Development of IoT Device for Traffic Management System

INTRODUCTION

Traffic congestion is a major issue that happens across urban cities around the world. Traffic congestion have major impacts to countries in several aspects: high fuel consumption, air pollution and slower economic growth .
The annual economic losses of Malaysia caused by traffic congestion is estimated about RM20 billion . Rising of population and lack of public transport are the main reasons for traffic congestion. In Malaysia, the number of urban population have increased by 242% for past 30 years, whereas number of vehicles have increased by 585% for past 35 years. These figures are shown in Table I and Table II.

TABLE I. SUMMARY OF URBAN POPULATION FOR THE YEAR 1980 TO 2010

Years	Urban Population
1980	5,816,257
1985	7,234,729
1990	9,068,034
1995	11,541,546
2000	14,515,479
2005	17,178,671
2010	19,940,100

TABLE II. SUMMARY OF NEW PASSENGER AND COMMERCIAL VEHICLES REGISTERED IN MALAYSIA FOR THE YEAR 1980 TO 2015

Years	Passenger Cars	Commercial Vehicles	4x4 Vehicles*	Total Vehicles
1980	80,420	16,842	-	97,262
1985	63,857	26,742	4,400	94,999
1990	106,454	51,420	7,987	165,861
1995	224,991	47,235	13,566	285,792
2000	282,103	33,732	27,338	343,173
2005	416,692	97,820	37,804	552,316
2010	543,594	61,562	-	605,156
2015	591,298	75,376	-	666,674

LITERATURE REVIEW

Architecture of Sensor Network for Traffic Light System There are three types of wireless sensor network (WSN) architecture for TLS: ad-hoc architecture, infrastructure-based architecture, and hybrid ad-hoc infrastructure-enabled architecture, which are shown in Figure 3 [11]. Fig. 3. WSN architectures Ad-hoc architecture have three types of sensor communication network: on road sensor network, on vehicle sensor network, and hybrid on sensor on vehicle network. On road sensor network requires all sensors communicated within themselves in multi-hoc way without infrastructure. On vehicle sensor network utilized vehicle in-built sensors for direct vehicle-to-vehicle (V2V) communication between each other. Hybrid on sensor on vehicle network combines both methods for communication. One of the sensors is acted as master to make decision on GLPT for each road bound. These architectures are shown in Figure 4. [11] Fig. 4. Ad-hoc architectures [11] Similar to ad-hoc architecture, there are three types of sensor communication network in infrastructure-based architecture, with additional of base station (BS): on road sensor network with BS, on vehicle sensor network with BS, and hybrid on sensor on vehicle network with BS. BS will communicate with these sensors via cellular, Wi-Fi, WiMAX or DSRC, and make decision on GLPT for road bound.

METHODOLOGY

Green Light Phase Time Calculation Algorithm Dynamic algorithm proposed by Collotta [14] is implemented to calculate GLPT of each road bound for the system, which is shown in Figure 6. For a given road intersection, there are four road bounds, which denoted as E, S, N, and W respectively. For a given traffic light cycle duration C, there are n vehicles queuing in each road bound, and current traffic volume CTV of each road bound are calculated. The formula is given by: C (n x 3600) CTV = (1) Traffic flow ratio FR of each road bound is then calculated based on CTV and maximum flow rate MFR for each road bound, which is calculated based on formula: MFR CTV FR = (2) These ratios are then sorted in descending order with priority assignment. The road bound with highest flow ratio is assigned with highest priority, and applies to remaining road bounds. Effective green time EGT for each road bound are then calculated based on formula: EGT = FR x C (3) For calculated effective green time, the data are used to compute phase green time PGT of each road bound. The formula is given as per below, where S refer to lost time due to start up and Y refer to yellow light duration: PGT = EGT + S - Y (4) Remaining green time RGT for road bounds are then calculated by subtracting EGT with PGT. Next, remaining effective green time REGT is calculated by formula: RGT = EGT - PGT (5) remaining previous current REGT = RGT x CRT CRT CRT − (6) For calculation of second road bounds and onwards, formula of PGT, RGT, and REGT is reused. Once phase green time for all road bounds are computed, the process is completed.

