Identify Traffic Congestion Using Speed Data Measured By Gis, Gps Technique

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Abstract:
With the rapid vehicle volume growth on roads, the performance of urban road traffic systems is a major concern to transportation planners, road users, and all members of the urban community. The evaluation of the performance measures relies on the accuracy and reliability of the collected traffic data.
This study investigates traffic speed measurement using GPS technique for parts of Al-Karada Khareeg road by identify the congested segments. The collected GPS points were mapped to the highway using "Arc Map 10" program in a GIS environment. Travel time, speed and congestion index values were measured along selected highway segments for evaluating the traffic condition of the highways. The benefit of this way is simple, and easy to understand.
Key words: Traffic congestion, Traffic speed, GIS, GPS, Travel Time, Congestion index.

تحديد الاختناقات المرورية باستخدام بيانات السرعة بتقنيات نظم المعلومات الجغرافية و نظام التموضع العالمي

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الخلاصة
مع التزايد السريع للحجم المروري على الطرق, فان الأداء المروري للطرق الحضرية هي الشغل الشاغل لمصممي النقل و لمستخدمي الطرق و كل من له علاقة بالتخطيط الحضري. ان تقييم الأداء يعتمد على دقة و فاعلية جمع البيانات المرورية.
تبحث هذه الدراسة في قياس سرعة مرور المركبات من خلال استخدام نظام التموضع العالمي لجزء من شارع الكرادة خارج و تحديد مناطق الازدحام. ان النقاط التي تم تحديد مكانها باستخدام نظام التموضع العالمي سوف يتم رسمها وتوضيحها على الطريق من خلال استخدام تقنية نظام المعلومات الجغرافية و من خلال برنامج (Arc Map 10). زمن الرحلة و السرعة و قيم الازدحام المروري تم قياسها على طول الطريق حيث يتم استخدامها في تحديد مناطق الازدحام على الطريق. ان الفائدة من هذه الطريقة هي طريقة جديدة و بسيطة وسهلة الفهم.
الكلمات المفتاحية: الازدحام المروري, سرعة المرور, نظم المعلومات الجغرافية (GIS), نظام التموضع العالمي (GPS), زمن الرحلة, معامل الازدحام.

1-1 Introduction:

The traffic volume has been increasing rapidly over recent year in Iraq especially in Baghdad city. As a result transportation related problems are getting worse. The increase in traffic volume result in growing of congestion level with associated environmental pollution and high risk of accidents and time wasted during travel.

With the rapid vehicle volume growth, the performance of urban traffic system efficiency affected by the congestion, this is important issue to all community concern with transportations planners and road users.

The evaluations of road performance need accurate and reliable data collection. There are various methods of traffic data collection include automatic traffic recording device, loop detector, sonic detector, video image processing system and other remote sensing techniques. (1)

Global position systems (GPS) provide a real-time and time measurement of location. GPS technology offers a low capital cost, a low installation cost and a low data collection cost combined with high location accuracy. GPS has increasly used in conducting transportation studies (1). In this study GPS technique has been used as traffic data collection system.

For the purpose of this study GPS data are collected for part of Al-Karada Khareeg road and analyzed. The measured data include Latitude Longitude Altitude speed data and time.

Congestion analysis based on "2" which recommended that travel time based measured should be used to estimate congestion levels. The next section provide descriptions to the study area, field observation, data processing, result presented after that and finally conclusions are developed.

1-2 Goal of the Study:

Identify the congested segment to part of Al-Karada Khareeg road by measuring speed data using GPS, GIS data.

1-3 Study Area:

The area of study is Al-Karada Khareeg highway in Baghdad city the segment studied equal to (5.1 km) length, the segment begin from Kamal Junblat square to Al-Huria intersection with length of (530m) , the second segment from Al-Huria intersection to AL-Masbahh intersection with length of (2560 m), the third segment begin from AL- Masbbah intersection to Aqba bin Nafi intersection with length of (565 m), the forth segment from Aqba bin Nafi intersection to Al –Tahariat square with length of (515 m), fifth segment begin from Al - Tahariat square to Abdul Kader Al-Jazairi square with length of (530 m) and finally the sixth segments begin from Abdul Kader Al-Jazairi square to Abdul Kareem Al-Kattabi intersection with length of (400 m) . This area considered as commercial area which is suffer from congestion problem. The data collection time continued along one month includes the A.M peak (7:00 A.M to 9:00 A.M) and the P.M peak (2:00 P.M to 4:00 P.M) periods on Monday, Tuesday, Wednesday and Thursday, which are considered typical weekdays for traffic analysis, on May 2012 for both directions. Figure (1) represents satellite photo for the road segments.

