**GSM BASED PARKING RESERVATION SYSTEM USING MICROCONTROLLER**

**ABSTRACT**

The project mainly aims in designing an advanced vehicle parking slot booking system for parking any vehicle in the parking area. Security is the bigger concern for an individual or a firm.

A **parking lot** ([British English](http://en.wikipedia.org/wiki/British_English): **car park**), also known as a **car lot**, is a cleared area that is intended for [parking](http://en.wikipedia.org/wiki/Parking) vehicles. Usually, the term refers to a dedicated area that has been provided with a durable or semi-durable surface. In most countries where [cars](http://en.wikipedia.org/wiki/Automobile) are the dominant mode of [transportation](http://en.wikipedia.org/wiki/Transportation), parking lots are a feature of every city and suburban area. [Shopping malls](http://en.wikipedia.org/wiki/Shopping_mall), sports [stadiums](http://en.wikipedia.org/wiki/Stadium), [megachurches](http://en.wikipedia.org/wiki/Megachurch" \o "Megachurch) and similar venues often feature parking lots of immense area. Modern parking lots utilize a variety of technologies to help motorists find unoccupied parking spaces, retrieve their vehicles, and improve their experience. This includes adaptive lighting, [sensors](http://en.wikipedia.org/wiki/Sensor), [indoor positioning system](http://en.wikipedia.org/wiki/Indoor_positioning_system) (IPS) and [mobile payment](http://en.wikipedia.org/wiki/Mobile_payment) options. The Santa Monica Place shopping mall in California has cameras on each stall that can help count the lot occupancy and find lost cars.

Recognizing the need of security of the vehicles we developed an advanced vehicle parking slot booking system with user friendly access. Automation is the most frequently spelled term in the field of electronics. The hunger for automation brought many revolutions in the existing technologies. One among the technologies which had greater developments is RF communications. The result of this is the RFID cards which transmit a unique identification number. This number transmitted by the RFID can be read with the help of a RF reader. We make use of both these devices to construct an advanced slot booking system for vehicle parking system. The concerned person of the vehicle should initially book as lot using GSM mobile, when the allotted slot is confirmed then the vehicle can be allotted a particular parking area, depending on the RFID cards. The decisions like slot area is filled or vacant are taken by an onboard computer to which the RF reader is interfaced. The parking gate forms the output module and is interfaced to the same onboard computer. This onboard computer consists of number of input and output ports. The onboard computer is commonly termed as micro controller. The input and output ports of thecontroller are interfaced with different input and output modules depending on the requirements. In other words micro controller acts as a communication medium for all the modules involved in the project .The device also consists of LCD which displays the information about the status of gate open and close.

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# CHAPTER 1

# INTRODUCTION

For today’s transportation professionals, traffic management, safety and security initiatives are an increasing priority.State and local agencies are searching for solutions to improve mobility, efficiency and safety of their operations and for the driving public.Current Transport facility is suffering with many issues.

Accident risk management

Environment alert

Traffic rule violation control

Vehicle theft identification

Traffic signal management

In the existing parking system searching for parking space is always been a difficult process. In metropolitan cities it became a major issue due to space problem, no parking zones etc, hence comes the need of such a system which can automatically assists us to search the nearest available parking space in the surrounding area. Thus it will help us in saving time, petrol & money. Most of them are manually managed and a little inefficient. All the work is done by staff of the parking slot. Drivers give the money to the staff directly. Many people are not satisfied with the current management of the parking system and the flexibility of finding empty space to park their vehicles. Parking demand is routinely high at theaters, shopping malls and offices. The problem that always occurs at the vehicle parking is time being wasted in searching for the available parking spaces. Users will keep on circling the parking area until they found an empty parking spot. That is, people often “circle around” looking for a good parking space then a traffic jam may occur .Parking is an ever-growing challenge in cities and towns across the world. So the demand for Reservation based parking System is expected to grow rapidly in the near future to eliminate or reduce this problem with parking facility by just reserving their parking slot using the SMS without having to go online. The main objective is to design a parking system with ATmega328 microcontroller which can run on an embedded system. By using GSM and RFID technology the parking problem in big cities, especially the megacities, has become one of the key causes of the city traffic congestion. The Reservation based Parking System is considered to be an effective way to improve parking situation.

## LITERATURE REVIEW

RFID technology has several applications in extend beyond the retail sector. RFID tags are embedded in passports for security and personal identification in ID cards to control access to buildings. Tags are used for electronic payment for transportation system and other payment systems, for example credit cards and smart cards. It has several medical uses including tracking of new born babies in hospital, storing information of surgical patients, procedures, and tracking medical equipment. RFID systems used in toll collection, transport payments and logistics management systems by using conventional RFID system. When the capability of RF communication is accurately analyzed, it can be seen that there are more possibilities beyond that. After considering the characteristics and behaviors of RF communication, it is possible to design some new applications that improve the safety, security, comfort-ability, and productivity in eco-friendly manner [8].

Automated Vehicle Identification process determines the identity of vehicle. At the toll gate there is limited number of gates facilities. So creates many problems. In this AVI system, barcodes are fixed in each vehicle which is read by objective tag on toll booth. This system is closely related to Vehicle Classification System. The Vehicle Classification System used for different types of vehicles had different charge rate at passing through toll facilities but it is limited users, more variety of sensors used to provide the presence of vehicle. Violation Enforcement System used for reducing unpaid toll or used to determine toll violaters. In this system, number plate recognisation is done in form of image.

This car parking security system is developed with the help of microcontroller and RFID technology. Existing applications are using conventional RFID tags and store only a unique number and the data related to the tag is taken from the proprietary databases. Though the RF tag can play a big role to achieve safety, security, productivity and comfort ability in our project, current usage of them is not up to the maximum possibility due to many reasons. If user used RFID technology with one more important design that is car parking security system. The RF tag can play a vital role to achieve safety, security, productivity and comfortability. The importance of RFID system is that, it gets verification from the Road Transportation Office (RTO).The user will require an authentication to get proceed to the thumb registration module by which the efficiency of thumb is enhanced using Pattern Matching Algorithm (PMA). Face recognition system is a technique in which will be used after the thumb registration system. At the last, this system allows the user to drive the car and for emergency, a key insertion slot will be placed in this system through which user can insert the key. In emergency mode of operation the camera captures the driver’s image and sends it to the owner’s mobile as Multimedia Messaging Service (MMS) and the owner will provide the authentication password. Global System for Mobile communication (GSM) module is kept inbuilt for tracking purpose [8]. The system used contactless smart card to limit the entries of unwanted persons. Contactless smart card has information stored in which when come in the field of RFID reader it reads the information stored in the card. Reader recognize information and match with the information stored in it .If this reader has the information about card it will allow the card user to enter in area. If reader does not find information in tag in its memory it will not allow.

# CHAPTER 2

# HARWARE COMPONENTS

## 2.1. Hardware implementation

The proposed system is designed with ATmega328 controller.. The major components used in this system hardware are ATmega328 microcontroller, GSM module & RFID module. ATmega328 microcontroller is interfaced with the GSM & RFID modules. Using GSM technology we can check for the parking slot using corresponding commands through SMS (Short Message Service). IR sensor which is placed at the slots sections checks for the availability of the slots, if there any availability a conformation message is received to the user mobile. Conformation message includes Parking slot number, Parking duration, charges for the parking depending upon the time duration & a security code. RFID technology consists of tracking tags attached to objects used for the security constrains and at the parking section and also to debit the amount for parking charges.

