Intelligent BRT in Tehran

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Abstract:
An intelligent BRT system is necessary when communities looking for new ways to use high capacity rapid transit at a reduced cost. This paper will describe the intelligent control system that works with Datacenter. With the help of GPS system, the data center can monitor the situation of each bus and bus station. Through RFID technology, bus station and traffic light can transfer data with bus and by Wimax communication technology all of parts can talk together; data center learns all information about the location of bus, the arrival of bus in each station and the number of passengers in station and bus. Finally, the paper presents the case study of those theories in Tehran BRT.

Keywords: *Tehran BRT, RFID, intelligent transportation*

1. Introduction

This paper presents a design of an intelligent BRT system to improve BRT service in Tehran, such as minimizing the delay of BRT buses by changing management on traffic lights and BRT stations that increasing speed and reducing travel time; that minimizes the count of active BRT buses that causes reducing the cost [1], [2].

In addition, a brief background of Tehran BRT can be found in section 2, the tools used are described in section 3, the methodology employed and the idea for improvement described in section 4 and conclusion can be found in section 5.

2. Background

2.1. What is BRT

BRT is a high quality, high capacity rapid transit system that in many ways improves upon tradition rail transit systems. Vehicles travel in exclusive lanes, thus avoiding traffic. Passengers walk to comfortable stations, pay their fare in the station, and board through multiple doors like a train. Service is very frequent and often passengers can choose between express and local routes, an option not available on most train systems.

Fig. 1. BRT

2.2. Tehran BRT

In Iran, the BRT system has been implemented in Tehran. Tehran Bus Rapid Transit has been officially inaugurated by Tehran's mayor in order to facilitate the motor traffic in Tehran on January 14, 2008. Tehran has five BRT lines. The first stretch of Tehran BRT corridor from Azadi square to Tehran-pars has been operational since Jan (2008).

Table I. Teheran BRT Lines

Line	Status	Start point	End point	Stations	Distance (KM)
1	ok	Azadi Terminal	Tehran-Pars	26	18.7
2	ok	Azadi Terminal	Khavaran Terminal	26	18.7
3	ok	Elm-O- Sanat Terminal	Khavaran Terminal	18	14.3
4	Under construction	Parkway	South Terminal	21	21.5
5	Under study	Elm-O-Sanat Terminal	Dehkadeh Olympic	16	22
6	Under construction	Babayee Highway	Ponak		19
7	Under construction	Railway station	Tajrish	27	17.5
8	Under study	Besat Highway	Basij		6.2
9	Under study	Besat Highway	Babayee Highway		17
10	Under construction	Ponak	Azadi Terminal		6

The total length of BRT in Tehran is about 100 km that will be increased to 300 km in future.

Fig. 2. Tehran BRT

3. Tool used

The BRT buses and bus stations will be equipped with; APC (Automatic Passenger Count System), RFID (Radio Frequency Identification) and GPS (Global Positioning System) [3], [4].

3.1. Automatic Passenger Count System (APC)

APC is an advanced technology solution that helps transit improves. APC technology puts infrared sensor at the bus doors and bus station gates to count passengers as they board and leave.

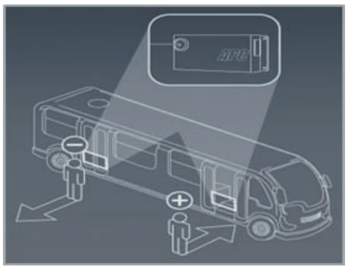

Fig. 3. APC

APC collects ridership data on every bus, per door per every bus station, and per every gate basis. Counted passengers are stored on the bus and bus station and downloaded into a data center where the information can be readily correlated to scheduled runs, routs, stops, time (arrive – leave), date and destination.

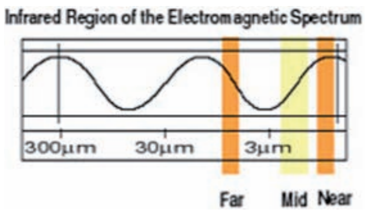

Fig. 4. Infrared sensor

3.2. Radio Frequency Identification (RFID)

RFID is an electronic method of exchanging data over radio frequency waves. There are three major components for a RFID system: Transponder (Tag), Antenna and a Controller. RFID tags can be active, semi-passive (=semi-active) or passive [5].

