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Safe Lines to Transit in Tehran's BRT

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Abstract-Transportation is one of the most important foundations of a city. With increasing population and the advent of modern navigation systems such as BRT, new problems have emerged. Security is one of the important parameters in the field of transport that can be divided by considering the nature of the system components, into two parts, physical and non-physical .In the physical part, measures such as placement of the stations along the way, the range of motion, and the specific route are discussed. The nonphysical part has provided appropriate field to control extremist buses safety system by considering the variety of new technologies .In this article is paid reviews to the safety of BRT lines in Tehran metropolis by using NFC, Infrared and RFID technologies. Creating a safe corridor by combining the existing physical infrastructure and the use of communications systems in all components of BRT system is improve passenger safety factor in the urban trips. The purpose of this paper is reduction and prevention from traffic injury and accident in Tehran's BRT lines.

Keywords-*Near Field Communication; Safety Transportation; Intelligent BRT.*

I. INTRODUCTION

This paper presents a design of safety BRT system to improve BRT service in Tehran, such as minimizing the accidents between bus and non-authorized vehicles by using RFID tags and motion sensors. By the aid of NFC communicative technology, the bus doors opened in the suitable locations. In addition, Historical development of BRT in the world and a brief background of Tehran BRT can be found in section2, the tools used are described in section3, the Safety parameters can be found in section 4, the methodology employed and the idea for improvement described in section5 and conclusion can be found in section6 [1].

II. BACKGROUND

A. 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 fair 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 [2].

Fig. 1 BRT

B. Historical Development Of BRT In The World

Bus Rapid Transit was first implemented in Curitiba, Brazil in 1974, and has become a global phenomenon in the twenty-first century. Major new BRT projects have opened since the turn of the century in Africa, Australia, China, India, Indonesia, Iran, Mexico, Turkey, several cities in Europe, and dozens of cities in Latin America.

In the 1970s, development of BRT systems was limited to the North and South American continent. In the late 1990s, the replication of the BRT concept gained momentum and BRT systems were opened in Quito, Ecuador (1996), Los Angeles, USA (1999) and Bogotá, Columbia (2000). Especially, the Trans Milenio project in Bogotá started operation in 2000 and its success drew attention from the world community as an example of the state of the art in BRT systems.

In 2008, transit ridership in the United States reached its highest level since the mid-1950s and ridership grew faster than population and vehicle miles travelled between 1995 and 2008.The flexibility and cost effectiveness of Bus Rapid Transit make it an excellent choice for cities and transit agencies facing both increasing demand for transit and increasingly constrained budgets[3].

C. 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. TEHRAN 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

III. TOOL USED

The BRT buses will be equipped with; Active RFID (Radio Frequency Identification) and Active NFC (near field communication). The BRT lines and input/output gates will be equipped with motion sensors, RFID Reader and Punitive cameras [4].

A. NFC

NFC is a standards-based, short-range wireless connectivity technology that that allows exchange of digital data between devices within a radius of more or fewer 10 centimeters (can be raised to 20 with compact antenna). With NFC technology, consumers can perform contactless transactions, access digital content and connect NFC-enabled devices with a single touch. NFC simplifies Setup of some longer-range wireless technologies, such as Bluetooth and Wi-Fi. It is also compatible with the global contactless standards (ISO 14443 and/or ISO 18092), which means transport agencies that have already deployed contactless programs enjoy a built-in advantage, as their equipment may readily interact with NFC enabled mobile devices and provide richer services.

The following chart shows how NFC compares in range and speed with other wireless technologies that can be used in a mobile phone. Communication occurs when two NFC-compatible devices are brought within about four centimeters of each other. By design, NFC requires close proximity and it offers instant connectivity, which provides an intuitive consumer experience that can be readily applied to the transit environment.