## 2.2. Functional Description

First, the user sends a message to the GSM modem which is placed at the parking end. The GSM modem will send a confirmation message to the user if whether the slot is vacant or not. If it is vacant then the user has to message the exact time and duration he/she wants to park the vehicle in parking spot such as whether the user wants to park their vehicle for 30 min, 60 min, 90 min, 120 min. Then the GSM modem will send the password and the parking lot number to access the reserved parking lot. Once the confirmation message has been sent, the counter for the reservation time will automatically start for sending message. vehicle. Just after the vehicle has parked in selected area, the green LED will be deactivated to indicate that the slot has been occupied. The user will need to use password provided upon confirmation of reservation to enter and exit through the barrier gate. The vehicle owner has to first register the vehicle with the parking owner and get the RFID tag. The tags contain electronically stored information like vehicle registration number, Name of the vehicle user & credit amount for example like petro card etc.., When the vehicle has to be parked, the RFID tag is placed near the RFID reader, which is installed near the entry and exit gate of the parking lot to authenticate only registered users.

## 2.3. Block diagram of the system

## 2.4. Hardware components used

### 2.4.1. GSM Technology

Global System for Mobile communication is a digital mobile communication network which has developed rapidly in recent years. It is a globally accepted standard for digital cellular communication and a common European mobile telephone standard for a mobile cellular radio system operating at 900 MHz. In the current work, SIM900 GSM module is used. The SIM900 module is a Triband GSM/GPRS solution in a compact plug in module featuring an industry-standard interface. It is used widely in mobile device standards. Because GSM network has almost covered the whole country, there is no need to set up another network when using wireless technology. Consequently, it can reduce the cost of construction and service which heightens economic benefit. Compared to other wireless network technologies, subscribers access GSM network freely, without any limitation. As the most basic business of GSM network, Short Message Services (SMS) has become more attractive than ever before. With SMS we can realize the function of data bidirectional transmission, and its performance is stable. Therefore, SMS provides powerful platform for remote data transmission.

GSM Module named SIMCOM\_900 with RS232, power supply; buzzer and audio interface are used. This can be connected to PC by using a USB to Serial Adaptor. Terminal programs such as Real term are used to send & receive data. The interface between GSM Module and microcontroller can also be done directly with the help of wires

GSM Module works with AT COMMANDS where AT stands for Application Terminal. Some useful AT Commands are:

1. AT

2. AT+CMGS

3.AT+CMGR

4.AT+CMGD

5.AT+CSQ

For connection between ATmega microcontroller and GSM, Receiver Pin (Rx) of Microcontroller is connected to the Transmitter Pin (Tx) of GSM Module and Transmitter Pin (Tx) of Microcontroller is connected to the Receiver Pin (Rx) of GSM Module.

### 2.4.2. RFID Technology

Radio-frequency identification (RFID) is an automatic identification method wherein the data stored on RFID tags or transponders is remotely retrieved. The RFID tag is a device that can be attached to or incorporated into a product, animal or person for identification and tracking using radio waves. Some tags can be read from several meters away, beyond the line of sight of the reader. It is the use of a wireless non-contact system that uses radio frequency electromagnetic fields to transfer data from a tag attached to an object. Some tags require no battery and are powered by the electromagnetic fields used to read them. Others use a local power source and emit radio waves (electromagnetic radiation at radio frequencies). The tag contains electronically stored information which can be read from up to several meters (yards) away. Unlike a bar code, the tag does not need to be within line of sight of the reader and may be embedded in the tracked object. While RFID’s original uses were primarily for inventory tracking in retail environment, this technology has quickly created a presence in an extremely diverse number of fields including easy gas payment, credit card replacements. RFID system has three major Components:

1. An RFID tag – transponder.

2. An RFID reader – transceiver.

3. A predefined protocol for the information transferred.

### 2.4.3. IR Sensor

IR Sensors work by using a specific light sensor to detect a select light wavelength in the InfraRed (IR) spectrum. By using an LED which produces light at the same wavelength as what the sensor is looking for, you can look at the intensity of the received light. Usually in the infrared spectrum, all the objects radiate some form of thermal radiations. These types of radiations are  invisible to our eyes, that can be detected by an infrared sensor.The emitter is simply an IR LED ([Light Emitting Diode](http://www.elprocus.com/explain-different-types-leds-working-applications-engineering-students/)) and the detector is simply an IR photodiode which is sensitive to IR light of the same wavelength as that emitted by the IR LED. When IR light falls on the photodiode, The resistances and these output voltages, change in proportion to the magnitude of the IR light received.

#### IR Sensor Circuit Diagram and Working Principle

An infrared  sensor circuit is one of the basic and popular sensor module in an [electronic device](http://www.elprocus.com/basic-components-used-electronics-electrical/). This sensor is analogous to human’s visionary senses, which can be used to detect obstacles and it is one of the common applications in real time.When an object is close to the sensor, the light from the LED bounces off the object and into the light sensor. This results in a large jump in the intensity, which we already know can be detected using a threshold.

#### Different Types of IR Sensors and Their Applications

IR sensors are classified into different types depending on the applications. Some of the typical applications of different [types of sensors](https://www.elprocus.com/types-of-sensors-with-circuits/) are

The speed sensor is used for synchronizing the speed of multiple motors. The [temperature sensor](http://www.elprocus.com/temperature-sensors-applications/) is used for industrial temperature control. [PIR sensor](http://www.elprocus.com/pir-sensor-basics-applications/) is used for automatic door opening system and  [Ultrasonic sensor](http://www.elprocus.com/motion-detector-circuit-with-working-description-and-its-applications/" \t "_blank) are used for distance measurement.

#### IR Sensor Applications

IR sensors are used in various [Sensor based projects](http://www.elprocus.com/infrared-ir-sensor-circuit-and-working/www.elprocus.com/sensor-based-electronics-projects/) and also in various electronic devices which measures the temperature that are discussed in the below.

#### Radiation Thermometers

IR sensors are used in radiation thermometers to measure the temperature depend upon the temperature and the material of the object and these thermometers have some of the following features

* Measurement without direct contact with the object
* Faster response
* Easy pattern measurements

#### Flame Monitors

These types of devices are used for detecting the light emitted from the flames and to monitor how the flames are burning. The Light emitted from flames extend from UV to IR region types. PbS, PbSe, Two-color detector, pyro electric detector are some of the commonly employed detector used in flame monitors.

#### Moisture Analyzers

Moisture analyzers use wavelengths which are absorbed by the moisture in the IR region. Objects are irradiated with light having these wavelengths(1.1 µm, 1.4 µm, 1.9 µm, and 2.7µm) and also with reference wavelengths. The Lights reflected from the objects depend upon the moisture content and is detected by analyzer to measure moisture (ratio of reflected light at these wavelengths to the reflected light at reference wavelength). In GaAs PIN photodiodes, Pbs photoconductive detectors are employed in moisture analyzer circuits.

#### Gas Analyzers

IR sensors are used in gas analyzers which use absorption characteristics of gases in the IR region. Two types of methods are used to measure the density of gas such as dispersive and non dispersive.

#### ****Dispersive****

 An Emitted light is spectroscopically divided and their absorption characteristics are used to analyze the gas ingredients and the sample quantity.

#### ****Non dispersive****

 It is most commonly used method and it uses absorption characteristics without dividing the emitted light. Non dispersive types use discrete optical band pass filters, similar to sunglasses that are used for eye protection to filter out unwanted UV radiation.

#### IR Imaging Devices

IR image device is one of the major applications of IR waves, primarily by virtue of its property that is not visible. It is used for thermal imagers, night vision devices, etc.

