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REAL TIME-BASED SMART TRAFFIC LIGHT SYSTEM WITH ITS SIMULATION USING 8051 MICROCONTROLLER

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Abstract- **The street lighting system is based upon the electronic controller that utilizes the traffic density survey data. Anandroid mobile app was developed for this purpose. Data was collected and analyzed at different busy junctions of Kathmandu Valley. The app maintained a database record of each vehicles type that enter in the system and simultaneously records the time they enter the junction. The data gives an insight into the number of vehicles entering the junction and the time required for them to cross it. This is helpful to calculate the stoppage time which was programmed into the system for optimized and efficient traffic management.**

Index Terms: **Traffic Counter, Stoppage time, Optimization.**

I. INTRODUCTION

Traffic congestion has become a serious problem with each passing day. The inadequacy of the infrastructures to manage the increasing number of vehicles has resulted in the traffic jam affecting an average of millions of people in Kathmandu valley every day. When vehicles are fully stopped for a certain period of time, this is colloquially known as a traffic jam or traffic snarl-up. Digital systems could be deployed to control the traffic lights that will result in better traffic movement and consequently reduce traffic congestions.

A. LITERATURE REVIEW

At the international level, many research works have been carried out for the automatic detection of vehicles using DIP (Digital Image Processing) algorithms. Some such works include Image Processing Based Intelligent Traffic Controller. [1]. In New York City, 7,660 (of a total of 12,460) signalized intersections are controlled by a central computer network and monitored by traffic

management centers [2]. Similarly, in Toronto, 83% of its signals are controlled by the Main Traffic Signal System (MTSS). 15% also use the SCOOT (Split Cycle and Offset Optimization Technique), an adaptive signal control system.

B. TRAFFIC CONGESION IN NEPAL

In Nepal too, academicians and stakeholders have done some level of research to develop solution to tackle traffic congestion in the cities, mostly in the Kathmandu valley. However, no concrete solution has been found yet and the problem of traffic congestion has been a troublesome. Metropolitan Traffic Police Division, Kathmandu and Road Division under Government of Nepal have done a kind of traffic assessment on the cities of Kathmandu valley which has already been almost four to five years. Although civil engineering students need to do road assessments and traffic survey under their course, it has only been focused to be submitted as a requirement for the degree.

The existing traffic is controlled manually by traffic policemen. However, as the complexity of road networks are increased to service the growing demand for road users, a sophisticated traffic control technology is needed in abating this problem. We are now totally dependent on the manual service of the policeman with boards on their hand commanding to the people which are not good in terms of efficiency and safety.

An immediate solution in the context of Nepal can be a microcontroller-based traffic light system. This system is based on real-time data. An app known as Traffic Counter was used to manually log the vehicles crossing the junction. A minimum of four volunteers was employed to collect the data of each route.
In order to know the present situation and analyze the traffic congestion, volunteers firstly stood on target junction for about an hour and recorded the data with a team of volunteers simultaneously standing on the different routes within a junction. The similar Out of the huge data collected, the represented one is just a model to clarify the concept.

Route	Morning	Evening
Maitighar to Pulchowk	1220	514
Maitighar to Tripureshwor	1350	772
Pulchowk to Maitighar	1292	1019
Tripureshwor to Pulchowk	635	582

Table 1: Vehicle Number at two different time

Time graph of the vehicle density in the various route in the intersection can be obtained from field surveys. Multiple surveys can be taken Various probabilistic approach is under research and has been found effective be used to such time-varying data to determine the dwell time, lost time and delay time of the vehicles[3]. Such estimated value can result in the efficient calculation of traffic signal delays. Moreover, advanced technologies including camera-based detection and classification are also progressing which can be used as a feedback mechanism to vary the signal time around the tolerance value.