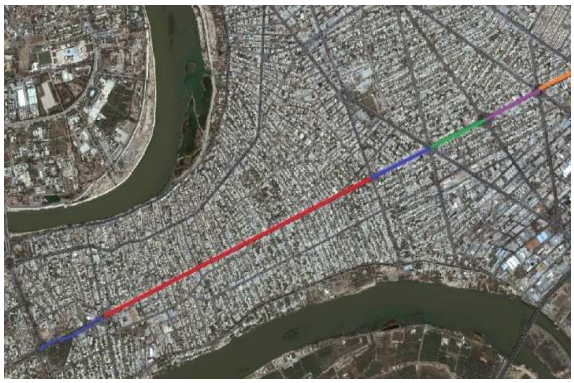

Figure 1- Satellite Photo For The Road Segments

1-4 Spot Speed Data:

Many of the performance measures use speeds reported by the GPS devices known as spot speed. Spot speed is the instantaneous speed measured at a particular moment in time. Spot speed collected by GPS devices have advantages over time and distance based speed calculations in that they can be directly obtained from GPS devices.

(Edward Mc.Cormak and Wenjuan Zhao, Washington University, June 2011) compare GPS spot speeds with speeds estimated from dual loop vehicle detectors on State Route 167, concluded that GPS spot speed data provide a reasonable approach for measuring freight corridor and segment performance characteristics of highway. Based on this concluded, GPS spot speed data can used for the analysis purpose of this paper.

1-5 GPS Data:
A vehicle mounted with GPS equipment record locations and speeds automatically every second. The travel times and speeds for specific roads can subsequently be obtained.

1-6 Data Processing:
1-6-1 GPS Data
The GPS data were keyed in Excel computer program to calculate the travel time and average speed for each segment of the road.

1-6-2 Map Preparation:
An existing digital map containing road network of the study segments was used as a background on which GIS related results were displayed. A map showing the average traffic speed for the segments of the rout studied. Arc view 10 program has been used to prepare this map. Different color codes have been used to presents different type of speed classes on the route. Section where traffic speeds are low and unacceptable presents bottlenecks in the road. Figure (2) and figure (3) presents map for average speed for the segments route for both A.M and P.M peak period in (Abdul Kareem Al-Katabi intersection towards Kamal Junblat intersection) direction. Also the Figure (4) and figure (5) presents map for average speed for the segments route for both A.M and P.M peak period in (from Kamal Junbalat intersection towards Abdul Kareem Al-Katabi intersection) direction.

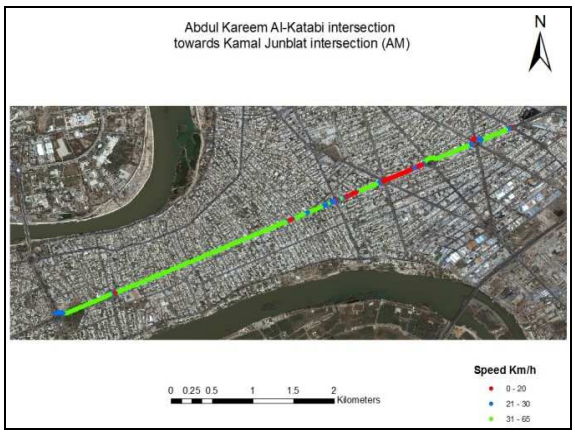

Figure 2- Average Speed For Abdul Kareem Al-Katabi Intersection Towards Kamal Junblat Intersection (AM)

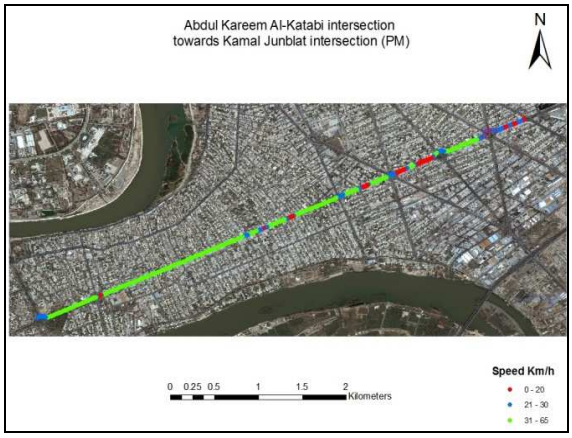

Figure 3- Average Speed For Abdul Kareem Al-Katabi Intersection Towards Kamal Junblat Intersection (PM)