For examples Water, rocks, soil, vegetation, an atmosphere, and human tissue all features emit IR radiation. The Thermal infrared detectors measure these radiations in IR range and map the spatial temperature distributions of the object/area on an image. Thermal imagers usually composed of a Sb (indium antimonite), Gd Hg (mercury-doped germanium), Hg Cd Te (mercury-cadmium-telluride) sensors.

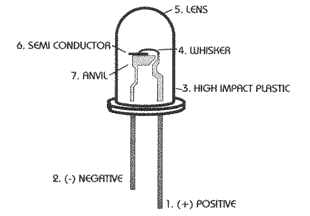
An electronic detector is cooled to low temperatures using liquid helium or liquid nitrogen’s.  Then the Cooling the detectors ensures that the radiant energy (photons) recorded by the detectors comes from the terrain and not from the ambient temperature of objects within the scanner itself an IR imaging electronic devices.

Thus, this is all about IR sensor circuit with working and applications. These sensors are used in many sensor based [electronics projects](https://www.elprocus.com/latest-electronics-projects-ideas/).

### 2.4.4. LED (LIGHT EMITTING DIODE)

A light-emitting diode (LED) is a semiconductor light source. LEDs are used as indicator lamps in many devices, and are increasingly used for lighting. Introduced as a practical electronic component in 1962,early LEDs emitted low-intensity red light, butmodern versions are available across the visible, ultraviolet and infrared wavelengths, with very high brightness.When a light-emitting diode is forward biased (switched on), electrons are able to recombine with holes within the device, releasing energy in the form of photons. This effect is called electroluminescence and the color of the light (corresponding to the energy of the photon) is determined by the energy gap of the semiconductor. An LED is usually small in area (less than 1 mm2), and integrated optical components are used to shape its radiation pattern and assist in reflection.LEDs present many advantages over incandescent light sources including lower energy consumption, longer lifetime, improved robustness, smaller size, faster switching, and greater durability and reliability. LEDs powerful enough for room lighting are relatively expensive and require more precise current and heat management than compact fluorescent lamp sources of comparable output.

Light-emitting diodes are used in applications as diverse as replacements for aviation lighting,automotive lighting (particularly indicators) and in traffic signals. The compact size of LEDs has allowed new text and video displays and sensors to be developed, while their high switching rates are useful in advanced communications technology. Infrared LEDs are also used in the remote control units of many commercial products including televisions, DVD players, and other electronic devices.



**FIGURE 2.8:LED**

### 2.4.5. GSM MODULE

This is a GSM/GPRS-compatible Quad-band cell phone, which works on a frequency of 850/900/1800/1900MHz and which can be used not only to access the Internet, but also for oral communication (provided that it is connected to a microphone and a small loud speaker) and for SMSs. Externally, it looks like a big package (0.94 inches x 0.94 inches x 0.12 inches) with L-shaped contacts on four sides so that they can be soldered both on the side and at the bottom. Internally, the module is managed by an AMR926EJ-S processor, which controls phone communication, data communication (through an integrated TCP/IP stack), and (through an UART and a TTL serial interface) the communication with the circuit interfaced with the cell phone itself.The processor is also in charge of a SIM card (3 or 1,8 V) which needs to be attached to the outer wall of the module.In addition, the GSM900 device integrates an analog interface, an A/D converter, an RTC, an SPI bus, an I²C, and a PWM module. The radio section is GSM phase 2/2+ compatible and is either class 4 (2 W) at 850/ 900 MHz or class 1 (1 W) at 1800/1900 MHz.The TTL serial interface is in charge not only of communicating all the data relative to the SMS already received and those that come in during TCP/IP sessions in GPRS (the data-rate is determined by GPRS class 10: max. 85,6 kbps), but also of receiving the circuit commands (in our case, coming from the PIC governing the remote control) that can be either AT standard or AT-enhanced SIMCom type.The module is supplied with continuous energy (between 3.4 and 4.5 V) and absorbs a maximum of 0.8 A during transmission.

**Features**

* E-GSM 900/1800 MHz and GSM 1800/1900 with GSM Phase 2 / 2+.
* Output Power Class 4 (2W) at GSM 850/900 MHz and Class 1 (1W) at GSM 1800/1900 MHz.
* Control via AT commands (ITU, GSM,GPRS and manufacturer supplementary)
* Supply Voltage range: 3.22 V - 4.2 V,nominal: 3.8 V.
* Power consumption: Idle mode: <1.8 mA, speech mode: 200 mA (average)
* Dimensions (mm): 3 x 20 x 20 and weight (g): 3.2 (including shielding)

The GSM module offers the advantages as below

* Ultra small size (22x22x3 mm),lightweight (3.2 g) and easy to integrate
* Low power consumption
* R&TTE type approval plus CE, GCF,FCC, PTCRB, IC
* Full RS232 on CMOS level with flow control (RX, TX, CTS, RTS, CTS, DTR,DSR, DCD, RI).
* Embedded TCP/IP Stack UDP/IP Stack ,Embedded FTP and SMTP Client
* High performance on low price.



**FIGURE 2.10. GSM MODULE**

### 2.4.6. Microcontroller (ATmega328)

ATMega328 is the ATMEL Microcontroller on which Arduino UNO is based.This will let us realize our small project without using a full size Arduino board. To make this microcontroller working with the Arduino IDE you need a 16 Mhz crystal, a 5 V power supply and a serial connection.

### 2.4.7. 10K Resistor

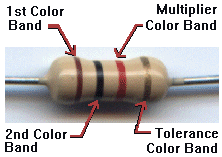
A **resistor** is a [passive](http://en.wikipedia.org/wiki/Passivity_(engineering)) [two-terminal](http://en.wikipedia.org/wiki/Terminal_(electronics)) [electrical component](http://en.wikipedia.org/wiki/Electronic_component) that implements [electrical resistance](http://en.wikipedia.org/wiki/Electrical_resistance) as a circuit element. Resistors act to reduce current flow, and, at the same time, act to lower voltage levels within circuits. In electronic circuits resistors are used to limit current flow, to adjust signal levels, [bias](http://en.wikipedia.org/wiki/Biasing) active elements, terminate [transmission lines](http://en.wikipedia.org/wiki/Transmission_line) among other uses. High-power resistors that can dissipate many [watts](http://en.wikipedia.org/wiki/Watt) of electrical power as heat may be used as part of motor controls, in power distribution systems, or as test loads for [generators](http://en.wikipedia.org/wiki/Electric_generator). Fixed resistors have resistances that only change slightly with temperature, time or operating voltage. Variable resistors can be used to adjust circuit elements (such as a volume control or a lamp dimmer), or as sensing devices for heat, light, humidity, force, or chemical activity.

Resistors are common elements of [electrical networks](http://en.wikipedia.org/wiki/Electrical_network) and [electronic circuits](http://en.wikipedia.org/wiki/Electronic_circuit) and are ubiquitous in [electronic equipment](http://en.wikipedia.org/wiki/Electronics). Practical resistors as discrete components can be composed of various compounds and forms. Resistors are also implemented within[integrated circuits](http://en.wikipedia.org/wiki/Integrated_circuits).

The electrical function of a resistor is specified by its resistance: common commercial resistors are manufactured over a range of more than nine [orders of magnitude](http://en.wikipedia.org/wiki/Orders_of_magnitude). The nominal value of the resistance will fall within a [manufacturing tolerance](http://en.wikipedia.org/wiki/Engineering_tolerance#Electrical_component_tolerance).

