



TRIBHUVAN UNIVERSITY  
INSTITUTE OF ENGINEERING  
**NATIONAL COLLEGE OF ENGINEERING**

A Report For Final Year Project On  
**INTELLIGENT HIGHWAY SURVEILLANCE SYSTEM**

**[CODE : EX755]**

By:

Ajit Pradhan (15913)

Niraj Pokhrel (15915)

Dipendra Shrestha (15916)

Krishna Kumar Shrestha (15936)

August, 2013



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A FINAL YEAR PROJECT REPORT IS SUBMITTED TO  
THE DEPARTMENT OF ELECTRONICS AND  
COMPUTER ENGINEERING  
IN PARTIAL FULLFILLMENT OF THE  
REQUIREMENT FOR THE BACHELOR'S DEGREE IN ELECTRONICS &  
COMMUNICATION ENGINEERING

DEPARTMENT OF ELECTRONICS AND COMPUTER ENGINEERING  
KATHMANDU, NEPAL

August, 2013

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Er. Pradip Adhikari  
Head of Department  
Electronics and Computer Engineering  
National College of Engineering  
Talchhikhel, Lalitpur

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INSTITUTE OF ENGINEERING  
NATIONAL COLLEGE OF ENGINEERING  
DEPARTMENT OF ELECTRONICS AND COMPUTER ENGINEERING

The undersigned certify that they have read, and recommended to the Institute of Engineering for acceptance, a major project report entitled "**Intelligent Highway Surveillance System**" submitted by **Ajit Pradhan, Dipendra Shrestha, Krishna Kumar Shrestha and Niraj Pokhrel** in partial fulfillment of the requirements for the Bachelor's degree in Electronics & Communication Engineering.

---

Supervisor

Er. Sabin Bhandari

Kantipur College of Engineering

Dhaphakhel, Lalitpur

---

Projector Co-ordinator

Er. Om Prakash Mahato

National College of Engineering

Talchhikhel, Lalitpur

---

External Examiner

Institute of Engineering

Tribhuvan University

---

Head of Department

Er. Pradip Adhikari

National College of Engineering

Talchhikhel, Lalitpur

**DATE OF APPROVAL:**

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## **ABSTRACT**

The world has become an advanced information-oriented and technologically robust society in recent years. Wireless communication has proved to be the key pillar of this development. 'INTELLIGENT HIGHWAY SURVEILLANCE SYSTEM' is centered on overhead wireless detection and tracking techniques through Radio-frequency based wireless communication. Highway monitoring and surveillance, traffic information provision are its key features. Some of the technologies that are being exploited for this purpose might have provided some benefits and feasibility but almost all of them have failed to counter cost constraints to availability of services and its effectiveness to the ordinary user. It is therefore necessary, to correctly analyze the tranquility of people in addition to the likelihood of provider while instigating the new technology. This project intends to detect the vehicle to provide information by tracking and recording its identity for future reference even on densely heavy traffic. The purposed system meets the essential requirements of highway surveillance and intelligent transportation in real time running. The flow of traffic data, as well as their reliability, consistency, accuracy and precision, and the response time are some of the critical parameters to be evaluated. 'INTELLIGENT HIGHWAY SURVEILLANCE SYSTEM' utilizes infrared sensor to detect vehicle by detecting its motion and heat radiated from it, Radio Frequency identification (RFID) to track the unique identity of each vehicle and GSM wireless network to broadcast the data and information to central server.

# TABLE OF CONTENTS

Acknowledgement .....	v
Abstract .....	vi
Table of Contents .....	vii
List of Figures .....	x
List of Tables .....	xi
List of Abbreviations .....	xii
1. INTRODUCTION .....	1
1.1 Background .....	1
1.2 Objectives .....	3
1.3 Features .....	4
2. LITERATURE REVIEW .....	5
3. SYSTEM MODEL .....	8
3.1 Working System .....	8
3.1.1 Vehicle identification through RFID transceiver .....	8
3.1.2 ID processing through microcontroller .....	8
3.1.3 Wireless communication through GSM .....	9
3.1.4 Database handling software .....	9
3.1.5 Display system .....	9
3.2 Basic System Operation .....	10
3.3 Algorithm .....	11
3.4 Flowchart .....	12
4. HARDWARE DESCRIPTION .....	13
4.1 RS232 .....	13

4.2 MAX 232 .....	16
4.3 GSM System .....	18
4.3.1 GSM Modem .....	18
4.4 Subscriber Identity Module .....	20
4.5 RFID System .....	20
4.5.1 RFID Tag .....	20
4.5.2 RFID Tag reader .....	21
4.6 Micro Controller (AT89S52) .....	22
4.6.1 Pin configuration and Description .....	22
4.7 Liquid Crystal Display (LCD) .....	24
4.7.1 Signals to the LCD .....	24
4.7.2 Pin Description .....	25
5. SOFTWARE PROFILE .....	26
5.1 Microcontroller (AT89S52) Program .....	26
5.2 AT Commands .....	27
5.3 Database Management Software .....	30
5.3.1 MsSQL .....	30
5.3.2 C# .....	30
5.3.3 .NET Framework .....	30
5.3.4 Structure of Software .....	31
5.3.5 Manual for Software .....	32
6. SYSTEM DESIGN .....	33
6.1 Implemented Block Diagram .....	33
6.1.1 Transmitter side .....	33
6.1.2 Receiver side .....	34
6.2 Implemented Circuit .....	35

7. RESULTS AND CONCLUSION .....	36
7.1 Limitations and Shortcomings .....	36
7.2 Problems Encountered .....	37
7.3 Future Enhancement .....	38
7.4 Discussion and Conclusion .....	39
REFERENCES .....	41

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## LIST OF FIGURES

Figure 1.1.1 Currently Used tolling System .....	1
Figure 1.1.2 Our Proposed Tolling System .....	1
Figure 3.2.1 Block Diagram of Detector and Transmitter .....	10
Figure 3.2.2 Block Diagram of Receiver at toll raising centre .....	11
Figure 4.1.1 RS232 DB9 connector .....	13
Figure 4.1.2 DB9 Null Modem Connection .....	14
Figure 4.1.3 DB9 DTE to DCE Connection .....	15
Figure 4.2.1 Pin Diagram of MAX 232 .....	16
Figure 4.2.2 Circuit Diagram of MAX 232 .....	17
Figure 4.5.2.1 Block Diagram of RF Tag reader .....	21
Figure 4.6.1.1 Pin Diagram of AT 89S52 .....	23
Figure 4.7.2.1 Pin Diagram of 2x16 Pin LCD .....	25
Figure 5.3.5.1 Block Diagram of Server Software User Interface .....	32
Figure 6.1 Implemented Block Diagram .....	33
Figure 6.2.1 Circuit Diagram of the transmitting side .....	35
Figure 6.2.2 Diagram of the receiving Module .....	35

## LIST OF TABLES

Table 4.1.1 Pin Description of RS232 DB9 connector .....	14
Table 4.7.2.1 Pin Description of LCD .....	25

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## LIST OF ABBREVIATIONS

ALE	Address Latch Enable
ASCII	American Standard Code for Information Interchange
AT	Attention command
CDMA	Code Division Multiple Access
CMOS	Complementary Metal Oxide Semiconductor
CTS	Clear To Send
DBMS	Database Management System
DC	Direct Current
DCE	Data Connection Equipment
DTE	Data Terminal Equipment
DTR	Data Transfer
DSR	Data Set Ready
FDMA	Frequency Division Multiple Access
GIS	Geographic Information System
GND	Ground
GPS	Global Positioning System
GPRS	General Packet Radio Service
GSM	Global System for Mobile Communications
GUI	Graphic User Interface
ID	Identification
IMSI	International Mobile Subscriber Identity
I/O	Input/Output
KHz	Kilo-Hertz
LCD	Liquid Crystal Display
LSB	Least Significant Bit
MC	Microcontroller
MMS	Multimedia Message Service
MODEM	Modulator and Demodulator

MsSQL	Microsoft Structured Query Language
RD	Read
RDMS	Relational Database Management System
RF	Radio Frequency
RFID	Radio Frequency Identification
RTS	Ready To Send
RST	Reset
Rx	Receiver
SIM	Subscriber Identification Module
SMS	Short Message Service
TDMA	Time Division Multiple Access
TTL	Transistor Transistor Logic
Tx	Transmitter
WR	Write

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## 1. INTRODUCTION

### 1.1 Background

Within the last decade, we have seen tremendous technological advances in sensors, networking, and processing that not only make the connection between the physical world and cyber-informatics world possible, but also make such connections much more affordable. We investigated how these new technologies can be used in our transportation systems to improve the cost-effectiveness, accuracy, and timeliness of data collection.

Very often we stuck in traffic for various investigations because of manual method of record checking we are using till these days in our country. Even video surveillances is limited for crime control only, the purposed system meets the essential requirements of highway surveillance and intelligent transportation in real time running. Highway surveillance is a project that involves large set of jobs to be performed with very high efficiency. Vehicular surveillance is a very important part of highway surveillance mechanism. A number of tasks like taxation on highways, vehicle tracking, and data keeping are related to vehicular surveillance.



**Figure 1.1.1** Currently used Tolling System      **Figure 1.1.2** Our Proposed Tolling System

This project intends to detect the vehicle to provide information by tracking and recording its identity for future reference even on densely heavy traffic. **‘Intelligent Highway**

## Intelligent Highway Surveillance System

By: Krishna, Dipendra, Niraj, Ajit

**Surveillance System'** utilizes Radio Frequency identification (RFID) to track the unique identity of each vehicle and GSM wireless network to broadcast the data and information to central server.

