Design Analysis of RFID Automotive Traffic Security System Using ARM Platform
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ABSTRACT
This paper is based on RFID technology using ARM processor. Nowadays traffic congestion network is characterized by longer trip times, increased vehicular queuing and slower speeds. Different techniques are there to detect the traffic congestion as vehicle volume has increased exponentially by the road infrastructure; more vehicles are thus causing more traffic. This project is used to detect traffic congestion management with the help of ARM processor. Radio frequency identification technique is more easier, efficient and reliable congestion detection technology. There are many security problems in traffic system due to congestion and mismanagement. This paper suggests an automated and friendly traffic security system which will automatically detect a vehicle using RFID card which is attached to the vehicle that passes by the reader. This process would lead to tracking and identification of each vehicle thus reducing traffic congestion. This paper focuses on the identification and vehicle management for an automated traffic security system.

Keywords — Embedded systems, RFID, ARM processor

1. INTRODUCTION
This paper focuses on the traffic congestion management system with the help of RFID technology merged with ARM platform. The design of the paper aims to highlight the importance of automated traffic management system and thus helping in tracking and identification of each vehicle which leads control the traffic management system. Density of the traffic can be evaluated with this technique for an automated traffic security system which provides useful aspects to the density of traffic and thus helps in providing a controlled and managed flow of traffic. RFID is a technology that is based on identification and tracking by using the radio waves with the help of RFID card, reader and the ARM processor. RFID tags or cards have two parts where one is an integrated circuit for storing and processing the data, modulation and demodulation of a radio-frequency signal and other functionalities. The second one focuses on an antenna part for receiving and transmitting the signal. Here, RFID technology has been used with the ARM platform where each vehicle should be attached to the RFID tag or reader within them. As soon as RFID card enters the range of the reader the tag would automatically get read and the traffic light would thus automatically and accordingly get the proper traffic flow and hence managing the congestion system which helps in making it more secure, reliable and efficient. The data which is been processed and is thus stored in ARM processor which is attached to RFID reader. An audio device can also be attached to the vehicle in case of instructing a vehicle. The security problems of congestion system can overcome by this technique. Even all violations could be identified thus which helps in managing the flow of traffic and security related issues. This technique is also applicable to the toll tax areas where vehicles would be charged automatically as they enter to a toll area. ARM processor is used in this design analysis as it is one of the powerful processor which is used for such embedded works. As nowadays fatal accidents happens due to the mismanagement on the road and traffic. So, to overcome this automotive traffic security system is been used using RFID and ARM processor. This design even can seize such vehicles where the speed limit is not appropriate.

2. OVERVIEW OF THE DESIGN
Radio frequency identification (RFID) technology is vastly growing and is been deployed in many applications and organisations. RFID technology is making great impact on the market with economic and financial impacts on the industry. RFID technology is making great impact on the chip manufacturing industry for various new applications and settings but particularly in consumer item level tagging. Do, thus RFID technology is vastly growing in inventory control, logistics, and supply chain management. RFID systems consist of RFID tags or transponders which are physically attached to objects which are most likely to become micro chips. These tags wirelessly communicate with the RFID readers or transceivers which thus respond back with some identifying information or data that is associated with the database [1, 12]. Thus RFID technology is one of the automation identification systems which are used by the spectrum of applications and organizations.

This paper is categorized into the following categories:
- RFID Tags
- RFID Reader
- RFID Coordinator
RFID system consists of three core components as stated above. RFID technology [3] includes a system of tags and readers which is used to identify and encode various information and data. RFID tags are the small silicon chips which contain a unique identification code and some form of battery power which is stored on-chip memory.

2.1 RFID Tag
It includes a microchip with data storage component and limited functionalities with an antenna which is used to receive radio frequency waves which are emitted by a reader or transceiver for the wireless communication. It is incorporated in the vehicles as RFID card which when enters in the range of reader tracking and identification of each vehicle becomes simple and easy.