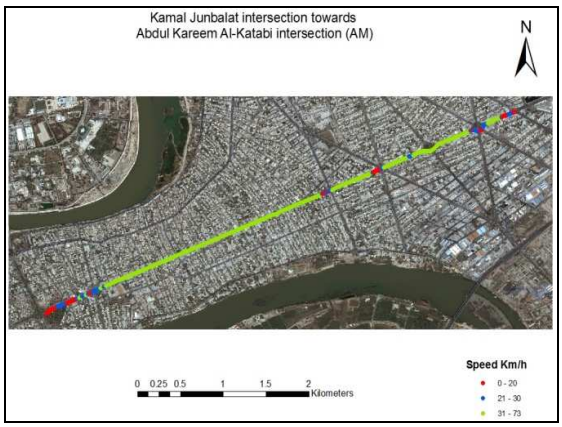

Figure 4- Average Speed For Kamal Junbalat Intersection Towards Abdul Kareem Al-Katabi Intersection (AM)

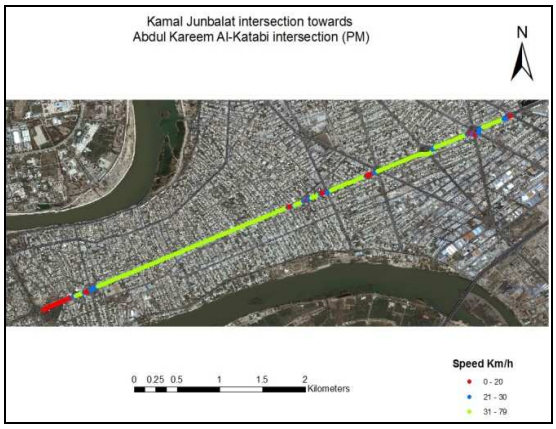

Figure 5-Average Speed For Kamal Junbalat Intersection Towards Abdul Kareem Al-Katabi Intersection (PM)

1-6-3 Speed Profile:
The average speed of the test vehicle can plot with distance for given period of time (peak period) to show speed profile to the designated

route. Figure (6) and figure (7) show speed profile for the study segments for A.M and P.M period for both direction. The speed profile in the figures indicated sections along the route where traffic speed very low (speed below 30 km/hr cause on that speed Flow is forced, with frequent drops in speed to nearly zero mph. Travel time is unpredictable which describes the level of service F (4)) These sections presented traffic congestion and bottlenecks in the road, and the level of service (LOS) was unacceptable and where speed were considered averagely high (speed greater than 30 km/hr.) with acceptable (LOS).

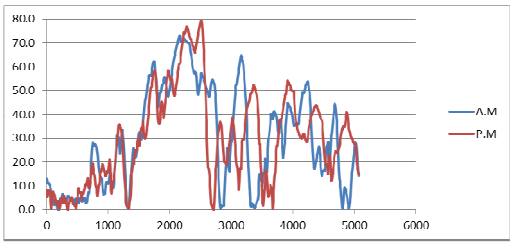

Figure 6- Average Speed Of The Study Rout Segments For A.M And P.M Period From Kamal Junbalat Intersection Towards Abdul Kareem Al-Katabi Intersection

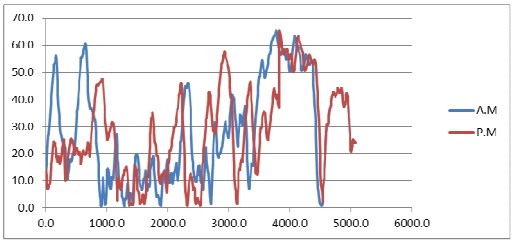

Figure 7- Average Speed Of The Study Rout Segments For A.M And P.M Period From Abdul Kareem Al-Katabi Intersection Towards Kamal Junblat **Intersection**

1-6-4 Percent Speed Distribution Of Congested Segments:

Table (1) show percent distribution of the congested sections of the selected route towards Abdul Kareem Al-Kattabi Intersection. . The heavily congested segment is segment (1), 96 % presented speed less than 30 km/hr. for A.M period and 95 % for P.M period, cause under 30 k/hr. flow is forced, with frequent drops in speed to nearly zero mph. Travel time is unpredictable, while segment (2) were the least congested segment, present 84% presents speed more than 30 km/hr. for A.M period and segment (4) present least congested segment, percent 82 % presents speed more than 30 km/hr. for P.M period.