The common method implemented for this purpose is the traditional manual method where traffic police/staff are assigned the job on several traffic posts. This method slows down the entire process and also susceptible to frauds. Instead of the traffic posts, we propose putting our reading module along the highway which consists of a Radio frequency tag reader, microcontroller and a GSM modem. This system requires a small RFID tag with unique Identification number to be attached to every single registered vehicle. The communication between the RFID reader module and the tag, acting as transponder, gives the identification number to the microcontroller which encrypts the data into a standard SMS format and sends to central server for processing. The central server is provided with software to manipulate the data and show it in the appropriate display format.

### 1.2 Objectives

The project 'Intelligent Highway Surveillance System' is initiated as per the requirement of Institute of Engineering (IOE) for the final year course of Bachelor in Electronics and Communication Engineering. The objectives of this project are as follows:

- a. To replace manual method of traffic surveillance and reduce human effort
- b. To provide an easier method of taxation
- c. To reduce the time and cost for management
- d. To eliminate the errors and frauds
- e. To set up an alternative for GPS system
- f. To provide an well-organized data acquisition which can be useful in
  - i. Traffic jam management
  - ii. Vehicle tracking
- g. To establish a resourceful data stream that can be helpful for future planning

### 1.3 Features

#### i. Automation

The complete layout of the 'Intelligent Highway Surveillance System' is based on electronic circuitry and components. This eliminates the need of traffic posts that are being used in the pre-existing system. Instead, a simple device holder for the RFID reader will be sufficient for the identification of vehicle on the run automatically.

#### ii. High Speed

The 'Intelligent Highway Surveillance System' can identify the vehicles in a very small interval of time. The GSM trans-receiving is also a very fast process of information exchange. This ensures very high speed of operation of the system.

#### iii. Reliability

Since this system is completely automatic and is based on very efficient Radio-frequency Identification technique, the overall processing of 'Intelligent Highway Surveillance System' is very reliable.

#### iv. Flexibility

The rules and regulations of the traffic management system are not permanent and are bound to change with time. Since the 'Intelligent Highway Surveillance System' uses software for handling administrative affairs, it is capable of changing the required issues just by modifying some program codes. All the acquired data are manipulated and operated by appropriate software which is designed as per the rules, regulations, requirement of the system. This provides an easier way of handling affairs as well as flexibility in the administration of the whole process.

## 2.LITERATURE REVIEW

Highway is an important auxiliary booster of the development of the country's economy and also an important symbol of traffic modernization in a country. At present, for the rapid development of the country economy, the highway also presents the momentum for robust growth. However, with continuous increase in highway traffic and complexity of road network, the traffic management faces enormous challenges. Moreover, some unexpected events and the areas with a lot of traffic lines often cause traffic jams, leading to traffic delays. Secondly, highways in our country basically are the toll road system. At each toll station, vehicles are basically parking for paying fee, so sometimes drivers face the experience of queuing to make payments during rush hours, which is a serious impediment for the highway's fast and efficient function, and also causes environmental pollution and the waste of energy. Furthermore, at this stage, although, highway in our country extends in all directions, the distributions of it in the provinces are very uneven.

The informatization level of highway in our country is low. Many information resources of highway do not obtain the effective integration and use, so it cannot provide the necessary information services and support for the demanders of information resources. The existence of this issue has seriously hindered the healthy development of the future highway. Meanwhile, the information expressway is the future development trend of expressway. So, it is urgent to achieve the informationization, networking and intelligence of highway management. In order to achieve the intellectualized management and the efficient use of expressway, we introduce the RFID technology. This technology has the unique advantage of wireless, automatic and efficient identification of the targets, and also has strong environmental adaptability and reliability so that it can effectively and accurately identify the target in a variety of harsh environments. Just because of the numerous merits of this technology, so applying it to the highway management system can achieve good results. It is assumed that the combined use of RFID technology and GSM communication can improve traffic efficiency in highway and simultaneously ensures the safety of vehicle in the highway

## **Intelligent Highway Surveillance System**

By: Krishna, Dipendra, Niraj, Ajit

and the rationalization and the transparency of charge work. In short, it makes the standardized, efficient and intelligent management of highway.

Surveillance systems are increasingly needed to provide security for citizens and infrastructures. In the last years, RFID technology has been gradually incorporated to commercial transportation systems. A well known example is the RFID-based highway toll collection systems which are routinely employed in many countries, like the Tele pass system in Italy or the Auto pass system in Norway. Other uses include monitoring systems to avoid vehicle theft, access control to car parking or private areas, and embedding of RFID tags in license plate with specially coded IDs for automatic vehicle detection and identification. Placement of RFID tags on the road lanes has been proposed in order to provide accurate vehicle localization in tunnels or downtown areas where GPS positioning might be unreliable. RFID tagging of cars is offered as an alternative to traffic data collection by inductive loops placed under the road surface. The information about the traffic collected by a network of RF readers is then used to regulate traffic at intersection or critical points in the city. Passive RFID tags are arranged in the road close to the position of real traffic signals. An antenna placed in the rear part of the car and close to the floor permits reading of the information stored in the tag memory and conveys a visual or additive message to the driver.

In order to increase the effectiveness of highway management, this project proposes a traffic management and monitoring system of highway based on RFID technology. It can achieve automatic identification of vehicle identity and the supervision of vehicle, simultaneously transmits the monitoring data to the total control centre server through the network. So that Highway transportation management department can check the movement of vehicles and current road situation through this platform to achieve reasonable arrangements about traffic. Highway toll management department can real time inquiry payment situation about vehicle to enhance the supervision. The owners of vehicle may verify and check the payment situation about their own vehicles. Moreover, according to the ID number of RF card attached on the vehicle and the IP address of the receiver, and combining with GIS and GPS

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By: Krishna, Dipendra, Niraj, Ajit

technology, managers can timely and intuitively understand the traffic condition and determine the position value of vehicle to realize the tracking of travelling vehicle, the real time control and scheduling of vehicle, the optimization of traffic routes and the alleviation of traffic congestion. With this advanced traffic monitoring tool, it makes the level of scheduling; command and management in highway get greatly enhanced.

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### 3. SYSTEM MODEL

#### 3.1 Working System

'Intelligent Highway Surveillance System' is centered on overhead wireless detection and tracking techniques through Radio-frequency based wireless communication. Highway monitoring and surveillance, traffic information provision are its key features. This project intends to detect the vehicle to provide information by tracking and recording its identity for future reference even on densely heavy traffic. The purposed system meets the essential requirements of highway surveillance and intelligent transportation in real time running.

As already stated vehicular surveillance is a very important part of highway surveillance mechanism. A number of tasks like taxation on highways, vehicle tracking, and data keeping are related to vehicular surveillance.

Different hardware equipments and software platforms should be used for successfully completion of the project. The overall processing methodology of the 'Intelligent Highway Surveillance System' can be divided into five steps in order to elaborately understand its working procedure. The five steps are discussed separately as follows:

##### 3.1.1 Vehicle identification through RFID transceiver

Radio-frequency Identification technique is implemented for the purpose of vehicle identification. Radio-frequency Identification use RFID tag and reader to track the moving vehicle. For this, every single vehicle is given a RFID tag with a unique identification number or ID. The RFID Reader is capable of detecting and identifying the RFID tags when it enters its periphery.

##### 3.1.2 ID processing through microcontroller

The RFID Reader reads the unique number from the vehicle. The reader then sends this ID to the microcontroller. After reading the ID of vehicles, the microprocessor sends ID to the GSM modem which sends the data in the form of SMS.

### **3.1.3 Wireless communication through GSM**

'Intelligent Highway Surveillance System' uses a GSM trans-receiving set up in order to communicate the data from the reader setup to the administration setup. The encrypted code from the microprocessor embedded to the reader module is sent from the transmission modem in the form of a SMS. This SMS is then received from the receiver modem and the data is decrypted and manipulated.

### **3.1.4 Database handling software**

The fact that a vehicle is present at some place can be interpreted and used in several ways. For example, road taxation, regional border- crossing tolls, tracking, emergency service providing, crime patrols etc. The data received from the GSM trans- receiving set up can be used in any way required, through a database handling software to administer the process.

### **3.1.5 Display system**

The overall output of the system can be shown either simply on LCD display or on the computer screen using various software.

## 3.2 Basic System Operation

Detecting the vehicle at every toll booth through radio frequency, transmitting the detected code along with place and time of detection through wireless medium and keeping the record according to the vehicles details (E.g.: Number plate, Engine Number) is the major issue that this project deals with.

The system design is basically divided into two parts:

- i. First part is a vehicle detector, tag reader and transmitter consisting of radio frequency reader and GSM modem.

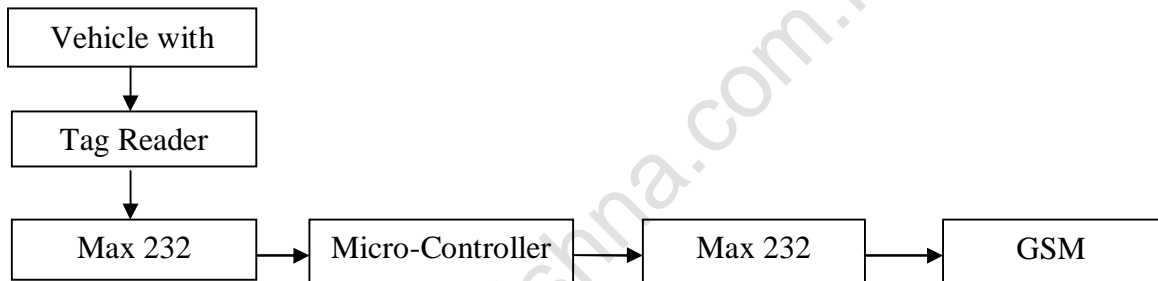


Figure 3.2.1 Block Diagram of Detector and Transmitter

As shown in the figure, a tag attached to the vehicle when comes within the range of radio frequency emitted by RF reader (RF Smart Table), it sends a signal that contains the unique identification of tag also known as Unicode.

