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Tehran-Tabriz Intelligent Highway

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***Abstract*—**The need to implement intelligent highways is much more emphasized with the growth of vehicle production line as well as vehicle intelligence. The control of intelligent vehicles in order to reduce human error and boost ease congestion is not accomplished solely by the aid of human resources. The present article is an attempt to introduce an intelligent control system based on a single central computer. In this project, central computer, without utilizing Global Positioning System (GPS), is capable of tracking all vehicles, crisis management and control, traffic guidance and recording traffic crimes along the highway. By the help of RFID technology, vehicles are connected to computerized systems, intelligent light poles and other available hardware along the way. By the aid of Wimax communicative technology, all components of the system are virtually connected together through local and global networks devised in them and the energy of the network is provided by the solar cells installed on the intelligent light poles.

***Keywords*—**intelligent highway, intelligent light pole, highway automation

I.INTRODUCTION

TEHRAN to Tabriz freeway is an important transit road that connects Iran's industrial zones to Tabriz and Turkey.

Fig. 1 Tehran-Tabriz Highway

Iran with the annual traffic fatalities of 28000 people has the highest traffic fatality rate in the world. The rate of traffic accidents in Iran are twenty times more than global average. A preview of the annual statistics from 2006, for instance, reveals that 2700 children under 15 years old died due to traffic accidents and near 95000 children and teenagers less than 20 years old were injured [1][2].

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TABLE I
TEHRAN – QAZVIN CAR ACCIDENTS STATISTICS

Head trauma	soft tissue injury	Fractures	abdominal injury	chest trauma
49%	48%	47%	12%	13%

II. COMPONENTS OF THE SYSTEM

A. Radio Frequency Identification

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 [3].

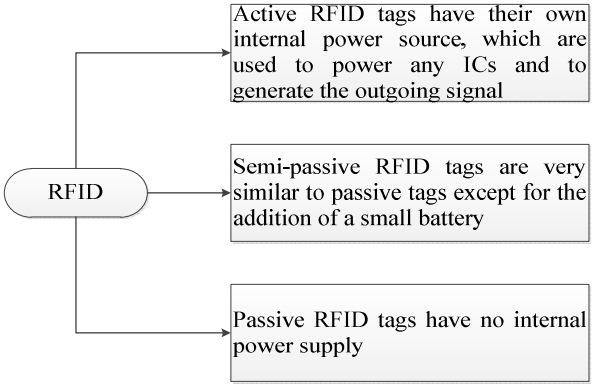

Fig. 2 RFID types

•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 to 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 [4], [5].

TABLE II
THE COMPARISON OF RFID, GPS AND WIFI

	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

B. Solar cell

A solar cell is a device which generates electricity directly from visible light by means of the photovoltaic effect. The development of solar cell technology begins with the 1839 research of French physicist Antoine-César Becquerel. Becquerel observed the photovoltaic effect while experimenting with a solid electrode in an electrolyte solution when he saw a voltage develop when light fell upon the electrode.

Various solar cells composed of various materials have been developed in the last decades. Cells are typically classified as crystalline or thin film. Crystalline silicon; these types of cells contain two layers, positive layer and negative layer just like in most semiconductors. Positive layer exist on the top side whereas negative layer exists on button. Electric field is created with in these layers. Photons from sun light strikes on semiconductors in result electrons are released, electrons are electric charge. This electricity is transferred as direct current (DC) in panel. Thin film; in these form of solar cells atoms arrangement is not in particular order. It is very efficient type of cell; it can convert over 90% of usable solar energy to electricity when it is exposed to light only by using amorphous silicon thin film cell which is only one micron thick. Thin film cells have advantage of being cost effective; they are required lesser amount semiconductor materials [6].