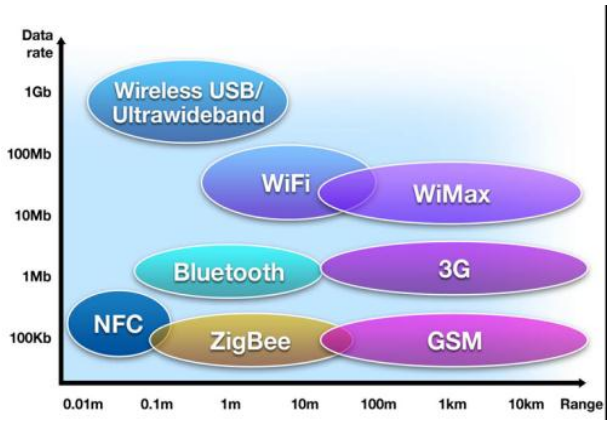

Fig. 3 NFC and Contactless Technologies

B. 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].

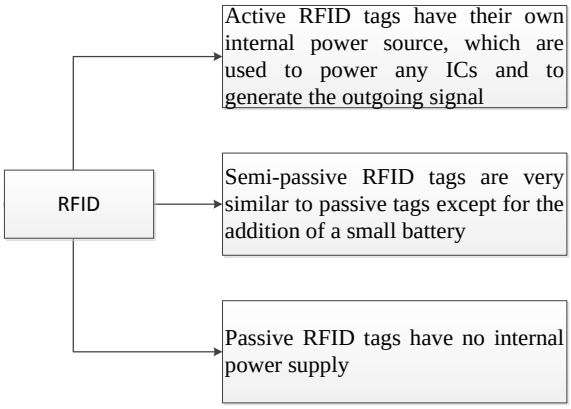

Fig. 4 RFID Types

- 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 both collect powers from the incoming signal and to transmit the outbound backscatter signal.

- 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.
- 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 [6], [7].

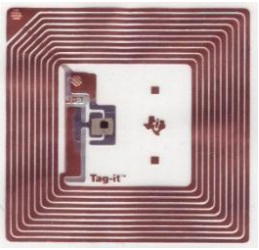

Fig. 5 RFID

C. Motion Sensor

A motion sensor is an electronic device -often part of a larger system, such as a light or camera- that detects motion to activate the system. There are two basic types of motion sensors: active sensors and passive sensors. Active sensors emit a signal, typically an ultrasonic burst of sound waves, similar to a sonar system, which is reflected by the surroundings; this reflected signal is received by the sensor. When something moves within the area of an active motion sensor, the change in signal that is reflected to the sensor activates the system. This type of sensor is often used for indoor security and automatic garage door openers.

Passive sensors are a type of motion sensor that do not emit a signal, but instead detect infrared radiation around the sensor. When a person or animal moves through the area, heat from the movement is detected by the sensor, which then activates the system to which it is connected. This type of motion sensor is often used for motion-activated lights or cameras in a security system. Passive sensors are typically set to detect only sudden or extreme changes in thermal radiation, which prevents such systems from activating due to changes in surrounding temperature caused by the sun rising or pavement cooling at night.

A motion sensor can also utilize a combination of passive and active technology. This type of system is often used in stores to trigger a sound when someone enters the business. The motion sensor usually consists of two parts: one that emits a laser or similar energy signal, and a second piece that receives the signal. When someone passes through the system, the signal is interrupted and the receiving piece activates a response such as a bell. This type of system is not usually used for security purposes, since the energy beam could be avoided quite easily to keep from activating the system.

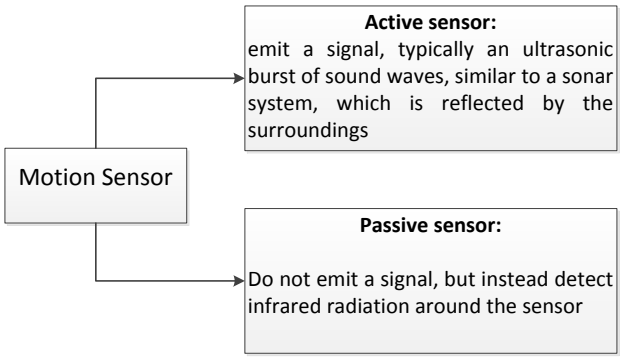

Fig. 6 Motion Sensor Types

D. Punitive Cameras

Punitive cameras are used by law enforcement agencies to automate part of the process used to ticket and fine motorists that are disregarding regulations and break the law.