MAX 232 is used to convert RS232 logic of RF reader to TTL logic because microcontroller works only on TTL logic. Microcontroller is programmed to retrieve the Unicode from reader and other information such as place, time etc. One of the most important parameter that should be considered while interfacing serial port is the Baud rate (the number of bits transmitted or received per second). Since in serial communication information is transferred bits by bits so, a microcontroller should be set to receive and transmit the bits at required baud rate through software instruction. Again MAX 232 converts TTL logic of microcontroller to RS232 logic to communicate with GSM modem. Now GSM modem

broadcast the information retrieved from microcontroller as a SMS. Since GSM is a slow device as it can only process six to ten SMS in a minute, so a memory buffer can be embedded between microcontroller and GSM modem.

- ii. Second part is a toll raising Centre consisting of GSM modem as a receiver connected to computer (PC).

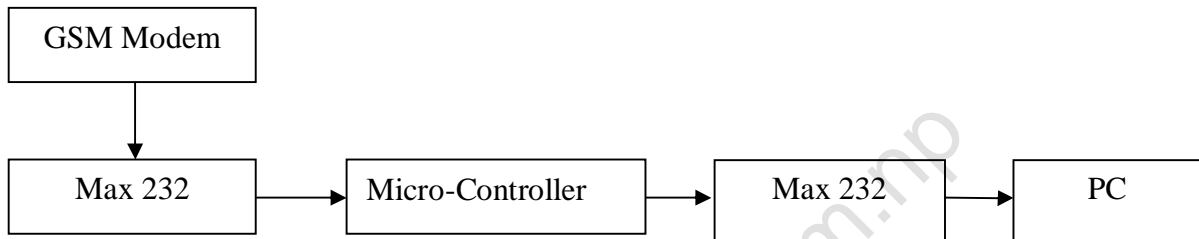


Figure 3.2.2 Block Diagram of Receiver at the toll raising centre

As depicted in the above figure, the GSM modem receive message signal. By converting its output into TTL logic it is send to the microcontroller. The microcontroller is then connected to the PC. Instead of this, GSM modem can be connected directly to the PC and message can be read through AT command. Now the software is designed to keep the record of received data through GSM modem. There is a database that holds the status of vehicle according to its Unicode. So, all the computations are automatically done by the designed software as it receives the data transmitted from toll booth.

### 3.3 Algorithm

- i. Start.
- ii. Read the unique id by RFID reader.
- iii. Serial data transmission to the GSM modem.
- iv. Data transmission from Tx modem to Rx modem.
- v. Receiving transmitted data at the receiver side.
- vi. Extracting data from hyperterminal to database.

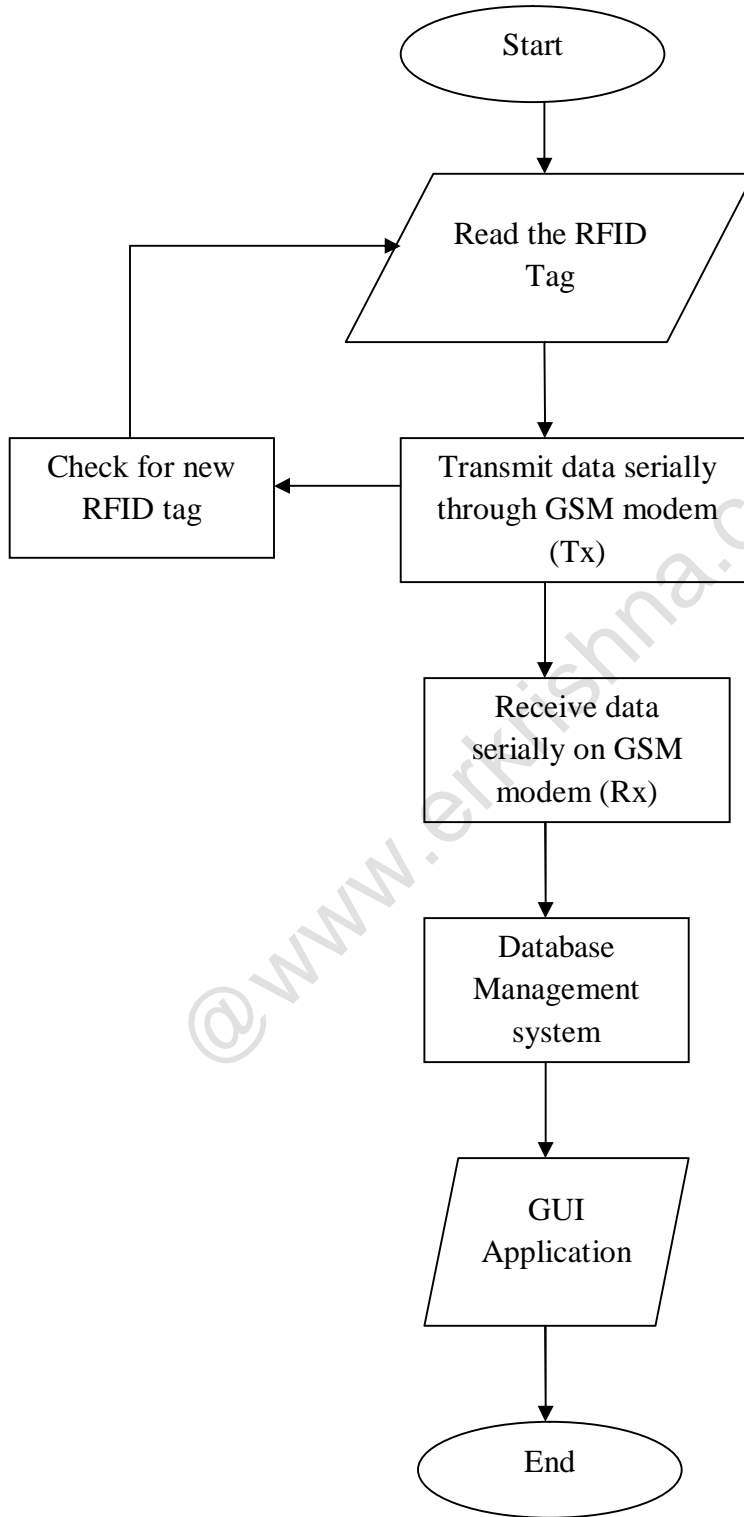
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- vii. Data processing and manipulation.
- viii. GUI interface for administrator.
- ix. End.

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3.4 Flowchart



## **4. HARDWARE DESCRIPTIONS**

Hardware used in 'Intelligent Highway Surveillance System' are listed below

- i. RS232
- ii. MAX232
- iii. RFID Tag
- iv. RFID Tag Reader
- v. GSM Modem
- vi. Subscriber Identity Module (SIM)
- vii. Microcontroller (AT89S52)
- viii. Microcontroller circuit
- ix. Liquid Crystal Display (JHD162A)
- x. Power supply

### **4.1 RS232**

RS232 is a common interface standard for data communications equipment developed in 1960 by Electronic Industry Association and Telecommunication Industry Association (EIA/TIA) in order to ensure reliable communication and to enable the interconnection of equipments produced by different manufacturers, thereby fostering the benefits of mass production and competition.

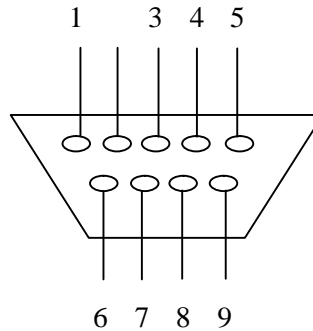


Figure 4.1.1 RS232 DB9 Connector

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Pin	Signal	Pin	Signal
1	Data Carrier Detect	6	Data Send Ready
2	Received Data	7	Request To Send
3	Transmitted Data	8	Clear To Send
4	Data Terminal Ready	9	Ring Detector
5	Signal Ground		

In RS232 standard data is transmitted serially in one direction over a pair of wires. Data going out is labeled Tx (indicating transmission) while data coming in is labeled Rx (indicating reception). To create a two way communication system a minimum of three wires are needed Tx, Rx and GND (ground). Crossing over Tx & Rx between the two systems lets each unit talk to the opposite one. Each byte can be transmitted at any time (as long as the previous byte has been transmitted). The transmitted byte is not synchronized to the receiver - it is an asynchronous protocol i.e. there is no clock signal. For this reason software at each end of the communication link must be set up exactly the same so that each serial decoder chip can decode the serial data stream.

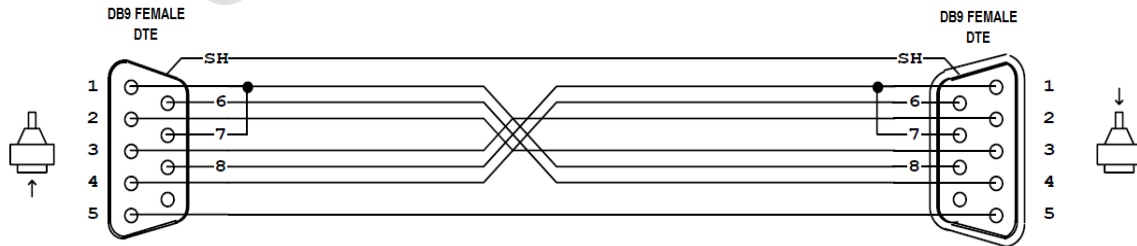


Figure 4.1.2 DB9 Null Modem Connection

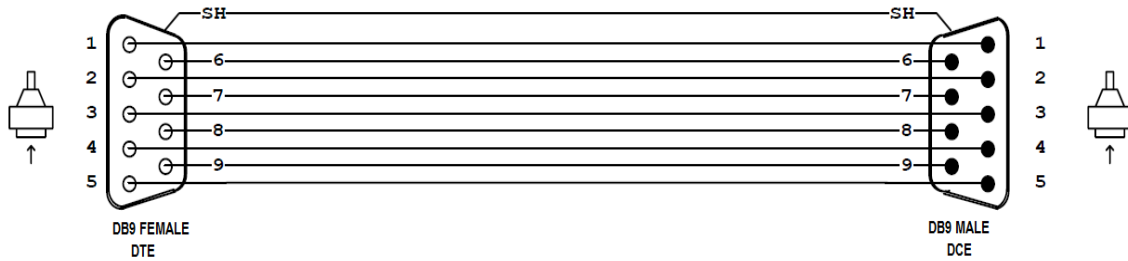


Figure 4.1.3 DB9 DTE to DCE Connection

## Some Related Terms

**i. Baud Rate:** This is simply the transmission speed measured in bits per second. It defines the frequency of each bit period. For a baud rate of 9600 (9600 bps) the frequency is 9600Hz and the bit period is  $1/9600$  or 104.166 us. This is the information that a receiver uses to recover the bits from the data stream.