Resistors are measured in ohms. Color "bands" are used to specify each band. There are three bands and sometimes four. The fourth band is the tolerance (Gold or Silver) if there is no band the tolerance is 20%.The first three bands are colored:  
Black = 0   Brown = 1  Red = 2  Orange = 3  Yellow = 4  
Green = 5   Blue = 6   Violet = 7   Gray = 8   White = 9  
*The fourth band (if any) is colored:*Gold = 5%,   Silver = 10%,  (NONE = 20%)  
   
To use this calculator simply select the color for each band from the drop down menus. Click "display value" for the result. To re-calculate, simply re-select any one of the drop down color bands,andcontinue  
  
The color bands one and two are NUMBERS BLACK = 0, BROWN = 1 etc. (see colors above). EXAMPLE: BROWN, BLACK would be 10, while BLACK, BROWN is 1 (drop the 0). The third band is a (X) multiplier of the first 2 bands; Black = 1, Brown = 10,  Red = 100, Orange = 10K, Yellow = 100K, Green = 1M, Blue = 10M.

EXAMPLE: Brown, Black, Blue = 10M Ohms. NOTE: The Black band is not used above 9 Ohms, Brown is the first band for all resistors with a value for 10 - 100 - 1000, 10,000  etc. EXAMPLE: Brown, Black, Red = 1000 Ohms not Black, Brown, Orange as this calculator will display as 1000 Ohms.  
  
 The fourth band is a TOLERANCE band. There are only two possible bands here: Silver (10%) and Gold (5%) if there is no band the resistor is 20% tolerance. EXAMPLE: A 1000 Ohm resistor with a 20% tolerance could be an 900 Ohm or 1100 Ohm value and still be within TOLERANCE. NOTE: Silver is most common in modern supply as we know it. NOTE: Some Japanese resistors have shown a band of Black (20%) or a band of White (2%). However these are rare and this calculator does not share the values.



**FIGURE 10K RESISTOR**

# CHAPTER 3

# MICROCONTROLLER AND GSM MODULE

**MICROCONTROLLER (ATmega328)**

A microcontroller (sometimes abbreviated µC, uC or MCU) is a small [computer](http://en.wikipedia.org/wiki/Computer) on a single integrated circuit containing a processor core ,memory ,and programmable [input/output](http://en.wikipedia.org/wiki/Input/output) peripherals. Program memory in the form of [Ferroelectric RAM](http://en.wikipedia.org/wiki/Ferroelectric_RAM), [NOR flash](http://en.wikipedia.org/wiki/NOR_flash) or [OTP ROM](http://en.wikipedia.org/wiki/Programmable_read-only_memory) is also often included on chip, as well as a typically small amount of [RAM](http://en.wikipedia.org/wiki/Random-access_memory). Microcontrollers are designed for embedded applications, in contrast to the [microprocessors](http://en.wikipedia.org/wiki/Microprocessor) used in [personal computers](http://en.wikipedia.org/wiki/Personal_computer) or other general purpose applications. Microcontrollers are used in automatically controlled products and devices, such as automobile engine control systems, implantable medical devices, remote controls, office machines, appliances, power tools, toys and other [embedded systems](http://en.wikipedia.org/wiki/Embedded_system). By reducing the size and cost compared to a design that uses a separate microprocessor, memory, and input/output devices, microcontrollers make it economical to digitally control even more devices and processes. [Mixed signal](http://en.wikipedia.org/wiki/Mixed-signal_integrated_circuit) microcontrollers are common, integrating analog components needed to control non-digital electronic systems.

Some microcontrollers may use four-bit [words](http://en.wikipedia.org/wiki/Word_(computer_architecture)) and operate at [clock rate](http://en.wikipedia.org/wiki/Clock_rate) frequencies as low as 4 kHz, for low power consumption (single-digit milliwatts or microwatts). They will generally have the ability to retain functionality while waiting for an event such as a button press or other interrupt; power consumption while sleeping (CPU clock and most peripherals off) may be just nanowatts, making many of them well suited for long lasting battery applications. Other microcontrollers may serve performance-critical roles, where they may need to act more like a [digital signal processor](http://en.wikipedia.org/wiki/Digital_signal_processor) (DSP), with higher clock speeds and power consumption.

## 4.1. Key parameters for ATmega328

**Parameter Value**

**Flash (Kbytes):**32 Kbytes

**Pin Count**:32

**Max. Operating Freq. (MHz):**20 MHz

**CPU**:8-bit AVR

**# of Touch Channels**:16

**Hardware QTouch Acquisition**:No

**Max I/O Pins**:23

**Ext Interrupts**:24

**USB Speed**:No

**USB Interface**:No

**SPI**:2

**TWI (I2C):**1

**UART**:1

**Graphic LCD**:No

**Video Decoder**:No

**Camera Interface**:No

**ADC channels**:8

**ADC Resolution (bits):**10

**ADC Speed (ksps):**15

**Analog Comparators**:1

**Resistive Touch Screen**:No

**DAC Resolution (bits):**0

**Temp. Sensor**:Yes

**Crypto Engine**:No

**SRAM (Kbytes):**2

**EEPROM (Bytes):**1024

**Self Program Memory**:YES

**External Bus Interface**:0

**DRAM Memory:**No

**NAND Interface**:No

**picoPower**:No

**Temp. Range (deg C):-**40 to 85

**I/O Supply Class**:1.8 to 5.5

**Operating Voltage (Vcc):**1.8 to 5.5

**FPU**:No

**MPU / MMU**:no / no

**Timers**:3

**Output Compare channels:**6

**Input Capture Channels**:1

**PWM Channels**:6

**32kHz RTC**:Yes

**Calibrated RC Oscillator**:Yes

**Watchdog**:Yes

**CAN**:0

**LIN**:0

**Etherne**t:0

**Debug Interface**:debugWIRE

**I2S**:No

**RTC**:Counter

## 4.2. Introduction to ATmega32 (AVR Series) 8bit Microcontroller

In our days, there have been many advancement in the field of Electronics and many cutting edge technologies are being  developed every day, but still 8 bit microcontrollers have its own role in the digital electronics market dominated by 16-32 & 64 bit digital devices. Although powerful microcontrollers with higher processing capabilities exist in the market, 8bit microcontrollers still hold its value because of their easy-to-understand-operation, very much high popularity, ability to simplify a digital circuit, low cost compared to features offered, addition of many new features in a single IC and interest of manufacturers and consumers.Today’s microcontrollers are much different from what it were in the initial stage, and the number of manufacturers are much more in count than it was a decade or two ago. At present some of the major manufacturers are Microchip (publication: PIC microcontrollers), Atmel (publication: AVR microcontrollers), Hitachi, Phillips, Maxim, NXP, Intel etc.  Our interest is upon **ATmega32**. It belongs to **Atmel’s AVR series micro controller family**. Let’s see the features.

#### ****PIN count:****

 Atmega32 has got 40 pins. Two for Power (pin no.10: +5v, pin no. 11: ground), two for oscillator (pin 12, 13), one for reset (pin 9), three for providing necessary power and reference voltage to its internal ADC, and 32 (4×8) I/O pins.

#### ****About I/O pins:****

ATmega32 is capable of handling analogue inputs. Port A can be used as either DIGITAL I/O Lines or each individual pin can be used as a single input channel to the internal ADC of ATmega32, plus a pair of pins AREF, AVCC & GND (refer to [**ATmega32 datasheet**](http://www.atmel.com/Images/doc2503.pdf)) together can make an ADC channel.No pins can perform and serve for two purposes (for an example: Port A pins cannot work as a Digital I/O pin while the Internal ADC is activated) at the same time. It’s the programmers responsibility to resolve the conflict in the circuitry and the program. Programmers are advised to have a look to the priority tables and the internal configuration from the datasheet.

#### ****Digital I/O pins:****

ATmega32 has 32 pins (4portsx8pins) configurable as Digital I/O pins.