These cameras are activated based on a special event, such as a motorist entering an intersection when the lights are red, or the vehicle is clocked at excessive speed by radar or systems mounted in or near the camera system. At this point the camera uses sophisticated software to take pictures of the areas on a vehicle that contain a license plate.

The data is then transmitted to the law enforcement agency electronically for processing. Usually the offender will receive a letter from the law enforcement agency through postal mail containing a ticket, the fine levied, and the picture taken during the illegal or offensive activity.

Fig. 7 Punitive Camera

E. Infrared Sensor

Infrared sensor units are capable of emitting infrared light, which cannot be seen by the human eye, and are able to turn on devices when the infrared light is disturbed. Selecting an infrared sensor with an appropriate range will ensure the sensor

covers the desired area so nothing can get around it. Infrared sensors can be mounted in either an outlet or a ceiling; both have their own advantages. White light can sometimes disturb the sensor, which may lead to problems, so it is best to get a sensor that is immune to this light. Sensors are hooked up to many different devices, such as burglar alarms and light switches, and the user should get the right sensor for the device.

Every infrared sensor has a certain operating range. The sensor will shine light as far as the specified range, and anything that gets close to the sensor will trigger a response. The best sensor will have enough range for the application. For example, a bathroom will need less range than an entire store, so the user should measure out the area and ensure the sensor can cover it.

When it comes to mounting an infrared sensor, there are two main mounting types: outlet and ceiling. Plugging the sensor into an outlet is the easiest mounting and is best for small areas; the common range of these sensors is about half that of a ceiling sensor. The ceiling sensor will require some wiring work to install, but this sensor usually has a better range and the sensor radiates light in an entire circle. The outlet version just radiates light in one direction.

During the day, especially if there is a window nearby, an infrared sensor may get confused and mistake white light for movement. This will cause the sensor to go off, along with any device connected to it. A sensor that comes with white light immunity will greatly reduce the chance of this happening and is best for areas where natural light will hit the sensor.

Infrared sensor units are typically made to work with one type of device. The most common devices are burglar alarms, lights and security cameras. They are made for a specific device, so the user should purchase one that works best for his or her intended application. Getting another type of infrared sensor may work fine, but this commonly leads to the sensor inaccurately activating.

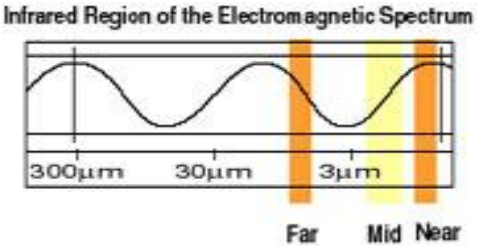

Fig. 8 Infrared Sensor

IV. SAFETY PARAMETERS

A. *Physical Safety Parameters*

1) Stations are in center and shared by both directions of service.

In general it is better if there is one bus station in the central median shared by buses traveling in both directions, rather than having split stations.

While this requires the procurement of buses with doors on the left side, it reduces the amount of space needed for bus platforms. As the corridor grows into a network, passengers will transfer between bus lines more frequently. This is more Convenient when one can simply cross the platform, than if one has to exit the station and enter another one.

Fig. 9 Stations are in center

2) Physically-separated right-of-way.

Providing buses with exclusive right-of-way in bus ways allows them to travel at free-flow speeds and avoid mixed traffic congestion. During periods of congestion, dedicated rights-of-way allow bus speeds between station stops to surpass vehicle Speeds in the remaining mixed traffic lanes.