**ii. Voltage Levels:** To make it work over long cables, high voltages are sent from each transmitter, since due to cable resistance the voltage reduces the further the signal has to travel. The output voltage specification is from +5V to +25V (transmitting a logical zero) and -5V to -25V (transmitting a logical one). All signals in the cable have to generate the same voltage levels e.g. DTR, DSR, RTS, CTS. So we need a lot of level translator chips for a full interface but for very short distances we only need TX and RX and ground. The receiver can accept minimum signal levels of  $\pm 3V$ . The maximum voltage of  $\pm 25V$  does not have to be used and a common voltage in use is  $\pm 12V$  (output by MAX232 transceiver chip).

**iii. Start Bits:** The protocol is described as asynchronous as there is no clock transmitted at all. Instead a different method of clock recovery is used. At the beginning of each transmission a start bit is transmitted indicating to the receiver that a byte of data is about to follow. The start bit lets the receiver synchronize to the data bits. What this means is that the receiver can create its own sample clock at the middle of each bit. Once the start bit is found

the receiver knows where the following bits will be as it is given the sample period (derived from the baud rate) as part of the initialization process.

**iv. Data Bits:** Data bits follow the start bit. There will be seven or eight data bits with the LSB transmitted first. The reason we can choose between seven or eight is that ASCII is made up of the alphabet within the first seven bits (as well as the control characters). The eighth bit extends the character set for graphical symbols. If we only want to transmit text then we only need 7 bits. This saves a bit and increases transmission speed when transmitting large blocks of data. Other data bit sizes are 5 and 6 bits. However bit length is usually ignored and a transmission size of 8 bits is commonly used.

## 4.2 MAX 232

In telecommunications, RS-232 is a standard for serial binary data signals connecting between a DTE (Data terminal equipment) and a DTE (Data Circuit-terminating Equipment). It is commonly used in computer serial ports. In RS-232, data is sent as a time-series of bits. Both synchronous and asynchronous transmissions are supported by the standard. But Microcontroller supports or works only on TTL logic.

The MAX232 IC is used to convert the TTL/CMOS logic levels to RS232 logic levels and vice versa during serial communication of microcontrollers with PC. The controller operates at TTL logic level (0-5V) whereas the serial communication in PC works on RS232 standards (-25 V to + 25V). This makes it difficult to establish a direct link between them to communicate with each other. The intermediate link is provided through MAX232. It is a dual driver/receiver that includes a capacitive voltage generator to supply RS232 voltage levels from a single 5V supply. Each receiver converts

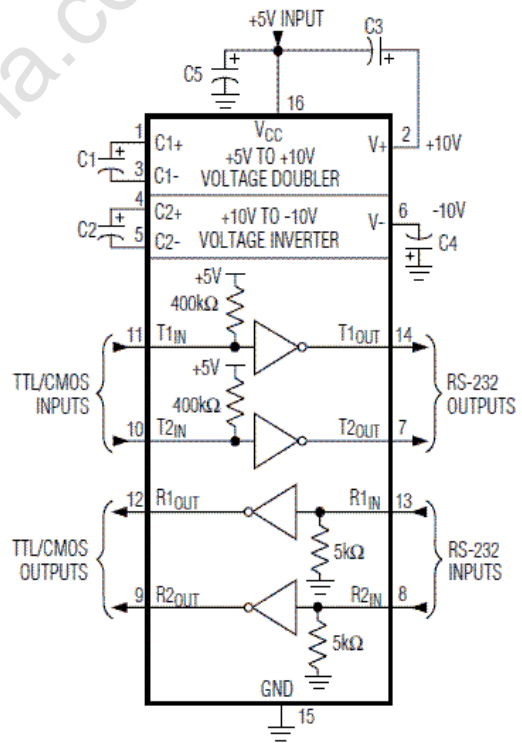


Figure 4.2.1 Pin Diagram of MAX232

Figure 4.2.1 Pin Diagram of MAX232

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By: Krishna, Dipendra, Niraj, Ajit

RS232 inputs to 5V TTL/CMOS levels. These receivers ( $R_1$  &  $R_2$ ) can accept  $\pm 30V$  inputs. The drivers ( $T_1$  &  $T_2$ ), also called transmitters, convert the TTL/CMOS input level into RS232 level. The transmitters take input from controller's serial transmission pin and send the output to RS232's receiver. The receivers, on the other hand, take input from transmission pin of RS232 serial port and give serial output to microcontroller's receiver pin. The table below illustrates conversion of TTL/CMOS logic level into RS232 logic level and vice versa.

Microcontroller	MAX232	RS232
TX	T(in)	T(out) Rx
RX	R(out)	R(in) Tx

MAX232 needs four external capacitors whose value ranges from  $1\mu F$  to  $22\mu F$ . But in this case we used capacitors with value of  $1\mu f$  each.

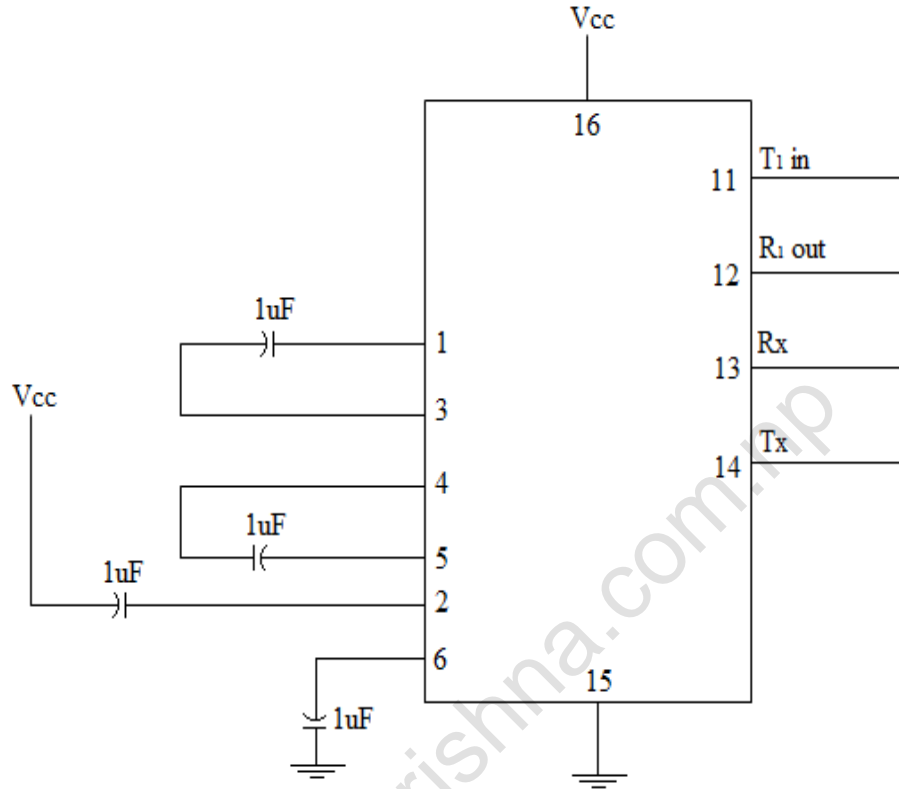


Figure 4.2.2 Circuit diagram of MAX232

### 4.3 GSM System

GSM (Global System for Mobile Communications) is the standard set for cellular communication developed by European Telecommunications Standards Institute. Initially developed as a digital, circuit switched network optimized for full duplex voice telephony, it later extended its services to short message service (SMS), data transfer and packet data transfer. Cellular system serves multiple end users at different locations in a simulcast fashion. Practically every cellular system has some kind of broadcast mechanism. This can be used directly for distributing information to multiple mobiles, commonly, for example in a mobile telephony system, the most important use of broadcast information is to set up channels for one to one communication between the mobile Trans-receiver and the base station. This is called paging. The details of the process of paging vary somewhat from

network to network, but normally we know a limited number of cells where the phone is located (this group of cells is called a location area in the GSM system). Paging takes place by sending the broadcast message on all of those cells. The Unicode identified as each point can be converted into text message and can be multicast to the entire center where the databases of vehicles are located.

### 4.3.1 GSM Modem

A GSM modem is a wireless modem that works with a GSM wireless network. A wireless modem behaves like a dial-up modem. The main difference between them is that a dial-up modem sends and receives data through a fixed telephone line while a wireless modem sends and receives data through radio waves. Like a GSM mobile phone, a GSM modem requires a SIM card from a wireless carrier in order to operate. For example; Matrix Simado GDT11.

The GSM Modem comes with a serial interface through which the modem can be controlled using AT command interface. An antenna and a power adapter are also provided.