2.2 RFID reader
RFID reader is a unit which identify the radio signal at a precise frequency and at a particular distance that causes the RFID tags to respond back with their identification code. The RFID chips can be broadly classified on the basis of features and characteristics such as distance, data stored, frequency, signal strength, multi read capabilities. RFID module [1, 4], a control unit and a coupling element are incorporated in a reader which thus communicates with the tag through radio waves. Readers can be classified in various forms and may operate on different frequencies and they offer a wide range of applications with different functionalities. Readers have their own storage space and internal processing power and readers are simple to connect to an external system where they store all the data locally. Many applications and organizations are dependent on the fixed readers. Readers are integrated to many applications such as smart cards, mobile phones, hand-held devices, inventory system, asset control, warehouse systems, computing devices.

2.3 RFID Coordinator
The RFID coordinator is one of the chief category, which acts as a backbone or the cell network which is utilizing the GPRS/CDMA modem. In this process the mesh network is used which will be responsible for managing the vehicle and in identifying the vehicle. The mesh network which is used is connected to a wired backbone via a host system. Coordinator receives data from either router or tag using its 2.4GHz RF interface and can communicate with remote server. Coordinators have a serial interface through which external GSM/GPRS devices can be interfaced with it to make it a dual radio device one is 2.4 GHz radio interface and the other is GSM/GPRS interface.

2.4 Database
In case where readers may not be trusted, it is useful to collapse the design of the reader and the database into an entity. Say, if tags include all the important information than there is no need to call an off-site database system. In the back-end database systems each product manufacturer has its own product look-up service and in this...
case it is useful to deploy an object naming service to locate the database system associated with the identification of tag. An object naming service provides a reader to find a database set which is connected with a tag value.

### 3. OPERATING FREQUENCIES

Tags which operate at ultra-high frequencies range do not operate efficiently in case of solids and liquids. Operating frequency is efficient and reliable in determining the dimensions which are physically related to RFID tag. Different frequencies will be operated at varied sizes and functionality. Every vehicle would have the RFID card. As the vehicle enters into the range of the RFID reader [6, 8] it will automatically get read and the traffic light would act accordingly. The processing of the data will be done on the processor attached to the RFID reader and data will be stored there. ARM processors are been used here because of its reliability and performance.

#### 3.1 Low Frequency System

The working of RFID technology is low frequency system is explained as following:

- Alternative current in the reader’s coil is created as an integrated circuit sends a signal to an oscillator.
- An alternating magnetic field is generated by the current that serves as a power supply for the tag.
- Current is induces as the field communicates with the coil which thus creates the charge to flow in the tag where the charge was trapped by a diode.
- In the capacitor charge is accumulated thus the voltage across it also increases and the integrated circuit of tag is activated which finally transmits its identifier code.
- High level of a digital signal corresponds to zeros whereas the low level of digital signal corresponds to ones which encodes the identifier number and corresponds to the on and off of the transistor.
- A result of the transistor turns on and off with the variation in the resistance of the circuit which causes the tag to generate its own magnetic field. This technique is called load modulation where magnetic fluctuations cause changes in the current flow from its reader to its coil in the same way as the ones and zeros were transmitted.
- A device senses the variation in the current coil of a reader which converts this pattern to a digital signal.

#### 3.2 High Frequency System

The working of RFID technology is high frequency system is explained as following:

- Transceiver receives a digital signal by an integrated circuit which thus generates a radio frequency signal that is further transmitted by a dipole antenna.
- There is a rise to a potential difference across the tag’s dipole antenna which further causes current to flow into a capacitor and thus the diode traps the resulting charge.
- On the tag’s integrated circuit the voltage across a capacitor is turned on which transmits its unique identifier code as a series of digital low and high voltage levels which corresponds to ones and zeros. The signal further moves towards the transistor.
- By the highs and lows of the digital signal the power supply of transistor [9] gets on and off which causes the antenna to reflect back or absorb the radio frequency energy from the reader.
- Backscatter modulation is the variation in the amplitude of the reflected signal which further corresponds to the pattern of the transistor signal turning on and off.
- The reflected signal is been detected by the reader’s transceiver which then converts them to a digital signal which is relayed to the integrated circuit where the unique identifier of the tag is determined.