#### ****Timers:****

3 Inbuilt timer/counters, two 8 bit (timer0, timer2) and one 16 bit (timer1).

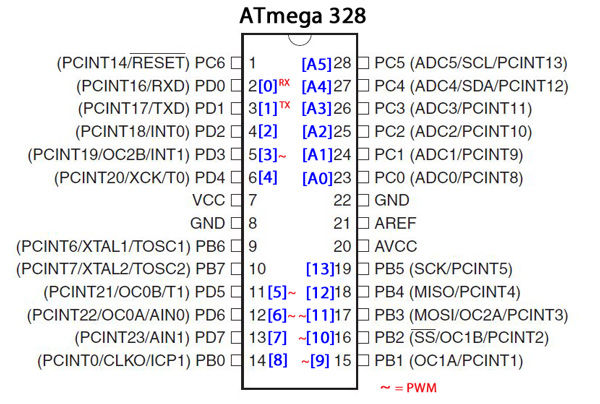
#### **ADC:**

It has one successive approximation type ADC in which total 8 single channels are selectable. They can also be used as 7 (for TQFP packages) or 2 (for DIP packages) differential channels. Reference is selectable, either an external reference can be used or the internal 2.56V reference can be brought into action.  There external reference can be connected to the AREF pin.

#### ****Communication Options:****

ATmega32 has three data transfer modules embedded in it. They are

* Two  Wire Interface
* USART
* Serial Peripheral Interface



**Atmega32 pin diagram**

#### ****Analog comparator:****

On-chip analog comparator is available. An interrupt is assigned for different comparison result obtained from the inputs.

#### ****External Interrupt:****

3External interrupt is accepted. Interrupt sense is configurable.

#### ****Memory:****

It has 32Kbytes of In-System Self-programmable Flash program memory, 1024 Bytes EEPROM, 2Kbytes Internal SRAM. Write/Erase Cycles: 10,000 Flash / 100,000 EEPROM.

#### ****Clock:****

It can run at a frequency from 1 to 16 MHz. Frequency can be obtained from external Quartz Crystal, Ceramic crystal or an R-C network. Internal calibrated RC oscillator can also be used.

#### ****More Features****:

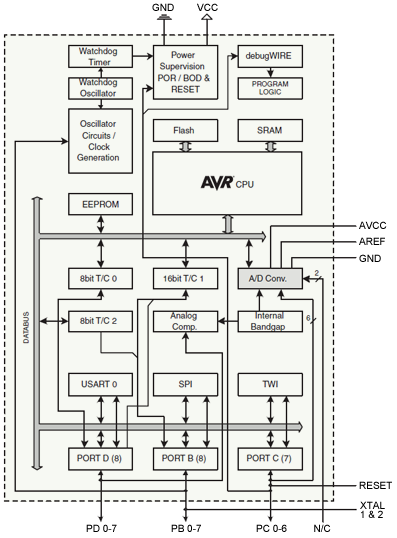
Up to 16 MIPS throughput at 16MHz. Most of the instruction executes in a single cycle. Two cycle on-chip multiplication. 32 × 8 General Purpose Working Registers

#### ****Debug:****

JTAG boundary scan facilitates on chip debug.

#### ****Programming:****

Atmega32 can be programmed either by In-System Programming via Serial peripheral interface or by Parallel programming. Programming via JTAG interface is also possible. Programmer must ensure that SPI programming and JTAG are not be disabled using  fuse bits; if the programming is supposed to be done using SPI or JTAG.

 **BLOCK DIAGRAM OF Atmega328**

### 4.2.1. Arduino Digital and Analog I/O Pins

**Digital pins**

Pins 0 – 7: PORT D [0:7]

Pins 8 – 13: PORT B [0:5] }

Pins 14 – 19: PORT C [0:5] (Arduino analog pins 0 – 5) }

digital pins 0 and 1 are RX and TX for serial communication }

digital pin 13 connected to the base board LED }

**Digital Pin I/O Functions**

* **pinMode(pin, mode)**

Sets pin to INPUT or OUTPUT mode

Writes 1 bit in the DDRx register

* **digitalWrite(pin, value)**

Sets pin value to LOW or HIGH (0 or 1)

Writes 1 bit in the PORTx register

* **int value = digitalRead(pin)**

Reads back pin value (0 or 1)

Read 1 bit in the PINx register

### 4.2.2. Arduino Analog I/O

**Analog input pins**: 0 – 5

**Analog output pins**: 3, 5, 6, 9, 10, 11 (digital pins)

* **Analog input functions**

int val = analogRead(pin)

Converts 0 – 5v. voltage to a 10-bit number (0 – 1023)

Don’t use pinMode

analogReference(type)

Used to change how voltage is converted (advanced) }

* **Analog output**

analogWrite(pin, value)

value is 0 – 255

Generates a PWM output on digital pin (3, 5, 6, 9, 10, 11)

@490Hz frequency

## 4.3. PWM – Pulse Width Modulation

* Use one wire to represent a multi-bit value.
* A clock with a variable duty cycle.
* Duty cycle used to represent value.
* We can turn it into a analog voltage using an integrating filter.

## 4.4. Applications

Today the ATmega328 is commonly used in many projects and autonomous systems where a simple, low-powered, low-cost micro-controller is needed. Perhaps the most common implementation of this chip is on the popular [Arduino](http://en.wikipedia.org/wiki/Arduino" \o "Arduino) development platform, namely the [Arduino Uno](http://en.wikipedia.org/wiki/Arduino_Uno" \o "Arduino Uno) and [Arduino Nano](http://en.wikipedia.org/w/index.php?title=Arduino_Nano&action=edit&redlink=1" \o "Arduino Nano (page does not exist)) models.

**Advantages OF ATMEGA328**

1. Still runs on 5 V, so legacy 5 V stuff interfaces cleaner
2. Even though it's 5 V capable, newer parts can run to 1.8 V. This wide range is very rare.
3. Nice instruction set, very good instruction throughput compared to other processors (HCS08, PIC12/16/18).
4. High quality GCC port (no proprietary crappy compilers!)
5. "PA" variants have good sleep mode capabilities, in micro-amperes.
6. Well rounded peripheral set
7. QTouch capability.

## 4.5. GSM module

A **GSM module** is a specialized type of modem which accepts a SIM card, and operates over a subscription to a mobile operator, just like a mobile phone. From the mobile operator perspective, a GSM modem looks just like a mobile phone.

When a GSM modem is connected to a computer, this allows the computer to use the GSM modem to communicate over the mobile network.  While these GSM modems are most frequently used to provide mobile internet connectivity, many of them can also be used for sending and receiving SMS and MMS messages.

A GSM modem can be a dedicated modem device with a serial, USB or Bluetooth connection, or it can be a mobile phone that provides GSM modem capabilities.

For the purpose of this document, the term GSM modem is used as a generic term to refer to any modem that supports one or more of the protocols in the GSM evolutionary family, including the 2.5G technologies GPRS and EDGE, as well as the 3G technologies WCDMA, UMTS, HSDPA and HSUPA.

A GSM modem exposes an interface that allows applications such as NowSMS to send and receive messages over the modem interface. The mobile operator charges for this message sending and receiving as if it was performed directly on a mobile phone. To perform these tasks, a GSM modem must support an “extended AT command set” for sending/receiving SMS messages, as defined in the [ETSI GSM 07.05](http://www.etsi.org/) and and [3GPP TS 27.005](http://www.3gpp.org/ftp/specs/html-info/27005.htm) specifications.

GSM modems can be a quick and efficient way to get started with SMS, because a special subscription to an SMS service provider is not required. In most parts of the world, GSM modems are a cost effective solution for receiving SMS messages, because the sender is paying for the message delivery.