GSM Modem can satisfy various data communication needs over GSM. It can be connected to a computer with the help of a standard RS232C serial port. Every GSM Modem offers features like Short Message Services (SMS), Data Services (sending and receiving data files). In addition to this Fax Services and Web Browsing, Remote login and data file transfer are also supported.

Most of the modem available has either M-Bus connection or F-Bus connection. M-Bus is a one pin bi-directional bus for both transmitting and receiving data from the modem. It is slow (9600bps) and only half-duplex. Only two pins on the modem are used. One is ground and another is data. M-Bus runs at 9600bps, 8 data bits, odd parity, and one stop bit. The data terminal ready (DTR) pin must be cleared with the request to send (RTS). This powers the electronics in the cable and it sets it for M-Bus operation. F-Bus is the later high-speed full-duplex bus. It uses one pin for transmitting data and one pin for receiving data plus the ground pin. Very much like a standard serial port. It is fast 115,200bps, 8 bits data, no parity, and one stop bit. For F-Bus the data terminal ready (DTR) pin must be set and the request to send (RTS) pin cleared.

The basic segregation of working of the modem is as under:

i. Voice calls

Voice calls are not an application area to be targeted. In future, if interfaces like a microphone and speaker are provided for some application then this can be considered.

ii. SMS

SMS is an area where the modem can be used to provide the features like:

- Pre-stored SMS transmission.
- Transmission of these SMS on certain trigger events in an automation system.
- Use of these SMS in areas where text information has to be sent. The transmitter can be an automation system for machines like vending machine, collection machines or applications like positioning systems where the navigator keeps on sending SMS at a particular time.
- SMS can also be a solution where GSM data call or GPRS services are not available.

iii. GSM Data calls

Data calls can be made using this modem. Data calls can be made to normal PSTN modem/phone line. Data calls are basically made to send or receive data streams between two units either PC's or embedded devices.

### 4.4 Subscriber Identity Module (SIM)

One of the key features of GSM is the subscriber Identity Module, commonly known as a SIM card. The SIM is a detectable smart card containing the user's subscription information and phone book. This allows the user to retain his/her information after switching handsets. Alternatively, the user can also change operators while retaining the handset simply by changing the SIM. Some operators will block this by allowing the phone to use only a single SIM, or only a SIM issued by them.

### 4.5 RFID SYSTEM

Radio-frequency identification (RFID) system is a wireless non-contact radio system to transfer data from a tag attached to an object, for the purposes of automatic identification. RFID has produced a competent approach of organization, management and distribution of objects. Based on the promise of lower operating costs combined with more accurate product and asset information, organizations and manufacturers to governmental agencies, retailers to healthcare providers are introducing RFID technologies in the supply chain, for asset tracking and management, and for security and regularity purposes. RFID is rapidly becoming a cost-effective technology

RFID system consists of two main parts:

#### 4.5.1 RFID Tag

- i. Passive:** These Tags are inactive until the reader's interrogation signals wakes them up. They are cheap but the range is short.
- ii. Semi-passive:** The tags contain on board cell but cannot initiate communication. They are expensive but can cover longer range.
- iii. Active:** They contain on board cell and also can initiate communication.

#### 4.5.2 RFID Tag Reader

The RFID tag reader consists of an antenna, transceiver and decoder. The reader generates a continuous activation signal, and when a tag is within range of this signal, the tag sends the reader its identification. Upon signal detection and identification of the tag, the tag reader then sends command signals to tag. Responding to commands from the reader, the tag sends out encoded data. This data is sent to modulator, and to the decoder, and then decoded data is sent to a host computer using GSM modem to be processed. The reader we are using is a low

frequency reader with an operating frequency of 125KHZ and the range lies between 5-10 cm. Simple block diagram of RFID tag reader with tag is shown below.

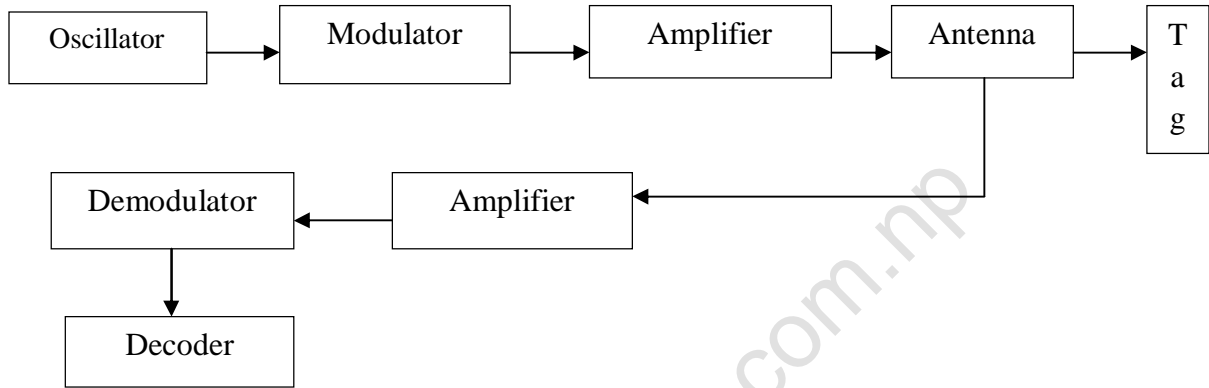


Figure 4.5.2.1 Block Diagram of RF Tag Reader

#### **4.6 Microcontroller (AT89S52)**

The microcontroller is the device that can perform various operations and computations on the data. It consists of the arithmetic and logic unit, input/output unit, control unit and various components.

The AT89S52 is a low-power, high-performance CMOS 8-bit microcontroller with 8K bytes of in-system programmable Flash memory. The device is manufactured using Atmel's high-

# Intelligent Highway Surveillance System

By: Krishna, Dipendra, Niraj, Ajit

density nonvolatile memory technology and is compatible with the industry-standard 80C51 instruction set and pin out. The on-chip Flash allows the program memory to be reprogrammed in-system or by a conventional nonvolatile memory programmer. By combining a versatile 8-bit CPU with in-system programmable Flash on a monolithic chip, the Atmel AT89S52 is a powerful microcontroller which provides a highly-flexible and cost-effective solution to many embedded control applications.

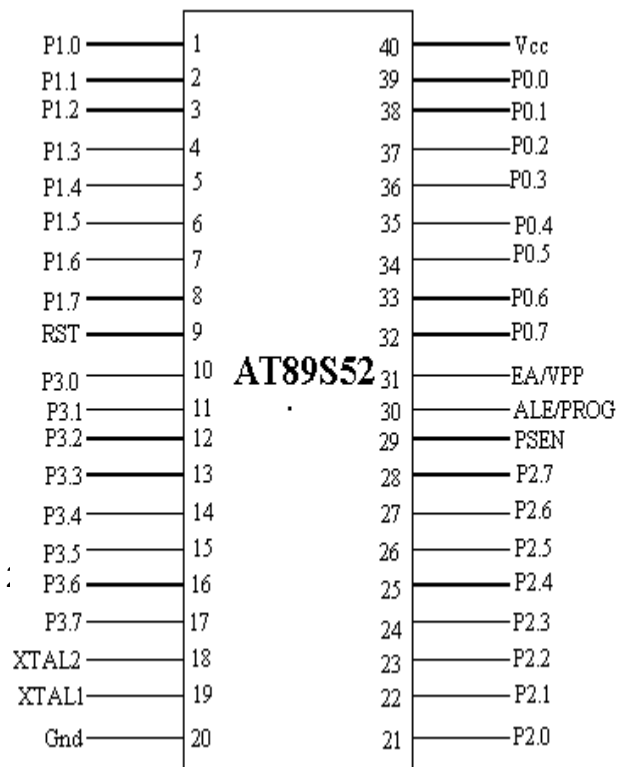
The AT89S52 provides the following standard features: 8K bytes of Flash, 256 bytes of RAM, 32 I/O lines, Watchdog timer, two data pointers, three 16-bit timer/counters, a six-vector two-level interrupt architecture, a full duplex serial port, on-chip oscillator, and clock circuitry. In addition, the AT89S52 is designed with static logic for operation down to zero frequency and supports two software selectable power saving modes. The Idle Mode stops the CPU while allowing the RAM, timer/counters, serial port, and interrupt system to continue functioning. The Power-down mode saves the RAM contents but freezes the oscillator, disabling all other chip functions until the next interrupt or hardware reset.

## 4.6.1 Pin configuration and Description

**i. Port 0:** Port 0 is an 8-bit open drain bidirectional I/O port. As an output port, each pin can sink eight TTL inputs. When 1s are written to port pins, the pins can be used as high-impedance inputs. Port 0 can also be configured to be the multiplexed low-order address/data bus during

accesses to external program and data memory. In this mode, P0 has internal pull-ups. Port 0 also receives the code bytes during Flash programming, and outputs the code bytes during program verification. External pull-ups are required during program verification.

**ii. Port 1:** Port 1 is an 8-bit bidirectional I/O port with internal pull-ups. The Port 1 output buffers can sink/source four TTL



inputs. When 1s are written to Port 1 pins, they are pulled high by the internal pull-ups and can be used as inputs. As inputs, Port 1 pins that are externally being pulled low will source current (IIL) because of the internal pull-ups. Port 1 also receives the low-order address bytes during Flash programming and verification.

**iii. Port 2:** Port 2 is an 8-bit bidirectional I/O port with internal pull-ups. The Port 2 output buffers can sink/source four TTL inputs. When 1s are written to Port 2 pins, they are pulled high by the internal pull-ups and can be used as inputs. As inputs, Port 2 pins that are externally being pulled low will source current (IIL) because of the internal pull-ups. Port 2 emits the high-order address byte during fetches from external program memory and during accesses to external data memory that use 16-bit addresses. Figure 4.6.1.1 Pin diagram of AT89S52

**iv. Port 3:** Port 3 is an 8-bit bidirectional I/O port with internal pull-ups. The Port 3 output buffers can sink/source four TTL inputs. When 1s are written to Port 3 pins, they are pulled high by the internal pull-ups and can be used as inputs. As inputs, Port 3 pins that are externally being pulled low will source current (IIL) because of the pull-ups. Port 3 receives some control signals for Flash programming and verification.

