Published by :
http://www.ijert.org

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 8 Issue 04, April-2019

Solutions for Deployment of Traffic Warning System Through City's Traffic Camera System

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Abstract- **Today, an intelligent transport system is considered as one of the top priorities in traffic development in Vietnam in general and Danang City in particular, in order to deploy intelligent urban areas at national scale. Today, the road users are getting into trouble with traffic situation at the peak time in Danang City. Some of the roads have encountered with local traffic congestion. It is essential to reduce traffic congestion existed in Danang City. Therefore, in this article, we would like to suggest algorithm which help determine the traffic density in order to provide traffic warning over traffic congestion.**

Key words- ITS; NodeJS; Warning of traffic congestion

I. INTRODUCTION

As you may know, traffic congestion is a common problem encountered by many cities in the developed countries, and it is becoming big obstacle to the development of a city. There were many solutions for this problem. One of the technical solutions is to concentrate two main problem directions in resolving traffic congestion. One direction of solution is to change and adjust planning for a city and expand operation of traffic system. The remain direction is to enhance, make use of capability of current traffic network. It is not easy to implement first direction, as the new infrastructure, although it was built, creates difficulties such as land clearance, reimbursement, clearance and change of planning for urban area, and big expenses, etc. Therefore, the second direction has been put a bigger consideration, in which it is done by applying modern technology to control, management of traffic network by using ITS technology - Intelligent transport system. Among them, providing detection and early warning of spots of traffic congestion to traffic users and providing traffic directional distribution to traffic users to help them prevent from moving towards to spots of traffic congestion are the necessity to which an intelligent traffic system should adapt.

Nowadays, many traffic cameras have been deployed at intersections and places of traffic lights in Danang City in order to monitor traffic situation at spots of crowded roads or intersections. Therefore, it is necessary and reasonable to carry out deployment of system which functions providing early warning of spots of traffic congestion and traffic directional distribution to the traffic users by using images captured from cameras.

There are currently some of applications which help traffic users with such functions: Functions of Warning Me, Goong 2 is to help traffic users automatically send notification of traffic situation at their current location to other users via Facebook, e-mail or the same applications used by the receiver

Besides, there are many researches into intelligent transport system, such as Research into safe driving assistance system to traffic users [1], research into actual state and solutions for Development of Intelligent Transport System in Vietnam [2], Deployment of warning system for traffic congestion and transport accidents in urban areas in Vietnam [3].

Article [1], [2] and [3] provide information about providing traffic warning to traffic users, but they do not mention providing traffic warning by using traffic camera system. Therefore, in this article, we intend to carry out deployment of warning system for traffic congestion through analysis of traffic density. We have suggested some of matters in this article, including:

- Provide suggestion over algorithm in order to determine traffic density through images directly captured by traffic cameras.
- Deploy servers for storage of traffic warning data.
- Develop traffic warning application for traffic congestion on mobile platform.

A.

The remainder of article is as follows: Part 2: Methods for determination of traffic density. Develop model for traffic warning indicated in part 3. Part 4: Deploy experimental system and collect result of system operation. Part 5: Make conclusion and provide direction for prospective development.

II. METHODS FOR DETERMINATION OF TRAFFIC DENSITY

Figure 1: An at-grade intersection, in general, or functional area of an intersection is a bigger expansion of physical intersection, including length of section of psychological reaction, section of maneuver and waiting line (if any).

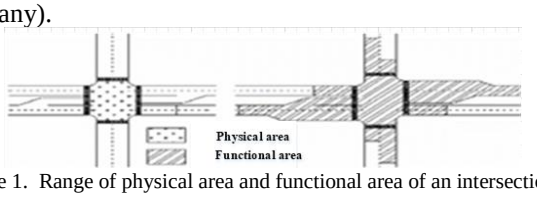

Figure 1. Range of physical area and functional area of an intersection [4]

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
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Situation of intersections, including situation of traffic congestion, as a whole has reflected through functional area of a branch moving towards to an intersection. When an intersection encounters with traffic congestion, it may cause the same traffic congestion at branches moving towards to it. Therefore, a research into functional area of a branch may provide us with necessary traffic warnings over traffic situation at an intersection.

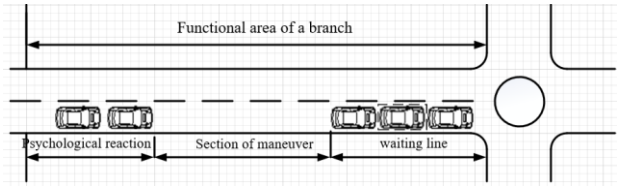

Figure 2. Traffic situation at an intersection [4]

In order to determine traffic density at an intersection through range of waiting line [5], if the traffic density maintain its high level without changing in the two consecutive cycles of traffic light, it means this intersection may have a sign of traffic congestion.

