CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusion

Intersections traffic lights management is a highly significant topic especially in urban cities as the roads are always congested with vehicles delayed at traffic lights. Even though a lot of researchers have researched this problem and produced varieties of solutions, their works tend to solve much more specified problems while neglecting others which made their systems unsuitable for employment at any signalized intersection. So we found a necessity for creating a more general solution that can collect more real time data about road status and responsible for using those data to make more accurate decisions and preserve system stability when implementing at any traffic light junction at any level of demand.

The existing traffic management systems thought of traffic light control as a sequencing problem while this project looked at it as a real time decision making problem. The aims of this thesis research are mainly to optimize a single signalized intersection traffic light control and to enhance its performance by having the traffic light controller to make highly accurate decisions and maintaining stability along all the levels of demand.

A data collecting system for collecting road real time status data was developed using VANET networking architecture by adding a lane specific vehicles presence detection facility. The collected data set includes: directions queue lengths, the total filled ratio of the road with vehicles, the total waiting time for the first vehicle arrived to the traffic light’s stopping line, and the availability of the next road for receiving vehicles. VANET environment was assumed to be exists and provided valid connections between vehicles and road side equipment. Although, the data collecting mechanism was created and meant to deliver them to the traffic light controller placed at the intersection.

A set of algorithms were established; one for prioritizing the directions and another for controlling the given green time among the competing directions according to their queue lengths. The directions weightage values were calculated using the collected road status data then they were assigned to a graph nodes. The graph network was designed to serve as the traffic light phase transitions map. By applying the modified dijkestra’s algorithm on that graph, the next phase priority was determined. The time of the next phase was calculated using the developed algorithm. Mainly it distributed a full cycle time justly among the directions according to their need. Applying these algorithms led to a more green time utilization, shorted average queue lengths, shorter vehicles average waiting time, higher intersection capacity, and leading to a more stable traffic light system at all levels of demand.

This project considered the problem of optimizing a single intersection traffic light control. Sidra Intersection simulator does simulate a single intersection but it does not offer users the ability to change the traffic light controller. That was the main reason behind creating our own customized simulator. Three of Sidra Intersection simulator’s models were used to create the customized traffic light simulator; the vehicles arrival model, the queues management model, and the vehicles departure model. The customized traffic light simulator was validated against Sidra Intersection simulator.

The developed system has been simulated using the customized simulator and its performance was compared with some of the existing solutions. The simulator has been used to achieve 95% of confidence. Using the simulator have shown significant enhancement in terms of maintaining stability, average queue length, maximum queue length, average waiting time, maximum waiting time, and time utilization.

Both of NM1 and NM2 have lost their stability at the large and the very large level of demand. This makes them ineligible to be used at the large and very large level of demand. Unlike NM1 and NM2, DT3P high stability in controlling an intersection was seen at all the five levels of demand. In addition, DT3P have managed to reduce the maximum queue length and the maximum waiting time for the queue. At the same time, DT3P have increased the green time utilization at the intersection which led to increase the intersection's total capacity.

The completion of this research came up with a set of contributions and these can be listed as:

1. The development of the VANET networking infrastructure setup, for a highly accurate Real-time Road status data collection. In addition, a messaging protocol to run over the VANET infrastructure networking devices to provide communication among those devices and to deliver the collected data to the traffic light controller is established. This VANET infrastructure setup allowed the development of a dynamic queue length detection mechanism.

2. The development of the Dynamic Traffic Light Phase Plan Protocol (DT3P) to make more accurate decisions for single-isolated intersections control which maintains high efficiency of intersection's traffic control at all levels of demand.

3. The development of the simulation tool for single-isolated intersection traffic lights with the ability to customize the controlling algorithm.

5.2 Directions for Future Work

The present introduced optimization approach works for a single intersection with four approaches traffic light. Theoretically, the proposed approach has the ability to maintain smooth traffic management in a city as the traffic light controller is able to integrate with the adjacent intersections TLCs. A possible continuation of this work would be applying the proposed approach on a city scale and see if the control optimization technique expansion is needed to run the traffic smoothly on a network of intersections.

In this work, having the queue length for each lane detected precisely was assumed to exist, whereas the current vehicles presence detection is being done per approach. That might be another thinkable extension topic to be researched to improve vehicles presence detection to be done per lane instead of per approach.

Worldwide, VANET framework is still in the development stage. In this work, a VANET network setup was developed to serve the goals of this work. Having such setup ready would be motivating to research and develop more applications using that developed network setup.