On the other direction from Abdul Kareem Al-Kattabi Intersection to Kamal Junblat intersection the heavily congested segment is segment (4) and segment (6) presents 100% percent less than 30 km/hr. for A.M and P.M period. While the least congested segment is segment (5) presents 90% speed more than 30 km/hr. for A.M period and segment (2) present 70 % speed more than 30 km/hr. for P.M period. This percent shows on table (2).

Table 1- Percent Distribution Of The Congested Sections For A.M And P.M Period Towards Abdul Kareem Al-Kattabi Intersection.

	A.M period		P.M period	
Seg. No	ds less than	% of speeds more than 30 km/hr	% of speeds less than 30 km/hr	% of speeds more than 30 km/hr
1	**96**	4	**95**	5
2	16	**84**	21	79
3	57	43	49	51
4	39	61	18	**82**
5	50	50	49	51
6	85	15	43	57

Table 2- Percent Distribution Of The Congested Sections For A.M And P.M Period Towards Kamal Junblat Intersection.

	A.M period		P.M period	
Seg. No	ds less than	% of speeds more than 30 km/hr	% of speeds less than 30 km/hr	% of speeds more than 30 km/hr
1	33	69	33	67
2	29	71	30	**70**
3	81	19	59	41
4	**100**	0	**100**	0
5	10	**90**	37	63
6	65	35	**100**	0

1-6-5 Congested Analysis:

Congestion analysis is critical for evaluating road performance. Lomax et al. 1997 recommended that travel time based measures should be used to estimate congestion levels, since speed data can be determined from the time and location provided by GPS receiver, the travel time and average travel speed, congested index that based on travel time were selected for

measuring the congestion for the study route segments.

Table (3) and table (4) present the travel time for each segments of the route for A.M and P.M peak period. The average travel time for all segments was calculated.

From the map prepared by GPS it can be seen that the segments separated by intersection or square round about, these intersection presents high delay in the direction of the selected route. Table (5) shows the delay time for each intersection separate the link road.

Table 3- Average Travel Time And Average Travel Speed For Each Segment A.M Peak Period

Segment No.	From Abdul Kareem Al-kattabi Int. to Kamal Junblat Int. ذهاب			From Kamal Junblat Int. to Abdul Kareem Al-kattabi Int. اياب		
	Length m	Average Speed km/hr.	Travel Time Sec.	Length m	Average Speed km/hr.	Travel Time Sec.
1	530	32.8	71	530	10.9	161
2	2560	40.6	231	2560	49	184
3	565	17.9	105	565	28.9	68
4	515	11.4	115	515	28.8	84
5	530	42.8	75	530	32.9	58
6	400	29.3	59	400	13.7	86

Table 4- Average Travel Time And Average Travel Speed For Each Segment P.M Peak Period

Segment No.	From Abdul Kareem Al-kattabi Int. to Kamal Junblat Int. ذهاب			From Kamal Junblat Int. to Abdul Kareem Al-kattabi Int. اياب		
	Length m	Average Speed km/hr.	Travel Time Sec.	Length m	Average Speed km/hr.	Travel Time Sec.
1	530	32.8	72	530	10.4	163
2	2560	38.3	262	2560	48	167
3	565	25.7	44	565	30.9	97
4	515	2.7	219	515	37.2	65
5	530	34.3	57	530	29.9	65
6	400	17.8	93	400	30.5	40

Table 5- Delay Value In Second For Each Intersection Separate Each Segments

Intersection Name	From Abdul Kareem Al-kattabi Int. to Kamal Junblat Int. ذهاب		From Kamal Junblat Int. to Abdul Kareem Al-kattabi Int. اياب	
	A.M period	P.M Period	A.M period	P.M Period
Al-Huria Intersection	22	21	22	24
Al-Masbbah intersection	168	126	38	31
Oqba bin Nafia Intersection	313	365	61	82

From table (5) it can be seen the high value of delay, knowing that the delay is for one approach, that approach is on the direction of the link selected to the study. It's obvious the level of service (LOS) for the intersections unacceptable.

Congested index has been calculated from the following equation (5):

$$C.I = \frac{C - C_\circ}{C_\circ}$$

C.I = Congestion Index

C = Actual Travel Time

$C_\circ$ = Free Flow Travel Time

Congestion index near zero will indicate very low level of congestion, while an index greater than 2 will indicate very congested condition. Actual travel time can be calculated for each segment from GIS speed data, speed limits were adopted for calculating the free flow travel time. (3).