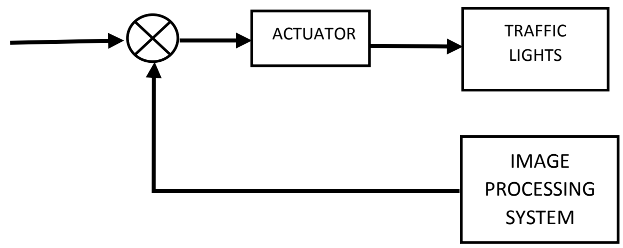

Figure 1: Feedback Mechanism from external digital system

VEHICLE COUNT OF THAPATHALI JUNCTION

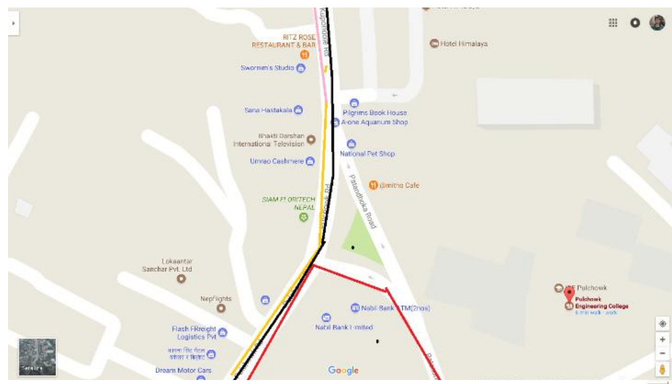

Figure 2: Road Map of Thapathali Junction

The size of each vehicle is different. Traffic jam contributed by a single public bus is completely not equivalent to the traffic jam caused by a motorbike. So, in order to make the distribution equal, we have expressed all the vehicle unit to a single unit equivalent to the Car which is termed as PCU [4].Passenger Car Equivalent (PCE) or Passenger Car Unit (PCU) is a metric used in Transportation Engineering, to assess traffic-flow rate on a highway.

The data presented here was collected at two different time periods. One from 8:45 to 9:30 in the morning and another from 3:15 to 3:45 in the evening. The total vehicles passing through the junction in respective routes are shown in table 1. As seen on the map in figure 1, there are three possible routes for vehicle stoppage which are Maitighar to Pulchowk, Pulchowk to Maitighar, Maitighar to Tripureshwor and Tripureshwor to Pulchowk. Since the vehicles are allowed to move continuously in the Pulchowk to

Tripureshwor route, the data count in this route was not taken into consideration.

The table 1 shows that the highest number of vehicles (1350) in the morning pass from Maitighar to Tripureshwor whereas the lowest (635) pass through Tripureshwor to Pulchowk. Similarly, in the evening, the highest number vehicles (1019) have moved from Pulchowk to Maitighar and the lowest (514) being through Maitighar to Pulchowk.

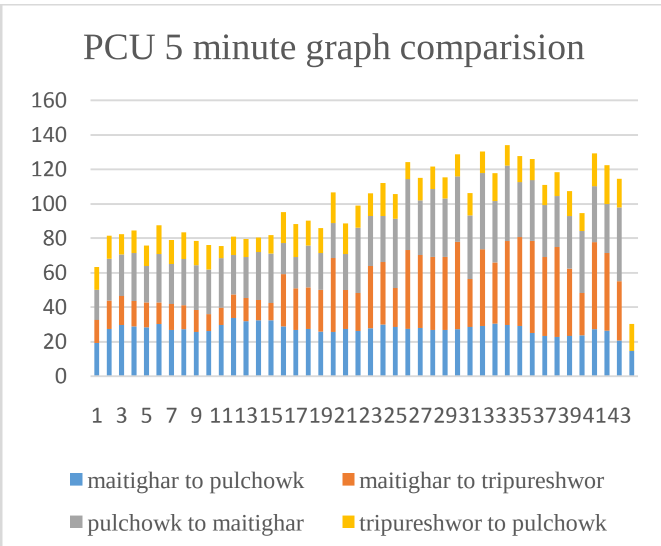

Figure 3: percentage PCU in a cycle of 15 minutes

Morning				
Location	Vehicle stoppage (sec)	Time limit (sec)	Through	Stop
Maitighar to Pulchowk	960	132	11%	89%
Maitighar to Tripureshwor	90	120	57%	43%
Pulchowk to Maitighar	90	96	52%	48%
Tripureshwor to Pulchowk	78	324	81%	19%
Evening				
Location	Vehicle stoppage (sec)	Time limit (sec)	through	stop
Maitighar to Pulchowk	120	420	78%	22%
Maitighar to Tripureshwor	84	282	77%	23%
Pulchowk to Maitighar	90	180	67%	33%
Tripureshwor to Pulchowk	90	420	82%	18%

