Chapter 9

Traffic Signal Control for a Single Intersection–Based Intelligent Transportation System

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ABSTRACT

Traffic optimization at an intersection, using real-time traffic information, presents an important focus of research into intelligent transportation systems. Several studies have proposed adaptive traffic lights control, which concentrates on determining green light length and sequence of the phases for each cycle in accordance with the real-time traffic detected. In order to minimize the waiting time at the intersection, the authors propose an intelligent traffic light using the information collected by a wireless sensors network installed in the road. The proposed algorithm is essentially based on two parameters: the waiting time in each lane and the length of its queue. The simulations show that the algorithm applied at a network of intersections improves significantly the average waiting time, queue length, fuel consumption, and CO₂ emissions.

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INTRODUCTION

Road congestion has become one of the main issues in urban cities due to the growth of vehicles numbers and the limitation of road infrastructure.

The results of this congestion could be seen through a difficult vehicles displacement, an increasing environmental pollution by higher CO2 emission, an increasing energy consumption, stressed drivers and the dismantling of the road safety. This is why traffic control has become an important area of research with one main objective being the reduction of traffic congestion.

Traffic regulation is an important component of the intelligent transportation system, which is defined as the integration of communication and information technologies in vehicles and road infrastructure to improve road traffic and safety. This regulation plays an important role in managing the flow of vehicles when controlling traffic lights. So, in this paper we choose to integrate a wireless sensor network into the road infrastructure to know the traffic status in real time, to design smart traffic signal control that dynamically and intelligently on the change of the traffic at the road intersection.

In this paper, we present an adaptive traffic management algorithm that allows to specify the sequence of phases and the green light time according to the waiting time and the number of vehicles in each lane.

The document is organized as follows: after a presenting the traffic light regulation context, its operation, and its main approaches. We expose later the wireless sensors network characteristics for traffic monitoring. Then, in the next section we present the shortest Job First method for phases scheduling and its effectiveness in reducing wait times, and we propose also in this section our ALCA algorithm based in SFP concept. Finally, we evaluate our solutions via the SUMO simulator and we demonstrate their effectiveness by comparing the results to other methods.

TRAFFIC LIGHT REGULATION

In cities, most traffic lights control systems are of two types: fixed lights control plan and adaptive control. The first type of regulation is older and less expensive, while the second is more complex and efficient. We present in this part the specifications of each of those types of regulation. But first, we will give a number of definitions for the intersection and its operation.

Definitions

Our intersection illustrated in Figure 1 consists mainly of four directions (N, S, E and W) each of which contains two lanes (go straight and turn left).

- **Movement**: A “movement” is defined by its origin and destination, in Figure 1 and 2 each arrow presents a movement. A movement is represented by a symbol consisting of a combination of two characters. The two characters represent the cardinal directions (S for the south, N for the north, E for the east, and W for the west) for the source lane with the first character and the destination lane with the second character.