**v. RST:** Reset input. A high on this pin for two machine cycles while the oscillator is running resets the device.

### 4.7 Liquid Crystal Display (LCD)

A liquid crystal display (LCD) is a thin, flat display device made up of any number of color or monochrome pixels arrayed in front of a light source or reflector. Each pixel consists of a column of liquid crystal molecules suspended between two transparent electrodes, and two polarizing filters, the axes of polarity of which are perpendicular to each other. Without the liquid crystals between them, light passing through one would be blocked by the other. LCD displays designed around LCD JHD162A module, are inexpensive and easy to use. They have a standard ASCII set of characters and mathematical symbols.

## 4.7.1 Signals to the LCD

The LCD also requires 3 control lines from the microcontroller:

### i. Enable (E)

This line allows access to the display through R/W and RS lines. When this line is low, the LCD is disabled and ignores signals from R/W and RS. When (E) line is high, the LCD checks the state of the two control lines and responds accordingly.

### ii. Read/Write (R/W)

This line determines the direction of data between the LCD and microcontroller. When it is low, data is written to the LCD. When it is high, data is read from the LCD.

### iii. Register selects (RS)

With the help of this line, the LCD interprets the type of data on data lines. When it is low, an instruction is being written to the LCD. When it is high, a character is being written to the LCD.

## 4.7.2 Pin Description

Most LCDs with 1 controller has 14 Pins and LCDs with 2 controller has 16 Pins (Two pins are extra in both for back-light LED connections).

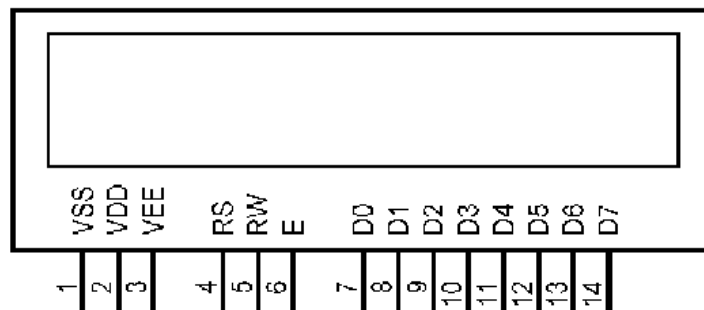


Figure 4.7.2.1 Pin Diagram of 2x16 Pin LCD

Pin no.	Name	Description
Pin no. 1	VSS	Power Supply (GND)
Pin no. 2	VCC	Power Supply (+5V)
Pin no. 3	VEE	Contrast Adjust
Pin no. 4	RS	0= Instruction Input 1= Data Input
Pin no. 5	R/W	0= Write to LCD module 1= Read from LCD module
Pin no. 6	EN	Enable Signal
Pin no. 7	D0	Data bus line 0 (LSB)
Pin no. 8	D1	Data bus line 1
Pin no. 9	D2	Data bus line 2
Pin no. 10	D3	Data bus line 3
Pin no. 11	D4	Data bus line 4
Pin no. 12	D5	Data bus line 5
Pin no. 13	D6	Data bus line 6
Pin no. 14	D7	Data bus line 7 (MSB)

Table 4.7.2.1 Pin Description of LCD

## **5. SOFTWARE PROFILE**

Software is a very important part of ‘INTELLIGENT HIGHWAY SURVEILLANCE SYSTEM’. The management of all the relevant information, be it hardware generic or data generic is dependent on the software branch. The hardware generic information refers to all the physical signals that are generated while the system is undertaking its regular tasks. Data

generic information on the other hand implies to the information about the vehicles that the system reads. To deal with these two types of information, the system will also require three types of software;

- i. Microcontroller program
- ii. AT commands
- iii. Database management software

### 5.1 Microcontroller (AT89S52) program

A microcontroller program is required to organize the input and output of the microcontroller. Since our system uses microcontroller embedded vehicle detection and identification module, a proper programming is mandatory to its smooth operation. The program will be able to read the data, encrypt the data in a required standard format and guide it to the central server in a way such that the security of data is not sacrificed as well as the decryption is easy.

Since the provision of unique ID to each vehicle, detection of vehicle and identification of it is the main leitmotif of our project so the microcontroller is programmed such that it detect the vehicle, read its unique id, generate error signal upon the truancy of ID and after a certain processing channel the ID to the destination.

Either Assembly language or high level language such as C can be employed for programming the microcontroller, but due to easiness in programming, easy availability of compiler and program burner we used C programming in order to program the microcontroller.

Here, both the reception of ID and the transmission of data involve serial communication. For this, there are two pins available (TxD and RxD) and are the part of the port 3 group (P3.0 and P3.1). Pin 10 (P3.0) is assigned RxD and pin 11 (P3.1) is assigned TxD. Also two register are available. SBUF register is an 8-bit register that hold a byte of data to be transferred through TxD line or that is received through RxD line. The SCON register is an 8 bit register used to program the start bit, stop bit and data bits of data framing.

## 5.2 AT commands

Computers use AT commands to control modems. There are also several extended AT commands that are defined in the GSM standards. With the extended AT commands, various things can be done. Such as:

- i. Reading, writing and deleting SMS messages.
- ii. Sending SMS messages.
- iii. Monitoring the signal strength.
- iv. Monitoring the charging status and charge level of the battery.
- v. Reading, writing and searching phone book entries.

The starting "AT" is the prefix that informs the modem about the start of a command line. It is not part of the AT command name. For example, D is the actual AT command name in ATD and +CMGS is the actual AT command name in AT+CMGS. However, some books and web sites use them interchangeably as the name of an AT command.

The commonly used AT commands in sending and reading SMS are:

**i. AT** - This command is used to check communication between the module and the computer. For example,

```
AT
OK
```

The command returns a result code OK if the computer (serial port) and module are connected properly. If any of module or SIM is not working, it would return a result code ERROR.

**ii. +CMGF** - This command is used to set the SMS mode. Either text or PDU mode can be selected by assigning 1 or 0 in the command.

```
SYNTAX: AT+CMGF=<mode>
0: for PDU mode
1: for text mode
```

The text mode of SMS is easier to operate but it allows limited features of SMS. The PDU (protocol data unit) allows more access to SMS services but the operator requires bit level knowledge of TPDU. The headers and body of SMS are accessed in hex format in PDU mode so it allows availing more features.

For example,

```
AT+CMGF=1
```

```
OK
```

**iii. +CMGW** - This command is used to store message in the SIM.

SYNTAX: AT+CMGW=" Phone number"> Message to be stored Ctrl+z

As one types AT+CMGW and phone number, '>' sign appears on next line where one can type the message. Multiple line messages can be typed in this case. This is why the message is terminated by providing a 'Ctrl+z' combination.

**iv. +CMGS** - This command is used to send a SMS message to a phone number.

SYNTAX: AT+CMGS= serial number of message to be send. As the command AT+CMGS and serial number of message are entered, SMS is sent to the particular SIM.

For example,

```
AT+CMGS=1
```

```
OK
```

**v. +CMGL**- This command is used to list received messages. If we want our PC to retrieve the entire inbound message that have not been read before than this command is used. This command can also be used to retrieve the entire message stored in the message storage area.

For example,

```
AT+CMGL="ALL"
```

```
AT+CMGL="REC READ"
```

```
AT+CMGL="REC UNREAD"
```

**vi. +CMGD-** The AT command +CMGD is used to delete SMS message from message storage. The message storage area from which the message are to be deleted is defined by the syntax or AT command +CPMS (Command Preferred Message Stored).

For example,

```
AT+CMGW="977xxxxxxxxxx"
```

```
+CMGW: 5
```

```
OK
```

This means message is stored at index 5. So this message can be deleted by using command

```
AT+CMGD=5
```

```
OK
```

**vii. +CMSS-** This AT command is used to send the SMS from message storage. To send the SMS message from storage first we have to use the AT command +CMGW in order to store the message in message storage. Then the message at a specified storage is then send to the number.

For example,

```
AT+CMGW="977xxxxxxxxxx"
```

```
+CMGW: 5
```

```
OK
```

```
AT+CMSS= 5
```

```
OK
```

### 5.3 Database management software

'INTELLIGENT HIGHWAY SURVEILLANCE SYSTEM' is knitted with a number of tasks to be performed. We have developed C#(C Sharp) desktop application software for user

## **Intelligent Highway Surveillance System**

By: Krishna, Dipendra, Niraj, Ajit

interface. The Database Management Software is the real interface of the system with the user. So, this software is required to interpret the given data in various ways in order to give an accurate assessment of the actual events happening on the highway. The tasks include tracking, surveying etc. This software has been designed in C# language using .net library and we exploited MsSQL for database.

### **5.3.1 MsSQL**

Microsoft SQL Server is relational database management system (RDBMS) developed by Microsoft Inc. . As a database, it is a software product whose primary function is to store and retrieve data as requested by other software applications, be it those on the same computer or those running on another computer across a network (including the Internet). There are at least a dozen different editions of Microsoft SQL Server aimed at different audiences and for different workloads (ranging from small applications that store and retrieve data on the same computer, to millions of users and computers that access huge amounts of data from the Internet at the same time).

### **5.3.2 C#**

C# is a multi-paradigm programming language encompassing strong, typing, imperative, declarative, functional, procedural, generic, object-oriented (class-based), and component oriented programming disciplines. It was developed by Microsoft within its .NET initiative and later approved as a standard by ECMA and ISO. C# is one of the programming languages designed for the Common Language Infrastructure. C# is intended to be simple, modern, general-purpose, oriented programming language.