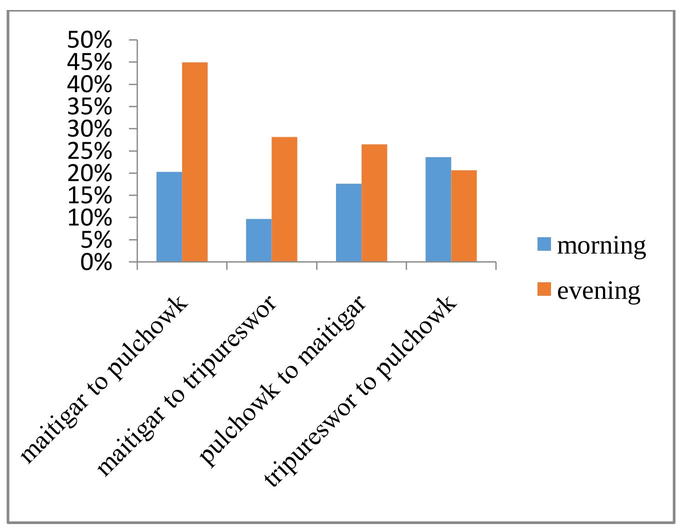

Figure 4: PCU at different directions in interval of 5 minutes

The PCU data count was divided in cycles each of fifteen minutes such that each cycle represents the blinking of red light at each turning once. In each cycle, the Maitighar to Pulchowk route was found to have the highest percentage of PCU (Per car Unit) in the evening and the Tripureshwor to Pulchowk route with the highest PCU in the morning. This information is used to calculate the stoppage time and vehicle flow time for each route.

II.CALCULATIONS

Throughout the calculation we have considered the following relation:

Car/Micro Vehicles equivalent to 1 car unit
Bus/Large Vehicles equivalent to 2 car unit
Bike/Scooter equivalent to 0.5 car unit

Let D be the data obtained during a survey and T(x) represent timestamp recorded in the data x.
Difference between two consecutive data,
$d = T(D_n)-T(D_{n-1})$ in second
For each data Dn:
Stoppage value Sn= IF (d/60 <1, 0, ROUND (d, 2))

Total stoppage time value $S = \sum_1^n S_n$

Flow time Fn = elapsed time after last stoppage

Total flow time value $F = \sum_1^n F_n$

Such values for flow and stoppage time can be calculated with number of surveys at varying time of the day consecutively for a number of weeks.

Table 2: Vehicle Stoppage and Flow time

III. RESULT AND ANALYSIS

The stoppage time was calculated using the PCU percentage of a cycle. We can observe in table 4 that Maitighar to Pulchowk route having the greatest number of vehicles in the evening also have the largest vehicle stoppage time and also the vehicle flow time. Analyzing figure 3, the descending order of vehicle flow in the morning is through the routes: Tripureshwor to Pulchowk, Maitighar to Pulchowk, Pulchowk to Maitighar and Maitighar to Tripureshwor. Depending on this number, the stoppage time for Maitighar to Pulchowk route should have been less than Maitighar to Tripureshwor and Pulchowk to Maitighar route. Owning to the same order, the flow time for Pulchowk to Maitighar route should have been more than Maitighar to Tripureshwor route but it is not which is depicted in table 2. The amber light timing and its calculations are incorporated inflow time and stoppage time. The actual delay time for traffic light either fixed or can be estimated dynamically with flow and stoppage time.

Similarly, if we analyze the evening data, the descending order of vehicle flow routes is Maitighar to Pulchowk, Maitighar to Tripureshwor, Pulchowk to Maitighar and Tripureshwor to Pulchowk. This implies the Maitighar to Pulchowk route must have least stoppage time and maximum flow time. It does have a larger flow time; however, the stoppage time is also large in its case. This directs us that had the Maitighar to Pulchowk route given more priority owing to the fact that more vehicles flow in this direction in the evening, there would have been fewer chances of traffic jams.