Determine range of survey

$$L_{cho} = \frac{\frac{N \times D}{3600} \times S_i}{B}$$

$$L_{cho} = \frac{\frac{N \times C}{3600} \times \frac{D}{C} \times S_i}{B}$$

Area for calculation of traffic density:

$$F = L_{cho} \times B = \frac{N \times D}{3600} \times S_i = \frac{N \times C}{3600} \times \frac{D}{C} \times S_i$$

Including:

N = traffic volume at branch moving towards to (vehicles per hour)

D = Signal timing for red light (in seconds)

Si = area of space occupied by design car (Si car) = 25m^2

B = Width of branch moving towards to with traffic light (may be equivalent to carriage-way width of branch)

C = Number of traffic light cycles

Table 1: Range of survey for determination of traffic density of an intersection deploying traffic light at branch with two traffic lanes (10.5m)

D/C / Vehicles coming in 1 cycle	0.3	0.4	0.5	0.6	0.7
10	11	14	18	21	25
20	21	29	36	43	50
30	32	43	54	64	75
40	43	57	71	86	100
50	54	71	89	107	125
60	64	86	107	129	150
70	75	100	125	150	175
80	86	114	143	171	200
90	96	129	161	193	225
100	107	143	179	214	250
110	118	157	196	236	275

III. DEPLOY TRAFFIC WARNING SYSTEM

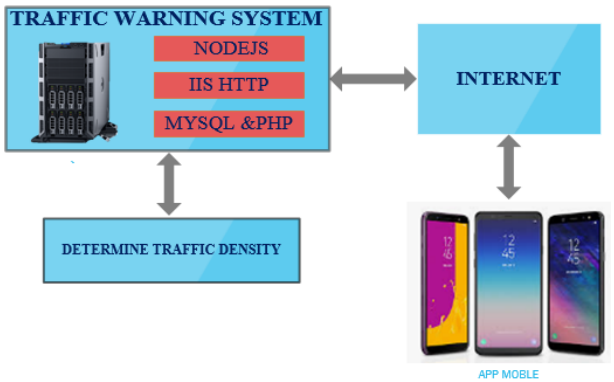

Figure 3. Model of traffic warning system

In figure 2, we have deployed traffic warning system with functional block

- Analysis of images captured from traffic cameras is implemented in order to calculate traffic density; from there, it is possible to determine spots of traffic congestion, then save this record into database
- This traffic warning system is connected to Internet. It sends notification to the traffic users through mobile devices
- Mobile application: It is to receive data on spots of traffic congestion.

A. Determine traffic situation

Base on table 1, we have had determination of traffic situation of an intersection. if the traffic density maintains its high level without changing in the two consecutive cycles of traffic light, it means this intersection may have a sign of traffic congestion, which shows in table 2.

International Journal of Engineering Research & Technology (IJERT)
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Table 2: Traffic situation

Change of traffic density in one cycle of traffic light	From 50% to 100%	From 40% to 50 %	From 30% to 40%	From 20% to 30%
Traffic situation	Normal	Traffic jammed	Traffic from jammed to obstructed	Traffic obstructed

In figure 4, we have had determination of traffic situation with 6 functions, in which collection of data from traffic cameras has been initially carried out [6]

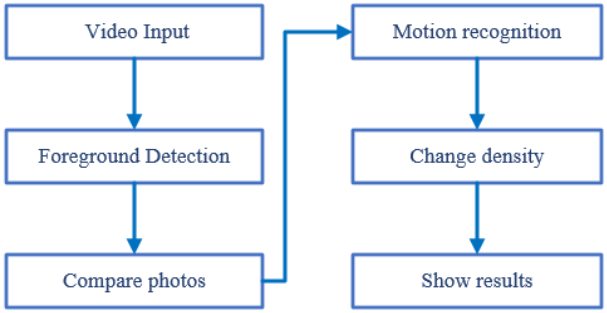

Figure 4 Determine traffic situation

B. *Traffic warning system*

Figure 3: Model of traffic warning system Base on figure 3, we have deployed traffic warning system with its functions showing in figure 5

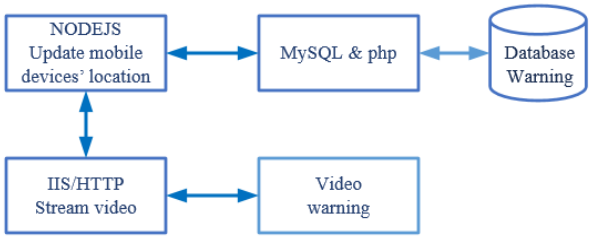

Figure 5 Traffic warning system

NodeJS [7] will determine mobile devices' location and store this data into server. The Server then receive data mobile devices' location created on Nodejs platform.