### **5.3.3 .NET Framework**

The .NET Framework (pronounced dot net) is a software framework developed by Microsoft that runs primarily on Microsoft Windows. It includes a large library and provides language interoperability (each language can use code written in other languages) across several programming languages. Programs written for the .NET Framework execute in

a software environment (as contrasted to hardware environment), known as the Common Language Runtime (CLR), an application virtual machine that provides services such as security, memory management, and exception handling. The class library and the CLR together constitute the .NET Framework.

The .NET Framework's Base Class Library provides user interface, data access, database connectivity, cryptography, web application development, numeric algorithms, and network communications. Programmers produce software by combining their own source code with the .NET Framework and other libraries. The .NET Framework is intended to be used by most new applications created for the Windows platform. Microsoft also produces an integrated development environment largely for .NET software called Visual Studio.

### 5.3.4 Structure of Software

The Application software we have designed consists of three layers of organization. The first two layers are source layers whereas the third layer deals with user interactions and is the face of our software. The layers are described in brief below.

- i. Layer 1 [Text File]: The first layer is the text file where all the received SMS are imported via hyper-terminal of computer. These data are to be incorporated to the second layer i.e. the MsSQL database by user with the help of software itself.
- ii. Layer 2 [MsSQL Database]: The second layer, as mentioned above, is the database layer. All of the data our software uses is stored in this layer. Basically, the database consists of three tables; one for the records of vehicles owner, for the records of vehicles and the other for the activities on highway i.e. which vehicle showed up where (location of the vehicle).
- iii. Layer 3 [User Interface]: The third layer is the uppermost and more or less the most important layer of the software since it controls all the action of user in a specified way. It is capable of using the data from second layer as well as modifying them as per the user action.

### 5.3.5 Manual for Software

This section deals with the third layer of the software i.e. user interface and its utility. As per the user tasks, the software can be divided in two main portions.

- i. Database Functions
- ii. User Functions

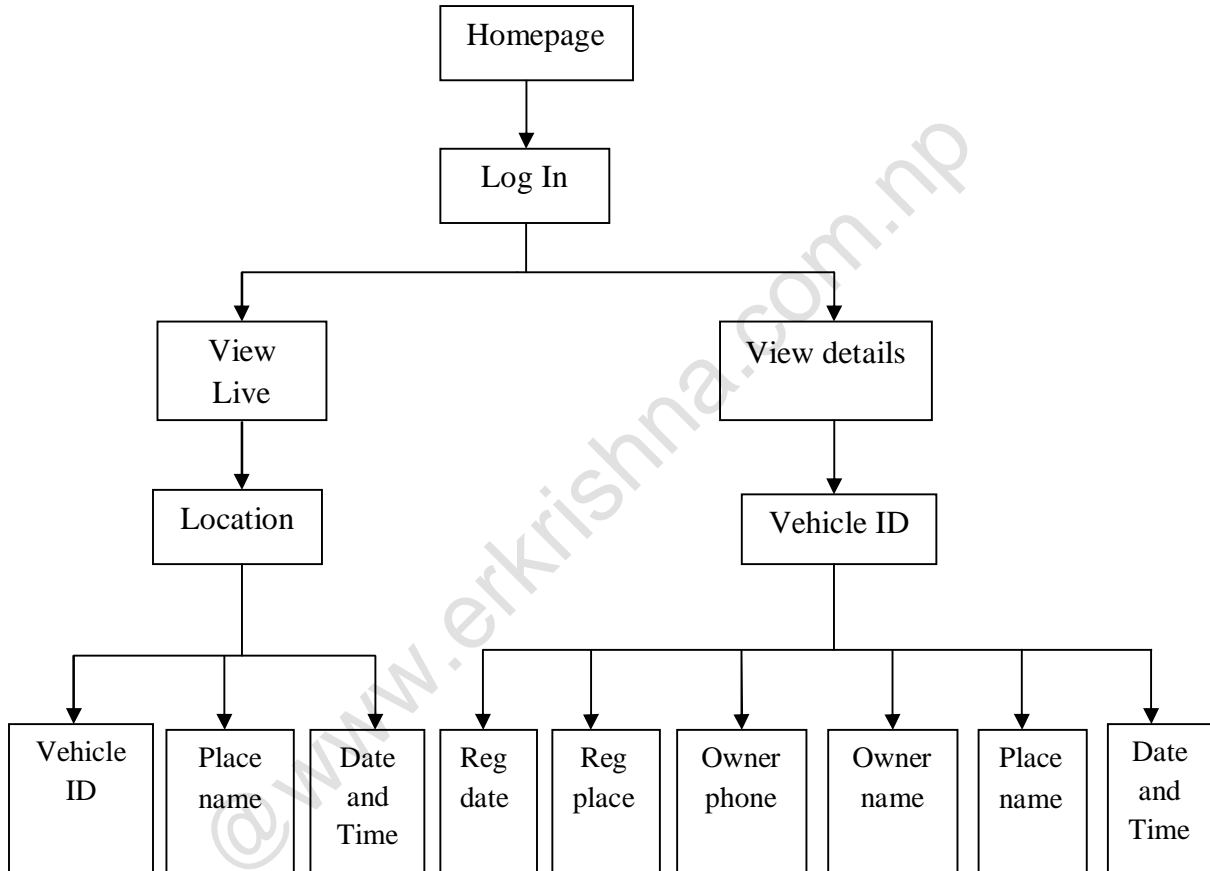


Figure 5.3.5.1 Block Diagram of Server Software User Interface

## **6. SYSTEM DESIGN**

The major issue of this project is to detect the vehicle in toll booth and keep its record using the unique Id provided to the vehicle. For the detection of the vehicle, radio frequency is used

and the record is kept in the central server in accordance to the place and time of detection using the wireless medium.

### 6.1 Implemented Block Diagram

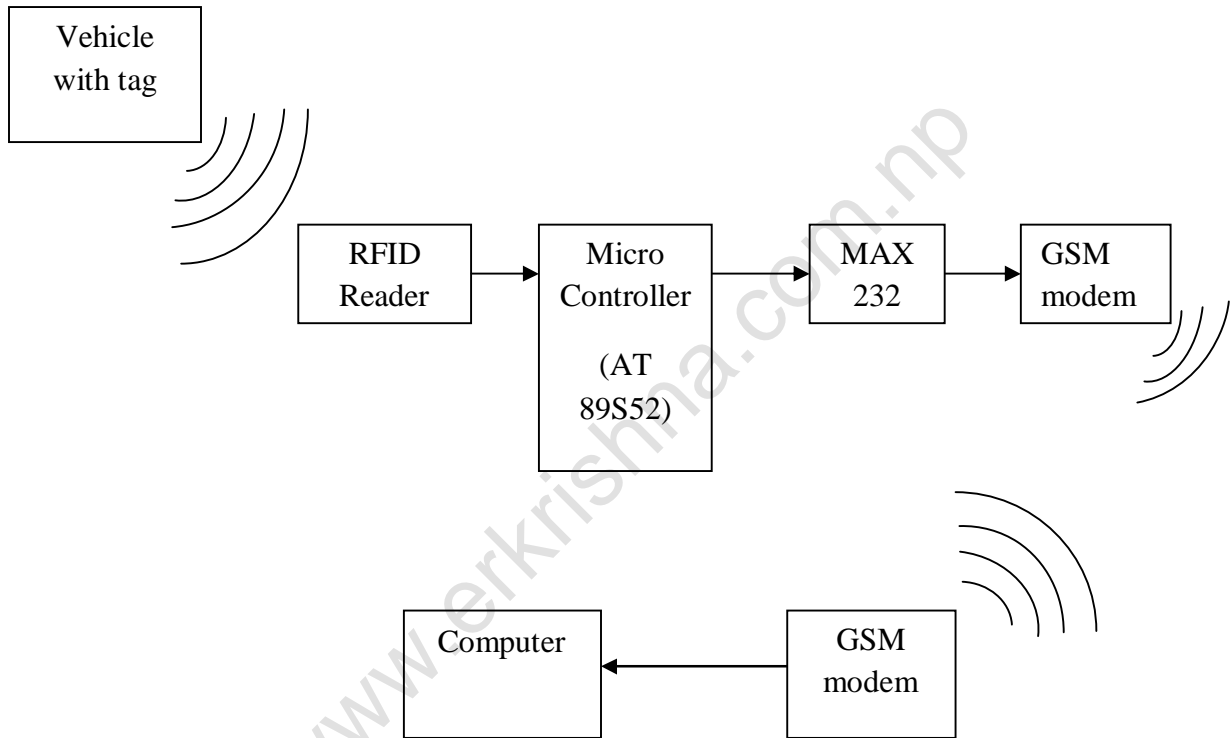


Figure 6.1 Implemented Block diagram of the system

The system consists of two parts

#### 6.1.1 Transmitter side

The transmitter side consists of the vehicle detector; tag reader, RFID, transmitter and GSM modem. According to our proposed system, each vehicle are provided with unique RFID

passive tag attached in a vehicle with an effective way. The RFID tag reader in a toll booth is provided with an antenna that radiates the radio frequency and creates an electromagnetic field. When the vehicle with tag is under the region of Interrogation, an Unicode of an RFID tag is read by the tag reader and transmits it to the central server serially through the GSM modem connected at the transmitting side of the tag reader. MAX 232 is connected for interfacing the microcontroller with GSM modem, since their operating voltage levels are not same. So, conversion from TTL logic to RS232 logic is necessary. An external memory buffer can be embedded between microcontroller and GSM for storing received tag and its information at transmitting side at high traffic condition.