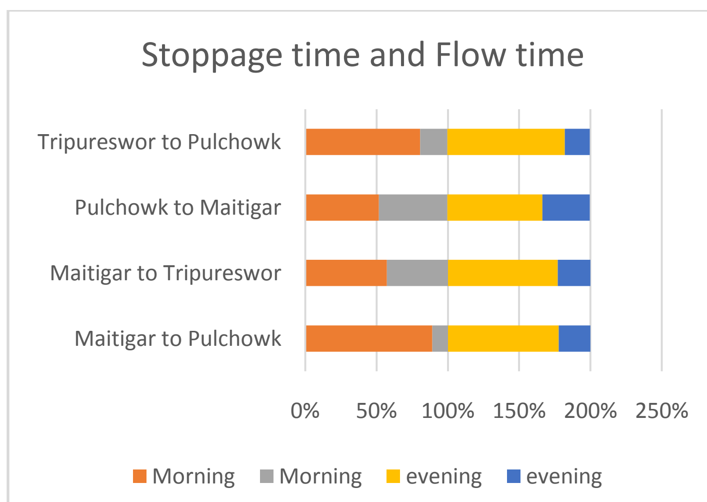

Table 3: Stoppage time and Flow time calculation

V. HARDWARE SIMULATION

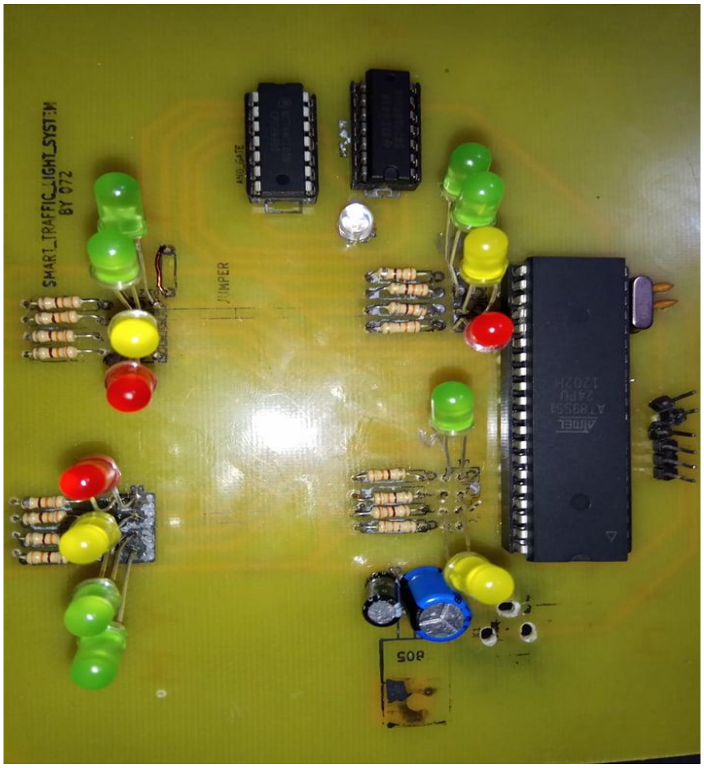

Figure 5: Implemented hardware circuit with 8051

We used the 8051 Microcontroller and implemented the project on hardware successfully. All four junctions of Thapathali was simulated along with the pedestrian consideration. We also did it using 555 Timer generating the pulses for our warm-up type simulation A separate lighting system was made for the pedestrian. We made the simulation on Proteus and designed the PCB circuit on Kicad and used a programmer to transfer the program to 8051 Microcontroller.

IV.CONCLUSION

We conclude that the traffic system in Nepal needs to be shifted to the electronic system. The analysis of the current traffic data shows that the human analysis of real-time traffic is not robust enough to prioritize directions for stoppage time to avoid the traffic jam. So, in the near future, the manual system should be substituted by the microcontroller so that the Traffic Light System gets implemented at every section. And to implement the Traffic Light system it is best to set the time of each command with reference to the real data and for that, the data we collected manually through a mobile based app can be a better option until further methods like image processing etc. are adopted which is highly advanced and costly too.

VI. REFERENCES

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