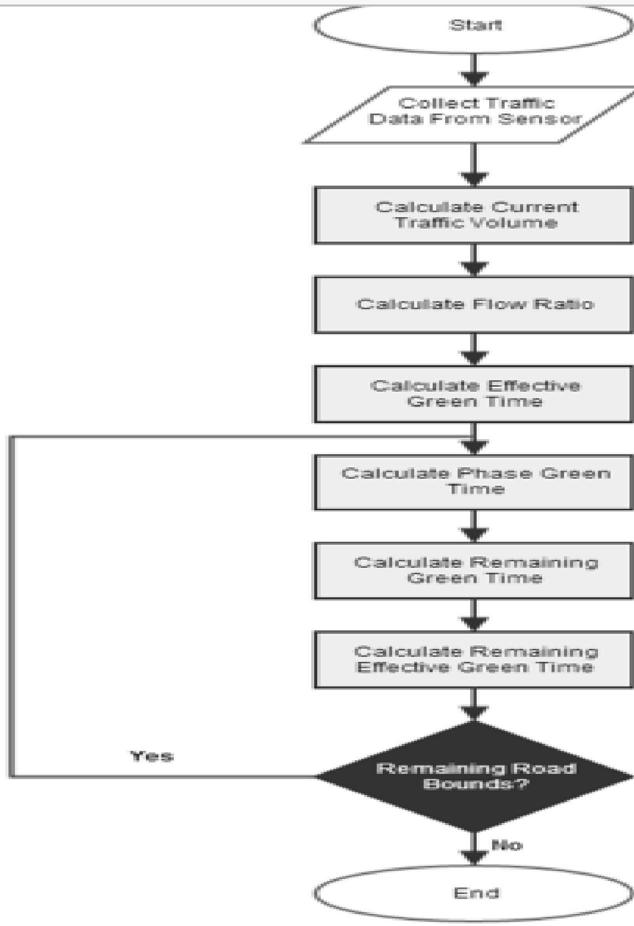
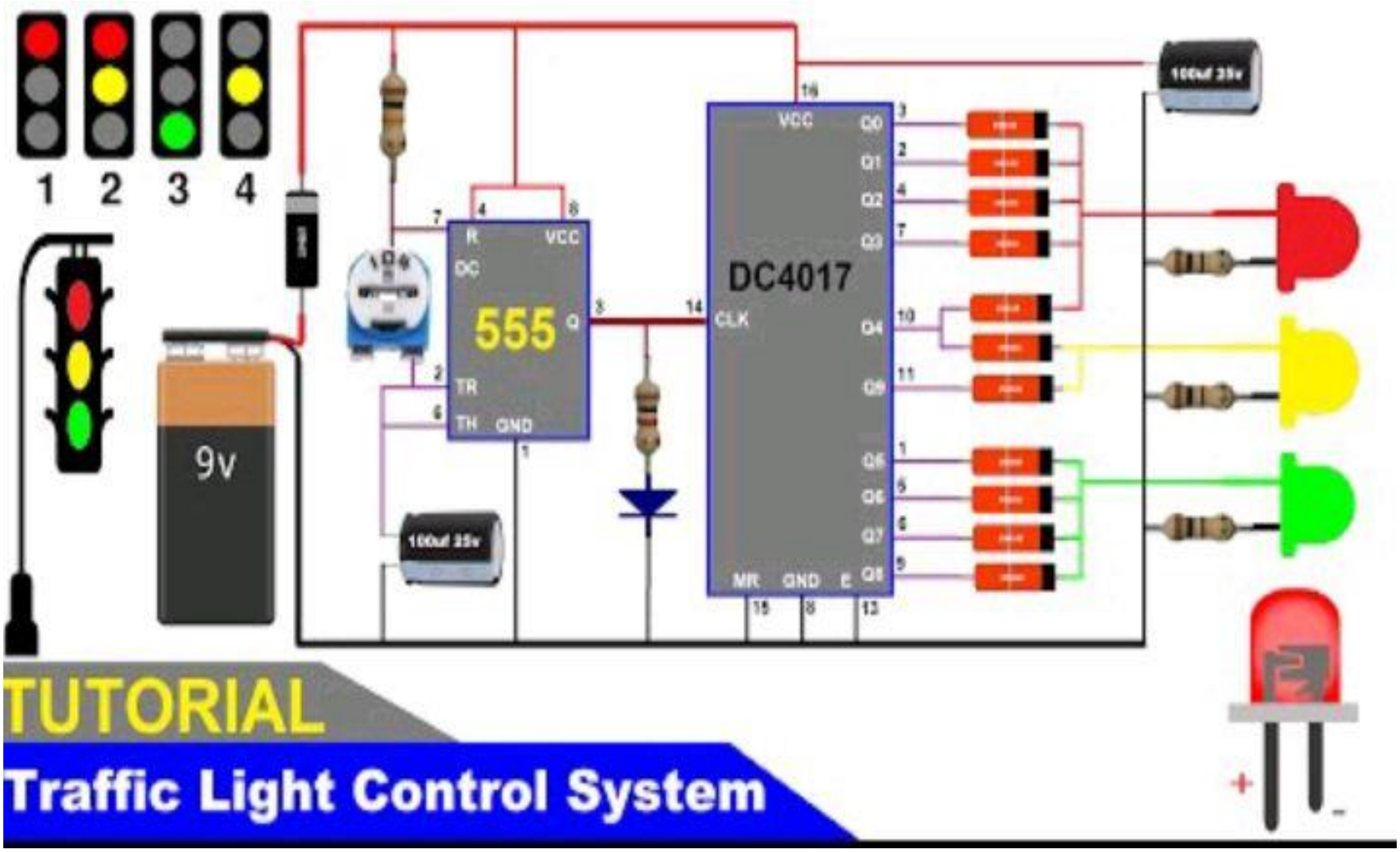