### 6.1.2 Receiver side

The receiver side consists of the GSM modem connected to PC, to retrieve the message and fill it to the database specified for the user related function. The transmitted data from the toll section side is received at the central toll raising side, using GSM modem, which is connected to PC. These data are stored in serial buffer of HyperTerminal, and are can be easily extracted to database for further processing and manipulation as required. Here, we only extract the vehicle tag, time, date and place. According to our proposed system, at the receiver side, there is a GUI based application that allows administrator to identify the vehicle location and unauthorized vehicles also.

## 6.2 Implemented Circuit

### 6.2.1 RFID Reader And Transmitting Module (Toll Post)

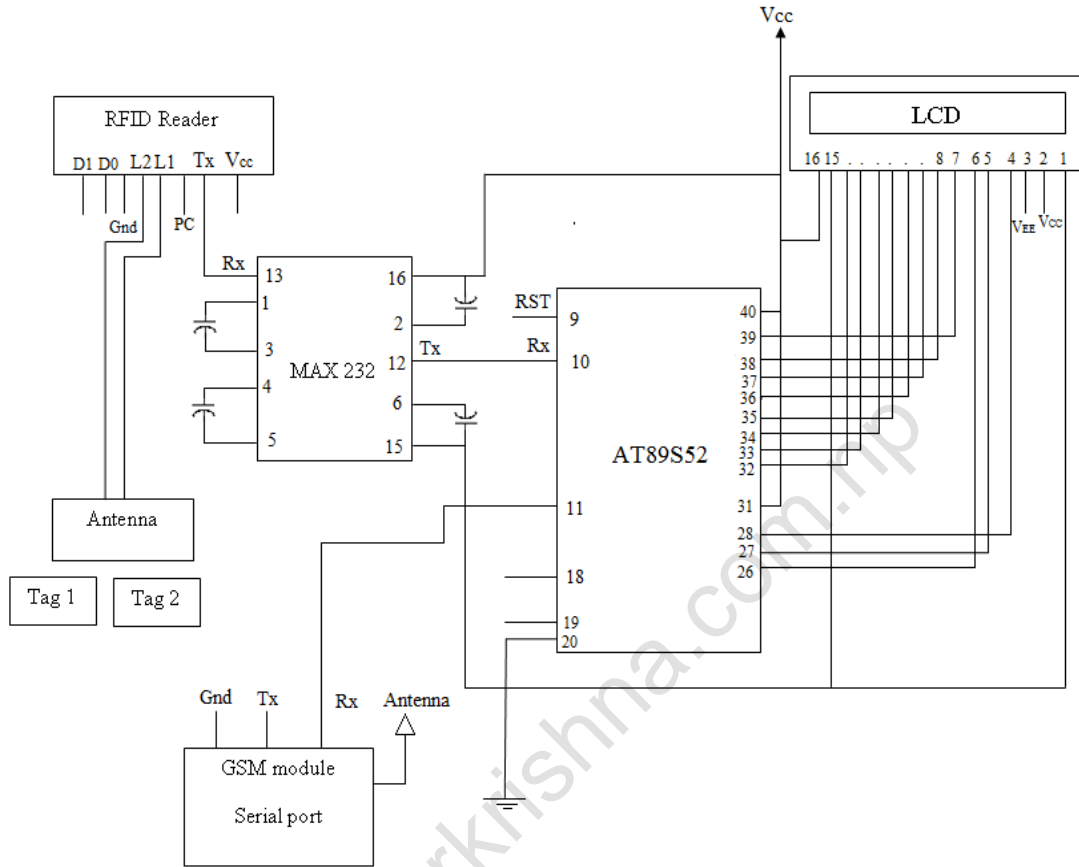


Figure 6.2.1 Circuit diagram of the transmitting side

**6.2.2 Receiving Module (Server/Control Room)**

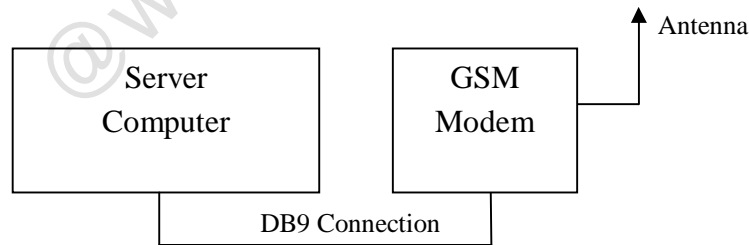


Figure 6.2.2 Diagram of the receiving Module

**7. RESULTS AND CONCLUSION**

The project entitled 'Intelligent Highway Surveillance System' was completed in time with the achievement of the target. With the completion of the project, we became able to track the vehicle in the surveillance zone. As the vehicle approaches near our tag reader, it reads the tag and collects the information and transmits it to the receiving side using GSM technology. At the receiving side, the information was received using GSM modem and transferred in the central server for the further processing. We, then become able to acquire various information about the vehicle, like vehical resent position, its Owner's name, registration date, time and place using the database on display.

### 7.1 Limitations and Shortcomings

Although the motto of every project is to complete the designated tasks in a flawless manner, there is bound to be limitations due to several factors. 'Intelligent Highway Surveillance System' too has some inadequacies occurred due to reasons ranging from technical constraints to financial restraints.

The most prominent problem is the range of RFID tag reader; it has to work not only in the range of meters but also process very fast in case of heavy traffic. This type of reader is very costly and can increase the overall cost of the project. Also, since we need to completely overthrow the existing system and establish a new one, it can be a tedious job at first. Some of the primary limitations and shortcomings can be listed as below.

- i. Unreliable Network Coverage of GSM
- ii. Prone to damage and theft
- iii. May Cause mass unemployment
- iv. Short range detection ( maximum 10 cm)

### 7.2 Problems Encountered

The Completion of a project requires a coordination and proper management of various elements such as time scheduling, work division, fault handling etc. One of the major problems that aroused was not being able to work independently in divided tasks and having to stick to traditional waterfall model. This was due to various factors including erroneous electronic components and modems, non availability of standard datasheets of some components and lack of proper training beforehand.

Software plays central role in this project; the compatibility issues of different platforms to different operating systems was one of the most troubling factor for us. It would also be appropriate to mention the difficulty created by load-shedding which altered our working schedule very much.

We had done extensive research but that too turned out to be lacking because we still had not outlined small details in our algorithm which prove to be very significant in comprehending the errors generated. We can now understand the reason behind giving so much great importance to the research phase in projects.

However, no one can completely remove problems and difficulties in any project. We have realized how we could have made things easier by making some wise choices and better techniques. We believe this will help us significantly in our future endeavors.

### 7.3 Future Enhancements

Highway Surveillance covers a wide range of tasks to be done. This project, 'Intelligent Highway Surveillance System', is just an elementary model of working which can be enhanced into a sophisticated system with additional features to administrate the vehicular traffic impeccably as well as to facilitate regulated and comfortable public service for the people. Some of the enhancements that can be employed to the project are listed below.

#### i. Notification/Warning Messaging to Vehicles

- Providing important messages such as accident prone areas, road blockings, alternative routes etc. to the moving vehicle.

#### ii. Automatic Ticketing using RFID Cards

- RFID posts acting as ticketing Centers for public buses using RFID cards

#### iii. Emergency Calling Services

- Automatic call generations to Police Stations and Hospitals in case of Emergency.

#### iv. Video Surveillance via 3G link

- Setting up Cameras at important posts and Communicating via 3G link to Surveillance centers.

#### v. Merge with GPS Tracking

- The vehicle location can be detected at any point in the highway, which are now tracked only when it reaches the toll booth. So, merging this system with GPS makes the system more effective and efficient one.

### 7.4 Discussion and Conclusion

The project 'Intelligent Highway Surveillance System' was initiated as per the requirement of Institute of Engineering (IOE) for the final year course of Bachelor in Electronics and Communication Engineering. The designing of this project has been structured so as to achieve the goals/objective set by the Institute of Engineering (IOE). This project has helped us comprehend the technical elements of engineering an idea to a real time operational set up. Coordination of this project included choosing the best option for a number of features/components from different types of alternatives. Identifying the most relevant choice from the pool of alternatives is also the key accomplishment we have gained from this project.

A vehicle tracking system incorporates electronics device/devices in the vehicle and software to let the third party track the system is installed in a computer at remote location. Most of the designers and researchers have proposed wide varieties of cutting edge technologies to serve the target of vehicle tracking which includes GPS (Global Positioning System) and GIS (Geographical Information of System). If the primary objective of any vehicle tracking project is to monitor and scrutinize the vehicle according to time and date so that the action of tolling become a laidback task for both the toll officials and vehicle owner, the exploitation of the above mentioned technologies may not be feasible either in terms of cost or in terms of availability of services. Also an owner may disable the GPS system installed in the vehicle in order to evade the toll. A similar problem may be encountered when such tracking system is used in any surveillance system. So, a core concern for designer is to embed a device that will be out of a normal reach from individual and quite arduous to halt it. Taking into consideration all the limitations of mentioned technology we have planned to use Radio-frequency Identification (RFID) as a tracking system in our project.

In the same way a RFID tag embedded into vehicle and readers placed at various locations help us to determine the current location of vehicle. Over and above it can be used to record

## **Intelligent Highway Surveillance System**

By: Krishna, Dipendra, Niraj, Ajit

when, where and how often a vehicle was on through a particular place (as well as highway, roadway and subway).

The project 'Intelligent Highway Surveillance System' itself is a pioneering concept to our country in the context of using technology for public services. It adjoins a new dimension of technological reliance to our traditional methods of taking on the jobs on hand. Therefore, the prospect of this project is not just limited to the undertaking of its own employment but also on adding a technological perspective to the possible designing of all the future projects. Hence, saying that this project will completely revolutionize the present way of working, would not be an overstatement.

@www.erkrishna.com.mp

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