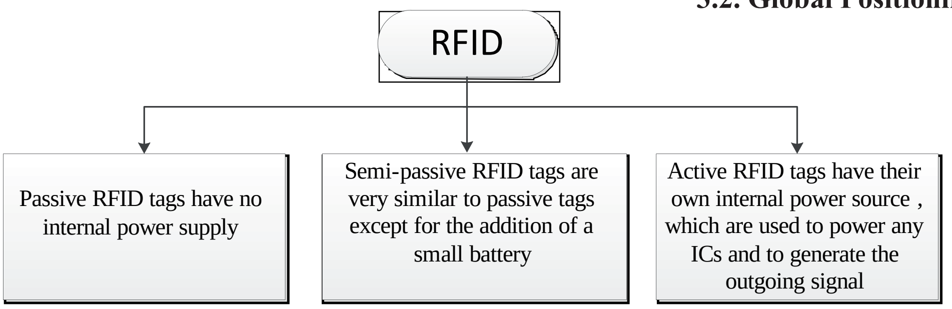

Fig. 5. RFID Types

3.2.1. Passive RFID tags

Passive RFID tags have no internal power supply. The minute electrical current induced in the antenna by the incoming radio frequency signal provides just enough power for the CMOS integrated circuit (IC) in the tag to power up and transmit a response. Most passive tags signal by backscattering the carrier signal from the reader. This means that the antenna has to be designed to both collect powers from the incoming signal and to transmit the outbound backscatter signal.

3.2.2. Semi-passive RFID tags

Semi-passive RFID tags are very similar to passive tags except for the addition of a small battery. This battery allows the tag IC to be constantly powered. This removes necessity the aerial to collect power from the incoming signal. Therefore, Aerials can be optimized for the backscattering signal. Semi-passive RFID tags are faster in response and therefore stronger in reading ratio compared to passive tags.

3.2.3. Active RFID tags

Active RFID tags or beacons, on the other hand, have their own internal power source, which are used to power any ICs and to generate the outgoing signal. They may have longer range and larger memories than passive tags, as well as the ability to store additional information sent by the transceiver. To economize power consumption, many beacon concepts are operated at fixed intervals.

A RFID-Reader is also required on bus stations and traffic lights to receive the signal from the BRT buses. The RFID-Reader requires the exact position of the intersection to make decisions; the code in each RFID-Reader is unique [6], [7].

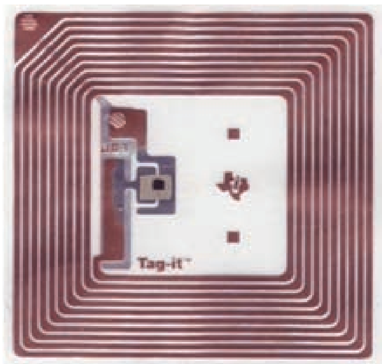

Fig. 6. RFID

3.2. Global Positioning System (GPS)

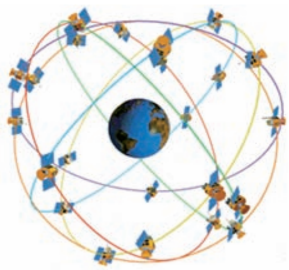

Fig. 7. GPS

GPS has been developed by the United States' Department of Defense. It uses between 24 and 32 Medium Earth Orbit satellites that transmit precise microwave signals. This enables GPS receivers to determine their current location, time and velocity.

Table II. Compare (RFID&WiFi&GPS)

	RFID-active	WiFi	GPS
Power Usage	Low to Medium	High	Medium
Data rate	Low to Medium	High	Not Applicable
Coverage	Medium	High	Very High
Security	Medium	High	Not Applicable

4. Methodology employed

This algorithm used with buses, bus stations and traffic lights, which have the hardware as described in Tools used. Modes of operation: the algorithm runs in different modes. First data center call a bus and the intelligent cycle will be started [8], [9].

