Conceptualization of Smart System Based on RFID Technologies for Controlling Vehicle Speed

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Abstract **- The Internet of things and its (IoT) application become more and more effective in various fields of our life. It provides many tangible and intangible advantages. The success of (IoT) Applications required many complimentary dimensions like the enhancements of needed technologies, developing appropriate business models in addition to the security issues. Radio frequency identification (RFID) is one of the widely used technology that belong to IoT family.**

This paper will introduce a concept model which is performed in Saudi Arabia, and it can be applied in another country as well. Country's specific requirements regarding legal issues and the use of IoT applications and technologies are taken into consideration, too. This idea is about Smart streets where reader for speed data is used from RFID chip placed in vehicles in order to control the speeds instead of the widely used camera system to increase the safety.

Keywords **– RFID technologies, Smart system Vehicle speed, Navigation tracker.**

1. Introduction

Nowadays, many countries are using radar or camera system to control speeds of vehicles in the streets, but there are many detection devices (like Radar detector[1]) being used from drivers to detect the radar or camera which reduce the effectiveness of those control systems. Therefore, this paper will present concept for Radio frequency identification (RFID) based on system for speed controlling vehicle speeds which can solve the problems faced with radar or camera systems. As base for the idea of this paper, this first section introduces definition of the main components of RFID system and classification of the capability of those components.

RFID is one of the oldest and always growing technologies which allows objects to be equipped with transponders, and this enables them to be clearly identified and data to be exchanged wirelessly. RFID systems have been applied widely in various fields like healthcare, transportation, security, safety, hospitality and many smart objectives [1], [2]. Based on many researched like [3], [4] and [5] RFID system consists of the following components:

- Tag (Transponder): Tag is an artificial word and consists of the components "Transmit" and "response" together. Transmit means "transmit, send, spark" and response "response, feedback". The transponder can provide information or record complex data using a memory. It can be read and described in certain versions. Transponders are also referred to as (RFID) tags.
- Reader is the part which includes three parts, the RF module, reading and writing modules and antenna. The basic function of the reader is reading or writing information from the electronic tags.
- Antenna: Antenna can transmit and receive radio waves between RFID Tags. It is a device that transmits and receives the radio waves between readers and tags.
- Middleware is a middleware which is placed between the RFID hardware and RFID applications in order to hide the implementation details and complexity of RF subsystem.

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[1] https://www.blackboxmycar.com/pages/what-is-a-radar-detector

In addition to the previous components, each reader should be connected to smart Database to receive data from it in real time.

For any system based on RFID it is essential to know the capacities (configuration) of RFID system components that has been addressed above. These capability (configuration) has been explained through the classifications of the RFID tags and readers as the core component of RFID system. This classification is presented in Tables 1 and 2 which has been derived and summarized based on [6], [7] and [8]:

Table 1. RFID tag classifications

RFID Tag	Depending on power supplying
Passive tag	get their energy from the electromagnetic field or from the electromagnetic wave of the reader
Semi-Passive tag	Has its own energy source to supply the microchip. However, it uses the energy from the reader to send the data.
Active tag	Has a battery via its own power supply.
	Depending on memory type
Class 0	Read only memory (ROM) including static written data
Class 1	Write one time and read many time memory
Class 2	Read and write many time memory
Class 3	Semi passive or active tag with Read and write memory and with integrated sensor for recording parameters like motion. Temperature and pressure
Class 4	Active tag with read and write memory works as small radio device which can communicate with another tags and devices through integrated transmitter without the presence of readers

Table 2. Reader classification

Reader type	Depending on used design and technologies
Read only	Read only from tag and transmit energy to it
Read/Write	Read and write from/on tag

There are also another classifications related to the read distance of tag signal which can differ (from few centimeters in case of some passive tags to 100 meter in case of some active tags) [9], [10].

The previous presenting of RFID components types and their related capabilities serve as a base for the practicability of the proposed idea in this paper which focuses on conceptualization of RFID based system for controlling the vehicle speeds over the streets as alternative system for camera system. Achieving the purpose of this paper will be completed through the following sections which include related works in field of RFID applications, research methods and results, discussion and the conclusion as the last section which summarize the result of this paper.