A GSM modem can be a dedicated modem device with a serial, USB or Bluetooth connection, such as the Falcom Samba 75. (Other manufacturers of dedicated GSM modem devices include Wavecom, Multitech and iTegno.  We’ve also reviewed a number of modems on our [technical support blog](http://www.nowsms.com/tag/gsm-modem).) To begin, insert a GSM SIM card into the modem and connect it to an available USB port on your computer.

A GSM modem could also be a standard GSM mobile phone with the appropriate cable and software driver to connect to a serial port or USB port on your computer. Any phone that supports the “extended AT command set” for sending/receiving SMS messages, as defined in [ETSI GSM 07.05](http://www.etsi.org/) and/or [3GPP TS 27.005](http://www.3gpp.org/ftp/specs/html-info/27005.htm), can be supported by the Now SMS & MMS Gateway. Note that not all mobile phones support this modem interface.

Due to some compatibility issues that can exist with mobile phones, using a dedicated GSM modem is usually preferable to a GSM mobile phone. This is more of an issue with MMS messaging, where if you wish to be able to receive inbound MMS messages with the gateway, the modem interface on most GSM phones will only allow you to send MMS messages. This is because the mobile phone automatically processes received MMS message notifications without forwarding them via the modem interface.

It should also be noted that not all phones support the modem interface for sending and receiving SMS messages. In particular, most smart phones, including Blackberries, iPhone, and Windows Mobile devices, do not support this GSM modem interface for sending and receiving SMS messages at all at all. Additionally, Nokia phones that use the S60 (Series 60) interface, which is Symbian based, only support sending SMS messages via the modem interface, and do not support receiving SMS via the modem interface.

### 4.5.1. GSM Modem Principle

#### ****4.5.1.1. FACTS OF GSM MODEM:****

 The GSM/GPRS Modem comes with a serial interface through which the modem can be controlled using AT command interface. An antenna and a power adapter are provided.The basic segregation of working of the modem is as under:

**•Voice calls**

**•SMS**

**•GSM Data calls**

**• GPRS**

#### ****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 applications then this can be considered.  
  
SMS:

SMS is an area where the modem can be used to provide features like:  
• Pre-stored SMS transmission, these SMS can be transmitted on certain trigger events in an automation system.

• SMS can also be used in areas where small text information has to be sent. The transmitter can be an automation system or machines like vending machines, collection machines or applications like positioning systems where the navigator keeps on sending SMS at particular time intervals  
• SMS can be a solution where GSM data call or GPRS services are not available  
  
GSM Data Calls:

  Data calls can be made using this modem. Data calls can be made to a normal PSTN modem/phone line also (even received). Data calls are basically made to send/receive data streams between two units either PC’s or embedded devices. The advantage of Data calls over SMS is that both parties are capable of sending/receiving data through their terminals.  
Some points to be remembered in case of data calls:

• The data call service doesn’t come with a normal SIM which is purchased but has to be

requested with the service provider (say Airtel).

• Upon activation of data/fax service you are provided with two separate numbers i.e. the Data call number and the Fax service number.

• Data calls are established using Circuit Switched data connections.  
• Right now the speed at which data can be transmitted is 9.6 kbps.  
• The modem supports speeds up to 14.4 kbps but the provider give a maximum data rate of 9.6 kbps during GSM data call.

• Technologies like HSCSD (high Speed Circuit Switched Data) will improve drastically the data rates, but still in pipeline.

Full Type Approved Quad Band Embedded GSM Module (GSM  850/900 1800/1900) with AT command set and RS232 interface on CMOS level.  
This GSM wireless data module is the ready a solution for remote wireless applications, machine to machine or user to machine and remote data communications in all vertical market applications.

**The GSM module offers the advantages as below**

* Ultra small size (22x22x3 mm), lightweight (3.2 g) and easy to integrate
* Low power consumption
* R&TTE type approval plus CE, GCF, FCC, PTCRB, IC
* Full RS232 on CMOS level with flow control (RX, TX, CTS, RTS, CTS, DTR, DSR, DCD, RI)
* Embedded TCP/IP Stack UDP/IP Stack , Embedded FTP and SMTP Client
* High performance on low price

**Smallest size designed for tiny applications**

Tracking (people, animals, people), container tracking, PDA, POS terminal, PCMCIA cards, AMR

**Pin to Pin upgrade policy to save your developing investments High level technical support to help you in the integration of your solution**

* Exhaustive product documentation
* Evaluation kit and reference design
* Quick technical assistance by dedicated e-mail services and user forum
* Deep technical assistance by dedicated engineering support
* RD support and certification lab for all your needs

#### Product Features

* E-GSM 900/1800 MHz and GSM 1800/1900 with GSM Phase 2 / 2+
* Output Power Class 4 (2W) at GSM 850/900 MHz and Class 1 (1W) at GSM 1800/1900 MHz
* Control via AT commands (ITU, GSM, GPRS and manufacturer supplementary)
* Supply Voltage range: 3.22 V - 4.2 V, nominal: 3.8 V
* Power consumption: Idle mode: <1.8 mA, speech mode: 200 mA (average)
* Dimensions (mm): 3 x 20 x 20 and weight (g): 3.2 (including shielding)

#### Interfaces

* Power supply nominal 3,8 V
* 10 general purposes I/O ports  and serial bi-directional bus on CMOS 2,8 V
* External SIM
* Analogue audio for microphone, speaker and hands free set plus digital voice interface
* RS232 on CMOS 2,8 V (One RS232 (2,8V) with flow control (RX, TX, CTS, RTS, CTS, DTR, DSR, DCD, RI), baud rate 300 - 115.200 bps, autobauding  1200 -  57.600 bps
* 50 Ohm antenna connector

#### Audio

* Telephony and emergency calls (Half Rate (HR), Full Rate (FR), Enhanced Full Rate (EFR))
* Echo cancellation and noise reduction
* DTMF
* Handset operations and basic handsfree operation

#### SMS

* [SMS](http://www.gsm-modem.de/sms.html) Mobile Originated (MO), Mobile Terminated (MT) and [Cell Broadcast](http://www.gsm-modem.de/sms-cell-broadcast.html) (CB - DRX)

#### GPRS, data and Fax

* [Circuit Switched Data](http://www.gsm-modem.de/gsm-data-call.html) (CSD) up to 14.4 kbps
* [Fax](http://www.gsm-modem.de/gsm-fax.html) Group 3
* Packed Data (GPRS class B, class 10) up to 115 kbps

#### GSM Supplementary Services

* Call Barring and Call Forwarding
* Advice of Charge
* Call Waiting and Call Hold
* Calling Line Identification Presentation (CLIP)
* Calling Line Identification Restriction (CLIR)
* Unstructured SS Mobile Originated Data (USSD)
* Closed User Group

#### Other Features

* SIM Phonebook management
* Fixed Dialling Number (FDN)
* SIM Toolkit class 2
* Real time clock
* Alarm management

#### Interfaces

Interface to external SIM 3V/ 1.8V ”

analog audio interface

RTC backup

SPI interface

Serial interface

Antenna pad

I2C

GPIO

PWM

ADC

# CHAPTER 4

# RFID TECHNOLOGY FEATURES AND APPLICATIONS

## 4.1. Overview Of RFID

RFID system consists of three components namely transponder (tag), interrogator (reader) and computer containing the database, as shown in Fig. 1. The interrogator reads the tag data and transmits it to the computer for authentication. The information is processed and upon verification, access is granted. The system offers diverse frequency band ranging from low frequencies to microwave frequencies [5]:

 Low Frequency: 125-134 KHz

 High Frequency: 13.56 MHz

 Ultra High Frequency: 902-928 MHz

 Microwave Frequency: 2.4 GHz

Depending upon the source of electrical energy, RFID tags are classified as either active or passive. The active tags use a battery for powering the circuit on the tag and transmit the tag information upon the reader request. However, these tags are very expensive and seldom used. On the other hands, passive tags get energy from the reader to power their circuit. These tags are very cost-effective and hence most of the applications use them. A comparison of these tags highlighting important features is shown in Table I [6]-[8]. In the present work, passive RFID tags have been used. A passive RFID tag transmits information to the reader when it comes in the vicinity of electromagnetic field generated by the reader. The phenomenon is based on Faraday‟s law of electromagnetic induction. The current flowing through the coil of interrogator produces a magnetic field which links to the transponder coil thereby producing a current in the transponder coil. The transponder coil then varies this current by changing the load on its antenna. This variation is actually the modulated signal (scheme is known as load modulation) which is received by the interrogator coil through mutual induction between the coils. The interrogator coil decodes this signal and passes to the computer for further processing.