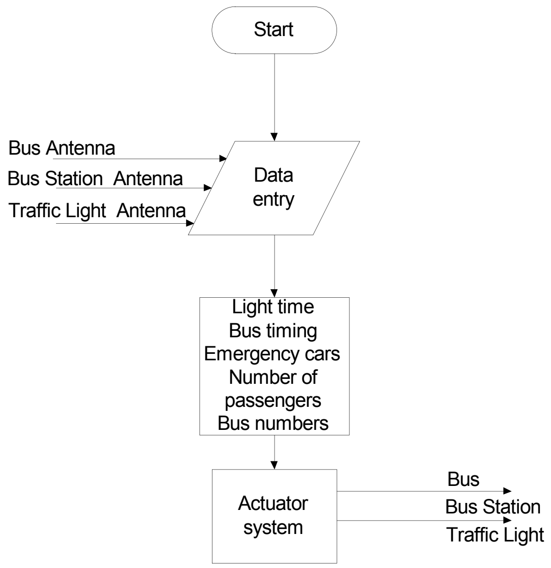

Fig. 8. A flowchart of system

1) Traffic light Act:
   - Green mode
   - Red mode
   - Idle mode
2) Bus Act:
   - Speed change
   - Stop
   - Acceleration mode
   - Deceleration mode
   - Passenger count
3) Bus Station Act:
- Choice terminal for bus
- Choice terminal for passenger
- Passenger count

Fig. 9. Bus signals

4.1. Bus station mode

When the distance between bus and bus station is less than 50 meters, bus sends a signal to the bus station and bus station listens for BRT interrupts – capacity, direction, speed and number of passengers that bus sends then bus listens for BRT bus station interrupts – free gate number, capacity and number of passengers in station [10], [11].

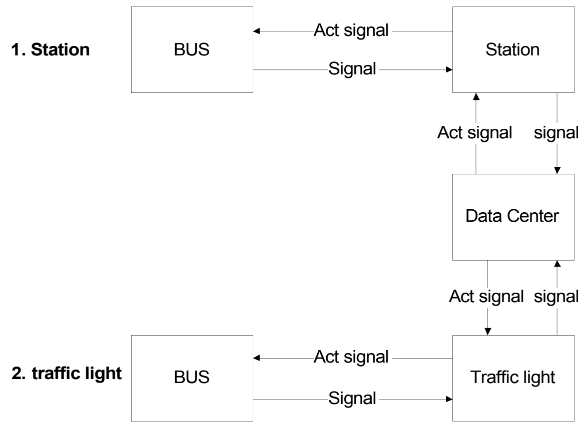

Fig. 10. A flowchart illustrating the flow of algorithm

4.2. Traffic light mode

When the distance between bus and traffic light is less than 50 meter, bus sends a signal to the traffic light and traffic light listens for BRT interrupts – capacity, direction, number of passengers then the bus listens for traffic light interrupts emergency mode, stop or keep riding [12], [13].