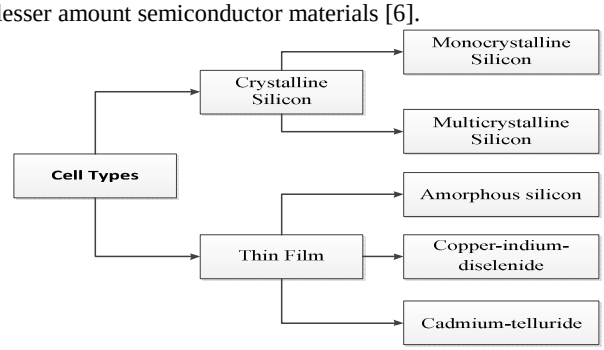

Fig. 3 Cell types

III. PROJECT UNDER STUDY

The general process of the system is as the following: in the mentioned system, all the vehicles are equipped with RFID. Along the highway, intelligent light poles which are equipped with RFID Reader, Solar Cells, etc. are used. In the entry and exit points on highway, road sign readers are used for activating/emitting record through local and global networks with Wimax technology to the central computer. Light poles whose energy is provided through solar cells cover both sides of the highway in the form of every three poles (Fig. 5) [7].

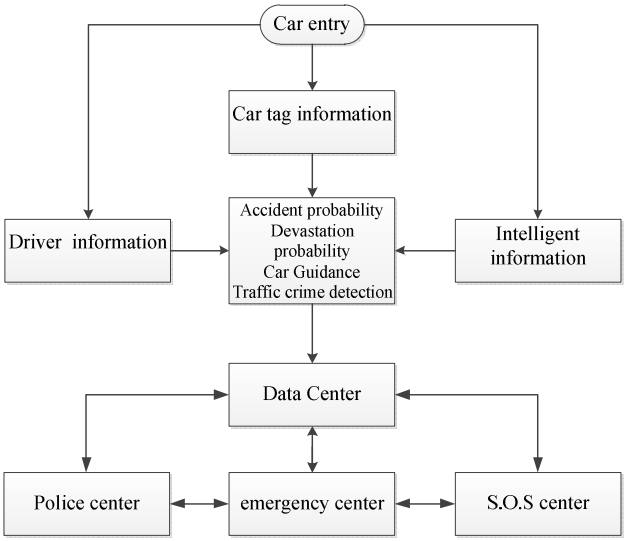

Fig. 4 Flowchart of system

Cars and intelligent light poles sensors communicate with together by Short Range Communications protocol. RFID and Wimax technologies allow vehicles to send and receive information to intelligent light poles sensors on the highway. Signals from vehicles will carry data such as car ID , position, etc. on the other hand; signal from intelligent light poles, will carry Data such as information about traffic conditions, accidents, the weather, etc. If one car stops suddenly or move in wrong direction, data center can send information to intelligent light poles on the road [8].

The operations conducted by the components of the system are as the following:

•Recording information on the vehicle's tag while entering the highway;

•Emitting signals through RFID to the intelligent light poles along the highway;

•Disseminating information such as traffic guidance and warning through the intelligent light poles to the cars along the highway;

•Collecting the information of the cars along the way in the particular installed places and disseminating them to the central computer;

•Removing the information off the vehicle's tag while leaving the highway and recording it in the vehicle's records.

IV. Methodology Employed

In this model, due to the presence of 3 lines, the cycling system including 3 light poles are used for controlling the highway [9].

Fig. 5 collecting the information of the cars

In the first phase, all the vehicles that tend to move along the highway pass under the installed readers on the road lines, by which the vehicle is reported to the data center. Due to the vehicle user type, either private or public, the following operations are done [10]:

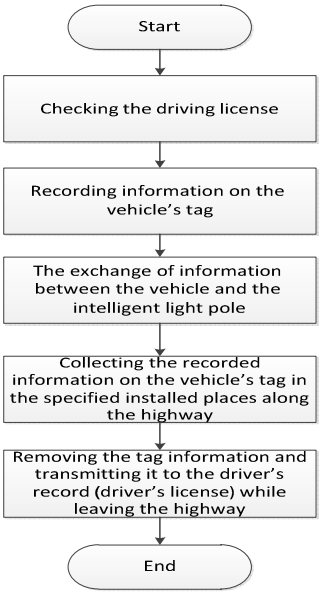

Fig. 6 Flowchart of steps

After analyzing the mentioned factors, if there is a problem with the vehicle, it is guided to a suitable exit. While moving along the highway, the vehicle constantly reports itself through using communicative signals between the tags and the present readers in the intelligent light poles [11],[12].