2. Related Work

There are many applications of RFID related to vehicle for different purposes but only few that focus on controlling vehicle speed. This section will summarize these application of RFID systems and RFID sensing system which are considered as related works to this paper. One of the research articles presented RFID based system to increase the efficiency of electronic toll collection (ETC) on the highways and support similarly the car parking of the mall in the cities which can reduce the time to toll plaza [11]. Similar system has been provided from [12] to automat the toll payment collection for improving the traffic flow where the vehicle cannot pass to the toll station before the payment collection (see also [13]). Another RFID based system has been introduced for solving and managing the parking related problems [14]. There are some RFID applications focused on the traffic safety like using RFID for automation of detecting the wrong way drivers (ghost drivers) and help for speed controlling efficient data to road maintenance or police in detecting speeding cars through calculating the speed average between two apart mounted [15]. Another RFID based vehicle positioning system has been proposed by [16] as alternative to positioning in connected vehicle applications where GPS is of poor quality or not available by connecting tag reader on vehicle and fixing tags that include the accurate position on the surface of the road with using kinematics integration algorithm for estimation to fill gaps between tags. Estimation has to be made on the latest position update from tags. In addition, [17] has proposed also RFID based system for determining accurate location of vehicles especially in places where there are no or poor GPS like underground tunnels.

One of the most significant works related to controlling vehicle speeds was proposed and implemented based on RFID technologies with using three integrated sensors: DGPS for determining the positioning of vehicle, RFID tags located on the traffic signals to transfer their information to the car and Hall Effect sensors located in the vehicle's wheels for high accuracy measurement of the speed of the car. This system was designed to increase the awareness of drivers about the street circummestances to control the vehicle speeds which help for avoiding one of the major causes of fatalities: the excessive or inadequate vehicle speed [18].

3. Research Methods

This paper uses analysis and designing methods to build suitable and applicable model for RFID based system which helps to increase the speed control especially in case when the drivers do not pay attention to speed limits. They can identify any traffic signals by using some devices like Radar detector which is mentioned in the introduction section. This device enables the drivers to detect the radar or camera places that allow driver to reduce the speed before they arrive to the radar or camera range.

The proposed system consists of three components (see Figure 1):

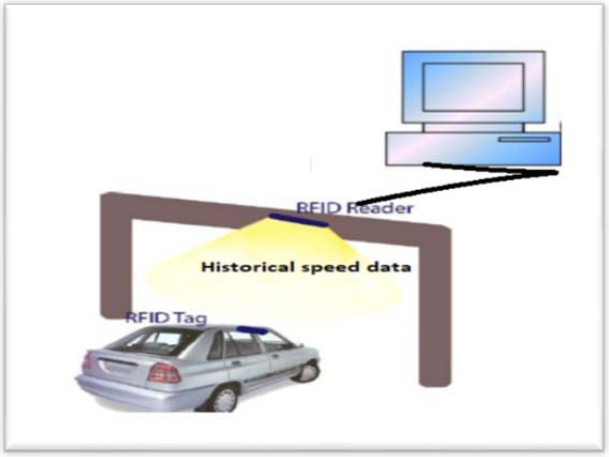

Figure 1. RFID based system for vehicle speed control

1. Sensing component which includes two sensors the GPS tracker sensor and Active read/write RFID tag

   GPS Tracker functionality is calculating the vehicle speed (S) systematically every one minute (even if the vehicle offline or not connected) through dividing the travelled distance (D) on the needed time (T) (1hour/60=0.01666667) as the following $S = \frac{D}{T}$. For example if the GPS tracker calculated the travelled distance (D) and it was =2KM that means the speed $S = \frac{2}{0.01666667}$ = 120 KM/Hour.

   Active read/write tag will include two type of data static and dynamic data. Static data includes vehicle information and timer which works as internal watch. The dynamic data will be logged from the GPS sensor with every minute when it calculates the vehicle's speed to generate the historical speed data HSD (speed average in every minute). Figure 2 shows example for HSD which is logged and stored systematically in RFID tag to be sent package, which was recorded after overflowing the previous RFID reader to the next reader.

+.. 14:30…… 120KM/H, Latitude: xx.xxxxxxx, Longitude: yy.yyyyyy+..14:31…… 130KM /H, Latitude: xx.xxxxxxx, Longitude: yy.yyyyyy

+..14:32……125KM/H, Latitude: xx.xxxxxxx, Longitude: yy.yyyyyy

+……..

Figure 2. example for historical speed data (HSD)

2. RFID Readers are fixed on road or traffic signals on specific places at the end of ways with different speed limit to receive static data (vehicle ID data with the HSD that is logged by RFID tag during the travelled distance from the previous reader as well as will send order to the RFID tag which is fixed in the vehicle to reset the speed data to be = zero for new recording: see Figure 3).