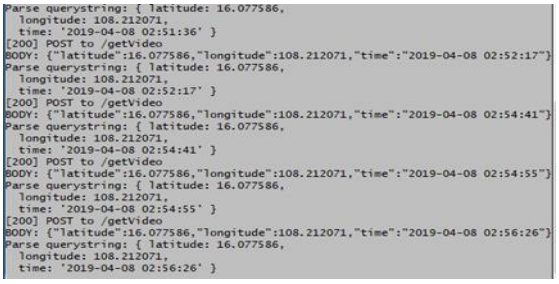

Figure 6: Nodejs server update location.

NodeJS will check mobile devices' location stored in database in MySQL in order to send corresponding video through http protocol. Internet Information System is installed on server in order to stream video and send it to mobile devices.

Database created by MySQL is used to store video for traffic warning and send it to mobile devices. Figure 6: Design of data table

No	Name	Values	Length
1	IDvitri	Int	11
2	Tenvitri	Varchar	255
3	Latitude	Double	
4	Longitude	Double	
5	Mota	Varchar	1000

Figure 7: Design of data table.

Base on figure 7: It will create two data table with the same field: 01 table is used to store information about location, calling location data table. 01 table is used to store any location binding to traffic warning, calling warning table.

C. *Mobile application*

Figure 8: Functional diagram of connection from mobile devices to server

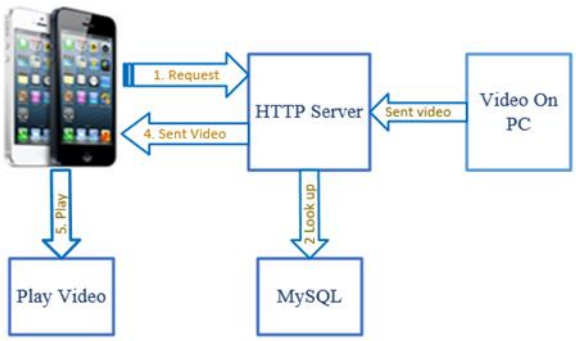

Figure 8 Diagram of mobile devices - server connection

Mobile application is developed by Android Studio [10] for mobile platform. It has the following functions:

- Location tracking will get current location of mobile devices in longitude and latitude.
- A connection to NodeJS server will be established to update current location
- Use Google Map API to show current location of mobile devices on Google Map. Show the markers over warning location on Google Map [7][9]
- Stream video to trigger server to generate traffic warning data.

IV. SYSTEM DEPLOYMENT

A. *Determine traffic situation*

In order to deploy experimental system, we have used data collected from traffic cameras as input data.

International Journal of Engineering Research & Technology (IJERT)
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Determine traffic density of carriage way through traffic camera system (video). Figure 9 shows traffic density of an intersection.

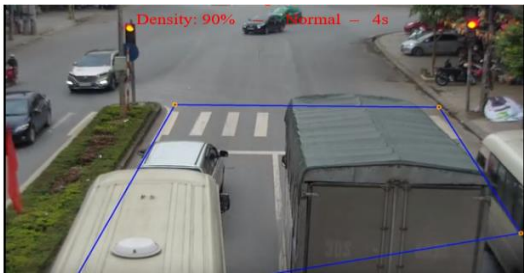

Figure 9: Calculation result of traffic density of an intersection

Determine proportion of reducing traffic density of carriage way in one cycle of traffic light. Figure 10 shows traffic density of carriage way in one cycle of traffic light

Figure 10: shows traffic density of an intersection in one cycle of traffic light

If traffic density changes depending on Table 2. Read data from warning information table, then store it into warning table

B. *Mobile application*

Mobile user interface

Stop Updates: Turn off location tracking on mobile device

Start Updates: Turn on location tracking on mobile device

Mobile device will connect to NodeJS server with address of 192.168.82.1:3000 to update its location in cycle.

Map will show information of location on Google Map. If the location of mobile device is near a traffic warning location, a notification will be displayed on map as indicated in figure 11.

Figure 11. Mobile user interface

When traffic warning location is received, this application has two functions, including warning video auto play in case the traffic users desire such video to be automatically played. If auto play is disabled, the traffic users should tap the icons having sign of warning spot for information about video.

Figure 12. Display warning spots on Google Map

V. CONCLUSION AND DIRECTION FOR PROSPECTIVE DEVELOPMENT

In this article, we have shown the employment of traffic warning system through traffic camera system.

In the future, we will suggest solutions for providing direction to the traffic user in order to prevent traffic congestion at intersections.

ACKNOWLEDGMENTS

"This research is funded by Funds for Science and Technology Development of University of Technology and Education under project number T2018-06-94"

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
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