In the best systems, enforcement of a dedicated right-of-way is assisted by a physical barrier to protect the lane from encroaching vehicles. In technical terms, the physical separation is only necessary where there is traffic congestion and a Risk that vehicles will encroach on the dedicated right-of-way. However, because congested conditions change over time, and because the physical separation makes the system feel more official, physical separation is generally recommended throughout the entire length of the trunk corridors.

This physical separation is ideally something that is not so rigid and impermeable that a bus cannot get out of the lane without damaging the vehicle or the barrier. As a rule of thumb, physical separation is most important in downtown areas and on the major trunk arterials that tend to experience traffic congestion.

Fig. 9 Physically-separated

3) Improved safe and attractive pedestrian access system and corridor environment.

As most transit trips begin or end in a walking trip, it is important that the walking environment around transit stations be safe and attractive. A safe and attractive walking environment is also attractive to developers and businesses. This means that all stations should include crosswalks or other amenities to ensure safe street crossings, and sidewalks in the nearby area should be sufficiently wide. Public art and street trees, to provide shade, should be added to enhance the pedestrian environment [8].

Fig. 10 Corridor Environment

B. Non-Physical Safety Parameters

1) Locating the bus doors in appropriate place by using the NFC technology.

To have enough assurance and safety of having the doors located in appropriate gateways, a connection between the transmitter installed on the gateway and the ones located on the doors of bus will be established, using the NFC technology. The doors will be having the opening permission once the connection is made thoroughly.

2) Passengers safe come and go in and from the bus using the infrared technology.

In order to have necessary assurance of a complete passengers replacement in the station, a coverage of infrared signal will be given to the interior section of the doors by having this method required control's on doors not to be closed while passengers are passing will be established.

V. METHODOLOGY EMPLOYED

This algorithm used with buses, BRT line and input/output gates, which have the hardware as described in Tools used.

First the motion sensor detect object in BRT line if the RFID Reader diagnosis emergency or authorized vehicle the control unit allow to across but if RFID Reader get invalid signal or can't diagnosis the object that want to across in BRT line ,send a signal to control unit and ask from Punitive camera to record object activity.

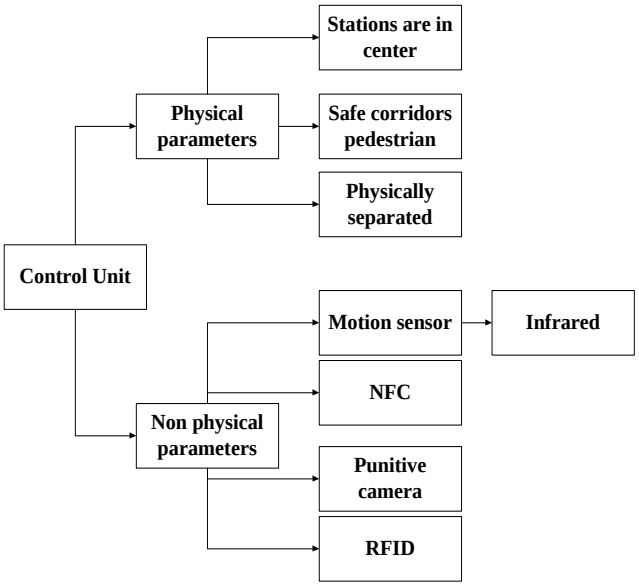

Fig. 11 a Flowchart of System

When the distance between bus and input/output gates is less than 50 meter, bus sends a signal to the input/output gate 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.

After bus station decided which gate should be chooses for the bus When the passengers wants to move between bus doors and bus stations space the infrared sensors that located on the bus doors sense people and prevent the bus to leave the station.

VI. CONCLUSION

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.

Some of the advantages of using this system are as the following:

- Passenger's safety will be increased in stations and during the tripe.
- Diagnosis non-authorized vehicles, direction them to the first exit.
- Time of delay to be decreased in stations.
- Accident probably will be decreased between bus and non-authorized vehicles.

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