for resilience of the system to errors in input data. These findings provide valuable guidance for practitioners in configuring signal parameters for real-world deployment and serve as a foundation for further research into the development of integrated traffic management systems, encompassing functionalities such as incident management, bus priority, and emergency response.

Keywords: centralized traffic signal control, real-time feasibility, modified S model, two-dimensional genetic algorithm, resilience