Fig. 6. Flowchart of GLPT calculation algorithm

CONNECTION DIAGRAM FOR TRAFFIC MANAGEMENT SYSTEM



PYTHON CODING

#Function to simulate a traffic light
 #It is required to make 2 user defined functions trafficLight() and light(). def trafficLight():
 signal = input("Enter the colour of the traffic light: ")
 if (signal not in ("RED","YELLOW","GREEN")):
print("Please enter a valid Traffic Light colour in CAPITALS")
else: value = light(signal)
 #function call to light()
 if (value == 0):
 print("STOP, Your Life is Precious.")
elif (value == 1):
print ("PLEASE GO SLOW.") else:
print("GO!,Thank you for being patient.")

```
def light(colour):
if (colour == "RED"):
return(0); elif (colour == "YELLOW"):
 return (1) else:
 return(2)
 #function ends here
 trafficLight()
print("SPEED THRILLS BUT KILLS")
```

Logic:

1.Define the function trafficLight().
2.Prompt the user to enter the color of the traffic light.
3.If the input is not “RED”, “YELLOW”, or “GREEN”, display an error message.
4.If the input is valid, call the function light() with the input as the argument.
5.Store the return value from the function light() in the variable “value”.
6.Based on the value of “value”, display the appropriate message.
7.Define the function light() which takes the color as an argument.
8.If the color is “RED”, return 0.
9.If the color is “YELLOW”, return 1.
10.For any other color, return 2.
11.Call the function trafficLight().
12.Print the safety message “SPEED THRILLS BUT KILLS”.

Output:

>> Enter the colour of the traffic light: RED
>> STOP, Your Life is Precious.
>> SPEED THRILLS BUT KILLS

RESULT

The GLPT calculation algorithm is tested using MATLAB simulation software. There are four road bounds E, S, N, and W, with maximum queue lengths of 75 vehicles. In this simulation, only standard passenger car (Length of 4.2 metres x width of 1.75 metres) is taken into consideration. For each traffic light cycle with total GLPT of 300 seconds, random traffic flows from 0 to 50 vehicles enter into all road bounds. For fixed time algorithm, each road bounds are assigned with GLPT 75 seconds. Both algorithms are tested iteratively for 100 traffic light cycles. Result showed that dynamic algorithm reduces queue length and waiting time on the road intersection by 68% and 67% respectively compared to fixed cycle algorithm, which is very effective in solving traffic congestion for road intersection.

CONCLUSION

By implementing the system, the queue length and waiting time of each road bound for dynamic cycle TLS is reduced dramatically compared to fixed cycle TLS. The system replaces current system where traffic police on duty during morning and evening peak hours. The implementation of Microsoft Azure IoT cloud server greatly improved security of TLS. With installation of this system in each road intersection of urban cities, traffic congestion can be mitigated.

THANK YOU