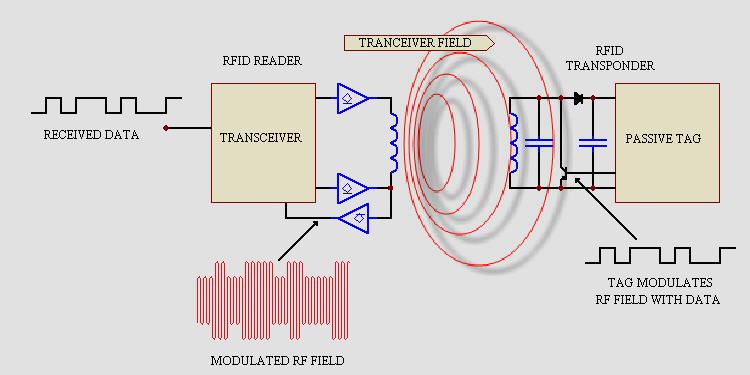


FIGURE: BASIC RFID SYSTEM

## 4.2. What is RFID?

RFID is an acronym for "radio-frequency identification" and refers to a technology whereby digital data encoded in RFID tags or smart labels (defined below) are captured by a reader via radio waves. RFID is similar to barcoding in that data from a tag or label are captured by a device that stores the data in a database. RFID, however, has several advantages oversystems that use barcode asset tracking software. The most notable is that RFID tag data can be read outside the line-of-sight, whereas barcodes must be aligned with an optical scanner. If you are considering implementing an RFID solution, take the next step and contact the RFID experts at American Barcode & RFID. RFID (radio frequency identification) is a technology that incorporates the use of electromagnetic or electrostatic coupling in the radio frequency (RF) portion of the electromagnetic spectrum to uniquely identify an object, animal, or person. RFID is coming into increasing use in industry as an alternative to the [bar code](http://searchmanufacturingerp.techtarget.com/definition/bar-code). The advantage of RFID is that it does not require direct contact or line-of-sight scanning. An RFID system consists of three components: an [antenna](http://searchmobilecomputing.techtarget.com/definition/antenna) and [transceiver](http://searchnetworking.techtarget.com/definition/transceiver) (often combined into one reader) and a [transponder](http://searchmobilecomputing.techtarget.com/definition/transponder) (the tag). The antenna uses radio frequency waves to transmit a signal that activates the transponder. When activated, the tag transmits data back to the antenna. The data is used to notify a programmable logic controller that an action should occur. The action could be as simple as raising an access gate or as complicated as interfacing with a database to carry out a monetary transaction. Low-frequency RFID systems (30 [KHz](http://searchnetworking.techtarget.com/definition/kHz) to 500 KHz) have short transmission ranges (generally less than six feet). High-frequency RFID systems (850 MHz to 950 [MHz](http://searchnetworking.techtarget.com/definition/megahertz) and 2.4 GHz to 2.5 GHz) offer longer transmission ranges (more than 90 feet). In general, the higher the frequency, the more expensive the system.

## 4.3. How Does RFID Work?

RFID belongs to a group of technologies referred to as Automatic Identification and Data Capture (AIDC). AIDC methods automatically identify objects, collect data about them, and enter those data directly into computer systems with little or no human intervention.

RFID methods utilize radio waves to accomplish this. At a simple level, RFID systems consist of three components: an RFID tag or smart label, an RFID reader, and an antenna. RFID tags contain an integrated circuit and an antenna, which are used to transmit data to the RFID reader (also called an interrogator). The reader then converts the radio waves to a more usable form of data. Information collected from the tags is then transferred through a communications interface to a host computer system, where the data can be stored in a database and analyzed at a later time.

## 4.4. What is meant by RFID tag?

A Radio Frequency Identification Tag (RFID tag) is an electronic tag that exchanges data with a RFID reader through radio waves.

Most RFID tags are made up of at least two main parts. The first is an an antenna, which receives radio frequency (RF) waves. The second is an integrated circuit (IC), which is used for processing and storing data, as well as modulating and demodulating the radio waves received/sent by the antenna.A RFID tag is also known as a RFID chip.

Although RFID tags have similar applications to barcodes, they are far more advanced. For instance, reading information from a RFID tag does not require line-of-sight and can be performed over a distance of a few meters. This also means that a single tag can serve multiple readers at a time, compared to only one for a bar code tag.

In the context of RFID technology, the term “tag” also includes labels and cards. The kind of tag depends on the body or object to which the tag is attached. RFID systems can operate in either Ultra High Frequency (UHF), High Frequency (HF) or Low Frequency (LF). Thus, tags also can vary in terms of the frequencies on which they operate.

These tags can be attached to almost any object. Although the usual target objects are apparel, baggages, containers, construction materials, laundry and bottles, they also may be attached to animals, humans and vehicles. Some RFID tags are designed for rugged, outdoor-based applications.

These are built to endure natural and incandescent light, vibration, shock, rain, dust, oil and other harsh conditions. They are normally passive in that to function, they do not require batteries and can operate 24/7 without risk of power loss. Such heavy-duty tags are usually attached to trucks, cargo containers and light rail cars for cargo tracking, fleet management, vehicle tracking, vehicle identification and supply container tracking, among others.

## 4.5. RFID Tags and Smart Labels

As stated above, an RFID tag consists of an integrated circuit and an antenna. The tag is also composed of a protective material that holds the pieces together and shields them from various environmental conditions. The protective material depends on the application. For example, employee ID badges containing RFID tags are typically made from durable plastic, and the tag is embedded between the layers of plastic. RFID tags come in a variety of shapes and sizes and are either passive or active. Passive tags are the most widely used, as they are smaller and less expensive to implement. Passive tags must be "powered up" by the RFID reader before they can transmit data. Unlike passive tags, active RFID tags have an on-board power supply (e.g., a battery), thereby enabling them to transmit data at all times. For a more detailed discussion, refer to this article: [Passive RFID Tags vs. Active RFID Tags.](http://www.abrfid.com/Content#rid=35?ck=JylIvMoCAucPgjAn&vid=JylIvMoCAvAPgrHb&cktime=131786)

Smart labels differ from RFID tags in that they incorporate both RFID and barcode technologies. They're made of an adhesive label embedded with an RFID tag inlay, and they may also feature a barcode and/or other printed information. Smart labels can be encoded and printed on-demand using desktop label printers, whereas programming RFID tags is more time consuming and requires more advanced equipment.

## 4.6. DESIGN OF RFID

### 4.6.1. Tags

A radio-frequency identification system uses *tags*, or *labels* attached to the objects to be identified. Two-way radio transmitter-receivers called *interrogators* or *readers* send a signal to the tag and read its response.