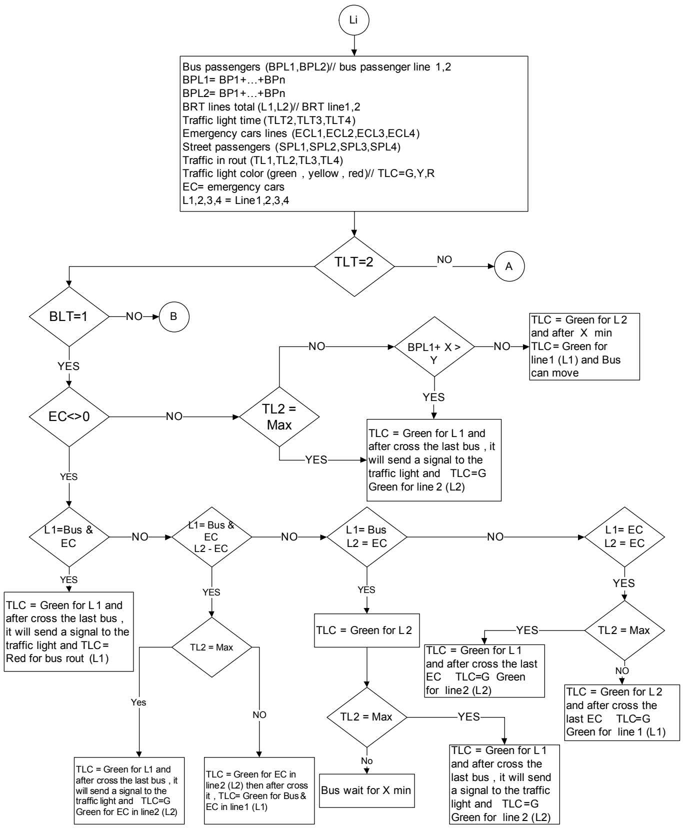

Fig. 11. Traffic Light Algorithm

5. Conclusion

With this research, this data will be accessible for Datacenter:

1) All of passengers in each station equal to all of passengers in waiting,
2) All of passengers in each bus in equal to of passengers in transfer,
3) Ability to analyze the critical stations,
4) Ability to Schedule traffic lights information,
5) Ability to record diary.

To get a good result we need data that are without defects in determination centers. With given information above two important points are enforceable:

1) Just in time determination,
2) Future forecasting with diary data.

Benefits:

1) Speed will be increased in BRT,
2) Cost of transformation will be decreased,
3) Time of delay to be decreased in stations,
4) Time of delay to be decreased behind traffic lights,
5) Passengers will be distributed among the buses.

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References:

[1] Yin Zhu, "Study on Intelligent Traffic Control Based BRT". In: *Conf. Intelligent Systems and Applications (ISA)*, Beijing, China, May 2010.

[2] T. Gang, "The Application Study of Model and Algorithm on Bus Scheduling", *Journal of Qingdao University of Science and Technology*, China, 2004.

[3] L. Da-ming, J. Xiao-jing, "General Introduction of Bus Rapicl Transport Intelligent System of Beijing South-Center Corridor". In: *Conf. Communication and Transportation Systems Engineering and Information*, China, 2005.

[4] W.H. Hsieh, C.J. Ho, G.J. Jong, "Vehicle Information Communication Safety Combined with Mobile RFID". In: *Conf. Intelligent Information Hiding and Multimedia Signal Processing*, China, 15th–17th August 2008.

[5] S. Inoue, H.Yasuura, "RFID privacy using user-controllable uniqueness (Privacy Workshop)", Nov. 2003.

[6] B. Jirong, S. Liya, L. Jinyuan, "Design of transportation safety management system for dangerous goods based on RFID", CNKI:SUN:NXGJ.0.2010-03-017.

[7] X.H. Fan, Zhang, Y.L.A, "Design of bi-verification vehicle access intelligent control system based on RFID". In: *Conf. International Conference on Electronic Measurement & Instruments*, Beijing, China, 16th–19th August, 2009.

[8] B.C. da Silva, R. Junges, D. de Oliveira, Bazzan, "An intelligent transportation system for urban mobility (Autonomous agents and multiagent systems)", *AAMAS'06*, 2006, pp. 1471–1472.

[9] G. Kotusevski, K.A. Hawick, "A Review of Traffc Simulation Software". In: *Conf. Information and Mathematical Sciences*, New Zealand, 23rd July, 2009.

[10] S. Wenchao X. Jianmin Y. Feng, "An Intelligent Transportation Simulation System Based on RFID Orientation Technology" , CNKI:SUN:JTJS.0.2009-01-031.

[11] J.-P. Hubaux, S. Capkun, J. Luo, "The security and privacy of smart vehicles", *IEEE Security and Privacy*, 2004, pp. 49–55.

[12] Y. Sato, K. Makane, "Development and Evaluation of In-Vechicle Signing System Utilizing RFID Tags as Digital Traffic Signals", *Int. J. ITS*, 2006, pp. 53–58.

[13] W. Hongjian, T. Yuelin, L. Zhi, " RFID Technology Applied in Highway Traffic Management (Periodical style)". In: *Conference on Optoelectronics and Image Processing*, vol. 2, November 2010, pp. 348–351.