### 4. SYSTEM DESCRIPTION

RFID system yields many reliable and efficient challenges and benefits. There are some major concern regarding the privacy and security in RFID systems besides the implementation challenges in the information technology system and economic barriers RFID tags either have an onboard source of power or they are connected to external power sources which are called active RFID tags while the tags that are dependent on the RFOD reader [8, 10] for their power supply called as passive RFID tags. These systems have varied operating frequencies, different functionality and operating frequencies. The manufacturing costs, physical specifications, performance, frequency and quality are identified by the property and regulatory restrictions of a particular RFID system. The item level tagging is one of the most used RFID based application with the electronic product codes and have physical access control with contact-less payment systems.

The working of RFID system with its front end and back end layer is shown below in the architecture. The front end layer includes the following components:

- Tags,
- Readers
Whereas the backend layer constitutes of the following elements:

- The collection layer
- Integration layer
- The enterprise layer
- Applications
- Databases

![Diagram of Back-End Layers](image)

Figure 3: Back-End Layers

5. OPERATIONS OF THE SYSTEM

In this paper the RFID tags plays a major role in traffic management, they are attached to the vehicle and helps in communicating to fetch all the necessary information and data. In the proposed paper the active RFID tag which incorporates the attributes such as vehicle number, Speed of vehicle, model number of the vehicle, owner of the vehicle. These attributes depends upon the four scenarios in which the RFID base system [9, 10] would work efficiently and effectively, these scenarios are important from the point of the system design. The scenarios are discussed below:

1. RFID tag plays an important role since it is attached to the vehicle, so whenever there is the problem of congestion, with the help of RFID base system and tag this congestion can be easily be detected, thus this scenario can help in managing the traffic.

2. The secondary case is dependent on the traffic density as there is different vehicular density on different roads. If there is more traffic density on a particular lane then that lane would be made open by the traffic lights for more interval of time as compared on the other roads in order to maintain the flow of traffic and to control the mismanagement of the traffic security system.

3. The next scenario is dependent on the area charges and the toll charges which can be automatically billed using RFID card, reader and ARM platform. Here, each vehicle has a RFID card which when enters to the range of reader attached to the toll gate the subsequent charges will be deducted automatically; this process is hindrance free and also optimizes the process in terms of complexity and cost.

4. Last scenario includes that when a vehicle crosses a limited speed on a lane than it would be easily detected and tracked by the help of this proposed system using RFID technology and ARM processor and hence with the help of this penalty charges would be deducted accordingly.

6. OVERVIEW OF THE SYSTEM DESIGN

RFID technology [1, 8] for automotive traffic security system focuses on the following objectives:

- Real time automatic congestion detection.
- Automatic detection of vehicles approaching towards congested area and automatic messaging for redirecting the selected vehicles for congestion avoidance.
- Priority based congestion management system.
- Signals are controlled adaptively by remaining them open for more duration of time where there is high traffic density on roads to control the flow of traffic security system.
- Automatic detection of the penalty charges and automatic billing of core area charges in toll tax areas.
- In case of traffic rule violation automatic penalty charges are been deducted to avoid the traffic violation and the speed limit violation.
In this paper active RFID has been chosen because of the following reasons:

- More memory
- Better read range
- Tag to tag communication is possible
- Capabilities of adhoc network
- Onboard battery to power up the tag circuitry

Active tags are not dependent on readers to initiate a communication as it can send unique code to inform its presence to all other components. Active RFID has more operating frequencies than the passive tags and can work on larger distances as active tags can be integrated with the sensors to form a standard wireless sensor communication node.

As active tags contain their own power sources so they have longer operating systems, operating range than the passive tags. Large asset and tracking applications use active tags as the items are attached. Active tag has a key feature which states that they initiate their own interaction with the readers. The advanced active tags forms adhoc peer networks with one another. The efficient application for the active tag is shipping containers. They can also function as a security alarm using various functionalities. Semi passive tags are battery operated as they have internal power sources for the power supply. Semi passive tags are only active when they have battery operated functionalities. The semi passive tags offer a longer reader range as they have an internal power source. One of the applications of semi passive tag is electronic toolbooth management system. Passive tags neither have their own power source nor do they initiate communication with the reader. Passive tags obtain energy and power by gathering it from an incoming RF signal. This energy is harvested inductively at the lower signals whereas they are harvested through capacitance at higher frequencies. The shortest read range is of passive tags in all the three powering types and they are the cheapest amongst all. They can easily be integrated amongst different applications and devices. As batteries are very expensive and they cannot be integrated easily into the devices and applications. For this obvious reason passive tags are most commonly used and EPC tags are passive tags. Passive tags cannot operate without the presence of a reader though passive tags temporarily cache some energy source in a capacitor. So, thus they lack an internal power source. Passive tags are more sensitive because of poor communication signals.