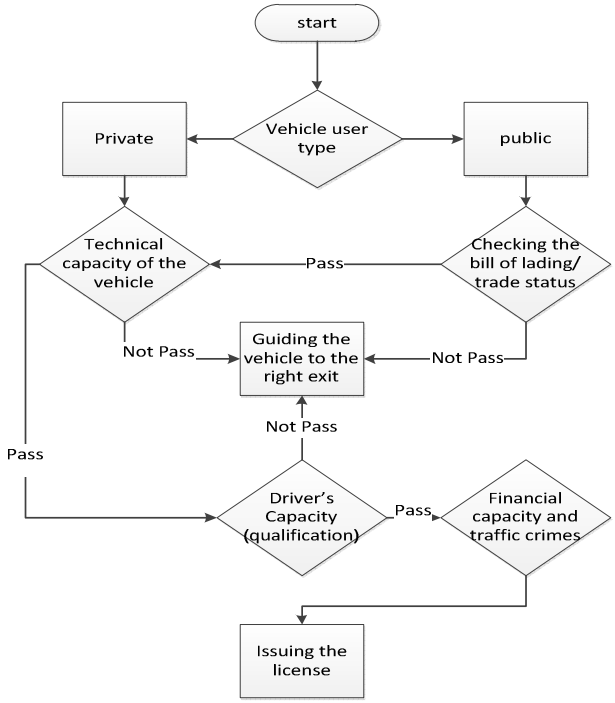

Fig. 7 Mechanism of system

The vehicle may fall under the following circumstances:

Horizontally

In this case, the vehicle may fall under two situations:

•Moving along the right direction and in one line

•Moving along the counter direction: the reverse light pole numbers appear on the tag

Stop

If a signal is sent to an intelligent light pole from an area out of parking space, a warning in a specified time will be sent to the patrol units using software. Now if this stop has taken place in the main lines of the road, or more than one signal is emitted from the same area, the signal will be subsequently sent to the emergency vehicles and the area police.

Vertically

Due to the fact the area is covered by the intelligent light poles, in case of changing lines, different numbers will appear on the tag which can be detected by traffic crime software[13].

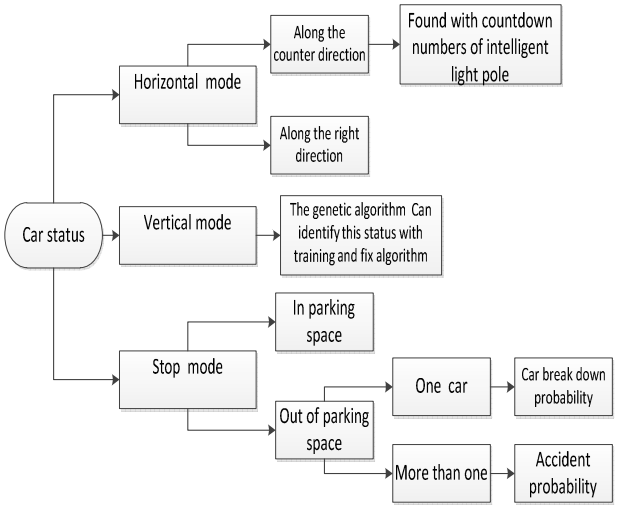

Fig. 8 Vehicle modes

V. Conclusion

Conducting the above project, the following data is being sent to the data center:

- The exact place of the vehicle and its direction
- The vehicle's just in time speed
- Time and place of the accident
- The exact place of the traffic congestion
- Driver's status
- The capacity of analyzing the data for the crisis stations
- The capacity of recording the data history

The key point at stake in the correct analysis and documented conclusion is the comprehensive and flawless data in the decision making centers. According to the above mentioned elements, two significant actions can be conducted.

1) Just in Time (JIT) decision making:

The just in time statistics and information makes any kind of programming and altering method possible for the sake of optimizing system.

2) Today, in most parts of the world, anticipating the future and pre-programming leads to the augmentation of the efficiency and placing the necessary equipment in the necessary places. With paying little attention, it becomes known that this method has less delay in comparison to JIT method. For this purpose, through using the history of the past and locating, the most of the future events can be predicted. Consequently, by decreasing the time of delay, the efficiency will certainly increase.

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

•Increasing traffic's safety

•Decreasing the cost: such as traffic fatalities, financial damages and fossil fuels

•Decreasing delay time while entering and leaving the highway

•Decreasing traffic crimes.

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