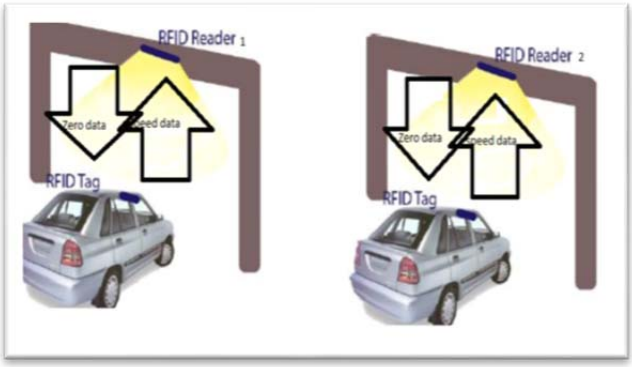

Figure 3. Example for data exchanging scenario between two RFID readers

3. Central computer, with database and speed control applications which care connected to RFID readers, will receive the vehicle date which includes ID data and the HSD from all the RFID readers to test if the speed within the travelled distance from the previous reader to the current exceeded, the allowed limit of speed which is specified and stored related to every reader in the central database to generate the traffic violation or not. Furthermore, based on the received historical vehicle speeds, positions and times, the system can track and calculate all possible speeds of different positions on roads that the vehicle came from. It can be done by mapping received information with the roads map. The application in the central computer will do this process as shown in Figure 4.

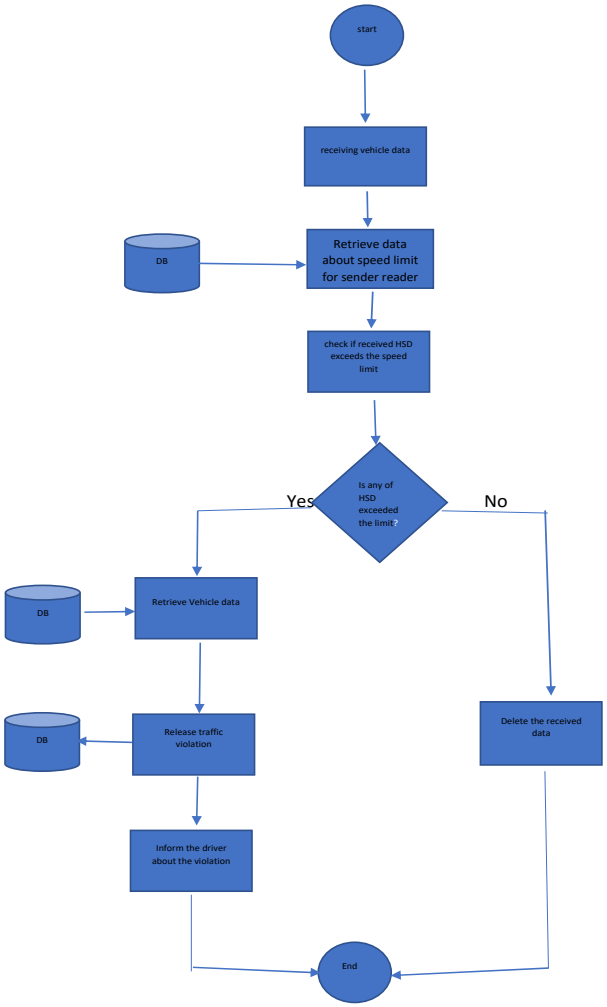

Figure 4. Application for controlling traffic violation

4. Discussion

This paper propose a conceptual model for an RFID based smart system to control the speed of vehicles in general, in the streets and not only in the places equipped with camera or radar. That would enforce drivers to respect the limited speeds and reduce accident possibility. The used device is targeted through combining a speed tracker with RFId tag, by which it will be able to calculate and record speed consistently and deliver historical speed data to reader devices that are placed on specific places over the roads in the points of speed limit change. The speed recording device should be placed inside the vehicle, and it is not allowed to be removed from the drivers. The advantages of this solution is providing self-monitoring the speed over all the road segments, which is not possible with the camera and radar system that can only control the speed on the specific road segments covered with its scope. Also, the targeted system in this paper can be extended to additional application that can be formulated in suitable business model to generate revenue for the government through intermediation of advertising from the companies depending on the vehicle location. This business model will be discussed in related works in the future. Although, many researches focused on the RFId and its applications in many aspects of vehicle and transport, but no work was focused on the similar idea that has been discussed in this paper.

Data generated through this approach can be used to encourage driver not only to control speeds of individual vehicles but for analysis and evaluation of traffics in general, which is related to specific regions to improve its traffic flows.

The most critical point of deployment of this approach is the privacy aspect. Because of gathering historical speed information of vehicles, such information is critical, since it could be abused for spying purposes for instance. That is why the security and privacy measures and features have to be implemented to comply the laws governing data protection and data security.

5. Conclusion

This paper proposed a conceptual model for RFID system which enable the controlling the vehicle speed commitment over all the roads in order to cover the lack related to the camera and radar systems. The idea of this work has been derived through studying the capability of RFID technologies and the innovative application of navigation system. They helped us to integrate the capabilities of the both systems to calculate and, record and send the speed historical data to reader devices. These facts allow the examining of the speed limit commitment.

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