6.1 Advantages of Active RFID Tags

- Optimized enhancement of performance even during bad weather conditions.
- RFID tags are helpful in determining simultaneous detection of vehicles.
- Specific domain of vehicles can be recognized with the help of RFID technology [1, 9].
- It reduces the complexity level and easily reads the reader when it is in the range of the RFID reader which helps in easy tracking and identification of the traffic congestion. Thus improving the flow of traffic congestion management system.

6.2 Congestion Detection and Management Scheme

The system design is dedicated on the following core parts of automotive traffic management system.

- Detection of traffic congestion at any road leading to a junction.
- Effective management to control the traffic congestion which ensures smooth flow of traffic.

6.3 Congestion Detection Phase

- When a vehicle passes the router, the active RFID tag [3] of that vehicle sends a beacon to the nearest router. Router then forwards it to the coordinator.
- As soon as the coordinator gets the routers message, immediately it saves the message and waits for getting another message from the same tag when it passes by the coordinator.
- When that tag passes by that coordinator it sends another beacon to the coordinator.
- After receiving the signal, from its timestamp, the coordinator calculates the speed of the vehicle and sends it to the control station.
- All the stretches leading to the junction get the green signal in a cycle, for a time duration that is proportional to the population of vehicles.
- This population is calculated from the number of tags that are in the range of each coordinator.
- After obtaining the count and the average speed of all vehicles, the coordinator determines the level of congestion depending on some predefined condition.

6.4 Congestion Management Phase

- When a coordinator detects a high level of congestion, it cannot take further load it sends a SMS to coordinators in its preceding junction notifying them to temporarily stop traffic along that stretch.
- After receiving the SMS from its successor crossing point the coordinator will put the red signal on for that stretch towards that congested crossing point for a set period of time.
As soon as the congestion is released at the crossing, the corresponding coordinator will send another SMS to its earlier coordinator indicating to resume the traffic flow again in that direction.

Accepting this message the coordinator of the preceding junctions put the red light off and green signal on and restart the signal cycle as before.

Figure 4: Block Diagram of RFID Automotive Traffic Security System Using ARM

RESULTS & CONCLUSION

The schematic of RFID automotive traffic security system using ARM platform is given as following:

In this design ARM processor acts as a host controller which is attached to the RFID reader for tracking and identifying each vehicle through the RFID card or tag which are attached inside the vehicle. Thus it provides a good support in controlling the flow of traffic congestion management system and hence providing a secure, reliable, cost efficient and manageable system.

The system is completely automated so it reduces the human and manual effort. The system uses ARM9 processor, as it is a very advanced processor and is used in embedded technology as it is reliable and efficient so certain applications can be added to it like a monitoring web camera can be added to the system to have a complete visualization at high congestion areas. The RFID cards being reusable, they are much more convenient compared to the cardboard based license system. Any unwanted events can be avoided as all the vehicles are carrying RFID tags and are being monitored every time they travel. So this system also helps to solve the security problems.

In conclusion, the objective to build an RFID based traffic system with ARM processor was successfully achieved. In terms of performance and efficiency, this project has provided a convenient method of controlling congestion traffic compared to the traditional methods. By using databases, the data is more organized. This
system is also a user friendly system as data manipulation and retrieval can be done via the interface. Thus, it can be implemented in either in any organization and applications.

FURTHER RESEARCH

- The GSM network is used to exchange SMS among the coordinators, which is not fully reliable.
- Loss of message or delay may hamper the correct detection of congestion and real time delivery of message.
- The consideration was only the velocity of the vehicles to determine the degree of congestion.
- Other criteria, such as, average waiting time, average queue length, and some special cases might be taken to consideration to measure congestion more accurately.
- This can also dynamically control the signal timing of the traffic light depending on the degree of congestion at a particular lane.
- Further traffic can be managed by using the monitoring or visualization system by including web cam.

REFERENCES