Congestion index were calculated for each segments, table (6) show congestion index for A.M and P.M period towards Abdul Kareem Al-Katabi intersection, While table (7) show congestion index for A.M and P.M period towards Kamal Junblat intersection.

Table 6- Congestion Index For A.M And P.M Period Towards Abdul Kareem Al-Katabi Intersection

Segments	C.I for A.M period		C.I for P.M period	
1	4	High congestion	4	High congestion
2	0.1	Low congestion	0.1	Low congestion
3	1	Medium congestion	2	High congestion
4	1.6	Medium congestion	1	Medium congestion
5	0.8	Low congestion	1	Medium congestion
6	3.6	High congestion	0.5	Low congestion

Table 7- Congestion Index For A.M And P.M Period Towards Kamal Junblat Intersection

Segments	C.I for A.M period		C.I for P.M period	
1	1.2	Medium congestion	1.2	Medium congestion
2	0.4	Low congestion	0.7	Low congestion
3	2.2	High congestion	0.3	Low congestion
4	2.6	High congestion	5.8	High congestion
5	1.3	Medium congestion	0.7	Low congestion
6	1.3	Medium congestion	2.7	High congestion

Figure (8) show the congestion index to the study rout segments for A.M and P.M period from Abdul Kareem Al-Katabi intersection towards Kamal Junbalat intersection, while figure (9) shows the congestion index to the study rout segments for A.M and P.M period from from Kamal Junbalat intersection towards Abdul Kareem Al-Katabi intersection

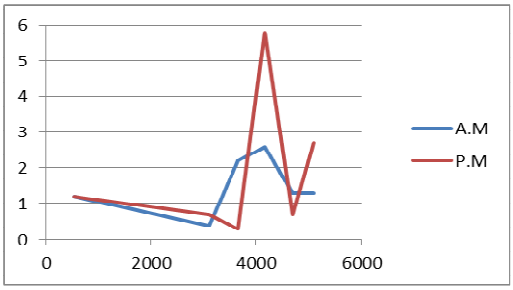

Figure 8- Congestion Index To The Study Rout Segments For A.M And P.M Period From Kareem Al-Katabi Intersection Towards Kamal Junbalat Abdul

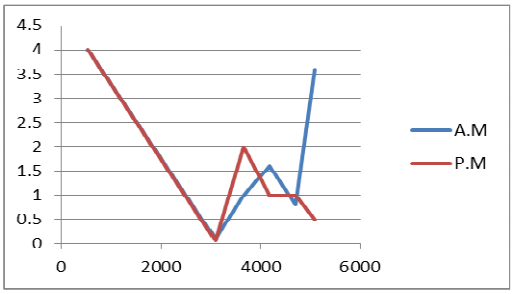

Figure 9- Congestion Index To The Study Rout Segments For A.M And P.M Period From Kamal Junbalat Intersection Towards Abdul Kareem Al-Katabi Intersection

1-7 Discussion:

From Figure (8) and table (5) can be seen that the maximum congestion index for A.M period is 2.6, and 5.8 for P.M period is for the fourth segments from Kamal Junbalat intersection towards Abdul Kareem Al-Katabi intersection direction, while from figure (9) and table (6) can be seen that the maximum congestion index for A.M period and P.M period is 4 for the first segments from Abdul Kareem Al-Katabi intersection towards Kamal Junblat intersection direction.

From the percent speed distribution and congestion index analysis can be seen the studied segments have relative congestion especially on the direction of Abdul Kareem Al-Katabi intersection to Kamal Junblat intersection at four and six segments. On the other direction from Kamal Junblat intersection to Abdul Kareem Al-Katabi intersection the congestion concentrated at the first segment at A.M and P.M peak period and at segment three at A.M period.

The difference along the studied route during A.M and P.M period because at the morning and afternoon people runs to attend or leave the area of their work.

From the map prepared by Arc view 10 program and from speed profile can be notice the area which vehicle volume is high because when traffic volume crowded the speed profile dropped at low speed value less than 20 km/hr. this identify the section area of bottleneck at the route. These sections need more critical attention from the planner or decision makers.

1-8 Conclusions:

1- Speed data derived from GPS and GIS can be effectively used to identify traffic congestion and bottleneck of highway road network.

2- Mapping the GIS and GPS speed data at any given time provide a tool for management of urban traffic system by urban planner.

3- The methodology used in this paper can be used for more highway network.

4- The intersections and square separate each segments of the route need special attention and improvements due to high delay value and low level of service at these intersections.

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