RFID tags can be either passive, active or battery-assisted passive. An active tag has an on-board battery and periodically transmits its ID signal. A battery-assisted passive (BAP) has a small battery on board and is activated when in the presence of an RFID reader. A passive tag is cheaper and smaller because it has no battery; instead, the tag uses the radio energy transmitted by the reader. However, to operate a passive tag, it must be illuminated with a power level roughly a thousand times stronger than for signal transmission. That makes a difference in interference and in exposure to radiation.

Tags may either be read-only, having a factory-assigned serial number that is used as a key into a database, or may be read/write, where object-specific data can be written into the tag by the system user. Field programmable tags may be write-once, read-multiple; "blank" tags may be written with an electronic product code by the user.

RFID tags contain at least two parts: an [integrated circuit](http://en.wikipedia.org/wiki/Integrated_circuit) for storing and processing information, [modulating](http://en.wikipedia.org/wiki/Modulation) and [demodulating](http://en.wikipedia.org/wiki/Demodulation) a [radio-frequency](http://en.wikipedia.org/wiki/Radio-frequency) (RF) signal, collecting DC power from the incident reader signal, and other specialized functions; and an [antenna](http://en.wikipedia.org/wiki/Antenna_(radio)) for receiving and transmitting the signal. The tag information is stored in a non-volatile memory. The RFID tag includes either fixed or programmable logic for processing the transmission and sensor data, respectively.

An RFID reader transmits an encoded radio signal to interrogate the tag. The RFID tag receives the message and then responds with its identification and other information. This may be only a unique tag serial number, or may be product-related information such as a stock number, lot or batch number, production date, or other specific information. Since tags have individual serial numbers, the RFID system design can discriminate among several tags that might be within the range of the RFID reader and read them simultaneously.

### 4.6.2. Readers

RFID systems can be classified by the type of tag and reader. A Passive Reader Active Tag (PRAT) system has a passive reader which only receives radio signals from active tags (battery operated, transmit only). The reception range of a PRAT system reader can be adjusted from 1–2,000 feet (0–600 m), allowing flexibility in applications such as asset protection and supervision.

An **Active Reader Passive Tag** (**ARPT**) system has an active reader, which transmits interrogator signals and also receives authentication replies from passive tags.

An **Active Reader Active Tag** (**ARAT**) system uses active tags awoken with an interrogator signal from the active reader. A variation of this system could also use a Battery-Assisted Passive (BAP) tag which acts like a passive tag but has a small battery to power the tag's return reporting signal.

Fixed readers are set up to create a specific interrogation zone which can be tightly controlled. This allows a highly defined reading area for when tags go in and out of the interrogation zone. Mobile readers may be hand-held or mounted on carts or vehicles.

## 4.7. USES OF RFID

### 4.7.1. Logistics & Supply Chain Visibility

Winning in the supply chain means increasing efficiency, reducing errors, and improving quality. In chaotic manufacturing, shipping, and distribution environments, real-time data on the status of individual items provides insights that turn into actionable measures. With the visibility provided by RFID, you’ll be on your way to Six Sigma Master Black Belt status in no time.

### 4.7.2. Item level inventory tracking

Tracking assets on the item level is beneficial across a broad cross-section of industries, but the retail sector has one of the highest ceilings in terms of opportunity from the use of RFID. As mentioned above, tracking items through the supply chain is wonderful, but now think about tracking items through the supply chain all the way to the point of sale. With a well designed inventory system sharing data across all business units, you’ll have a treasure trove of actionable data. One last added benefit — store employees can count inventory in a matter of minutes with a handheld RFID reader.

### 4.7.3. Race timing

Timing marathons and races are one of the most popular uses of RFID, but often race participants never realize they’re being timed using RFID technology, and that’s a testament to RFID’s ability to provide a seamless consumer experience. If you want to learn more about RFID race timing, read our do-it-yourself guide and check out our recent interview with prominent timing company RaceWire.

### 4.7.4. Attendee Tracking

If you’ve ever managed a large conference before, you’ll know that it’s key to keep the flow of traffic moving at a steady pace, especially in and out of seminars. With an RFID attendee solution, eliminate the need for registration lines at entrances.

### 4.7.5. Materials management

In construction and other related industries, materials are often the largest project expenditure. On large job sites, simply finding materials can be problematic. RFID solutions like Jovix take the guess work out of the equation.

### 4.7.6. Access Control

Certain areas require an expected level of security and access. From doors to parking lots, RFID access control tags restrict access to only those pre-approved.

### 4.7.7. IT Asset Tracking

IT assets such as server blades, laptops, tablets, and other peripherals are costly investments for any company, not to mention that information stored on those items could prove detrimental in the wrong hands. IT asset tags give your IT team the ability to quickly do an inventory count and make sure everything is in place.

### 4.7.8. RTLS (Real Time Location System)

In some applications, you need to track the real-time location of assets, employees, or customers. Whether you’re measuring the efficiency of worker movements, the effectiveness of a store floor plan, or tracking the location of valuable resources, RFID systems provide visibility in any number of locations.

## 4.8. RFID Security Benefits and Threats

Universally deploying RFID tags offers many potential security benefits, yet may expose new privacy threats. Otherwise intrusive or cumbersome security practices, such as airline passenger and baggage tracking, can be made practical by using RFID systems. Authentication systems already take advantage of RFID technology, for example car key-less entry systems. Embedding RFID tags as seals of authenticity in documents, designer products, and currency may discourage forgery. While RFID tags improve certain security properties in these applications, they may exacerbate privacy threats or pose new security risks. RFID systems are different from other means of identification because RF communication is non-contact and non-line-of-sight, whereas other means of identification are either contact-based or require line-of-sight. In other words, it is more difficult for the owner of the RF tag to physically impede communication with the tag. The promiscuity of RF tags is not unique; magnetic stripe cards, for example, are promiscuous, but we assume that the owner of the card takes the physical responsibility of preventing unauthorized users from physically accessing the card. Of course, the propagation characteristics of electromagnetic fields do limit the range from which passive RFID cards can be read. In fact, most tags operating at 13.56 MHz cannot be read from more than a meter away, and 915 MHz tags are difficult to read through most materials. Yet, as the information stored on the tag becomes more and more valuable, it is necessary to think through some of the security and privacy related issues in RFID.

## 4.9. Security Goals

It is useful to state clear security goals when discussing security properties of various RFID designs. Tags must not compromise the privacy of their holders. Information should not be leaked to unauthorized readers, nor should it be possible to build long-term tracking associations between tags and holders. To prevent tracking, holders should be able to detect and disable any tags they carry. Publicly available tag output should be randomized or easily modifiable to avoid long-term associations between tags and holders. Private tag contents must be protected by access control and, if interrogation channels are assumed insecure, encryption. Both tags and readers should trust each other. Spoofing either party should be difficult. Besides providing an access control mechanism, mutual authentication between tags and readers also provides a measure of trust. Session hijacking and replay attacks are also concerns. Fault induction or power interruption should not compromise protocols or open windows to hijack attempts. Both tags and readers should be resistant to replay or man-in-the-middle attacks.

## 4.10. Low-Cost RFID Issues

With these security goals in mind, consider the security properties of passive factory-programmed, read-only tags. Each tag contains a unique identifier such as an EPC. While no more “promiscuous” than an optical bar code, automated monitoring of RF tags is possible. This basic design clearly violates the privacy goal since tracking tag holders and reading tag contents are possible if the tag is properly presented to a reader’s interrogation field. Neither tags nor readers are authenticated; therefore, no notion of trust exists either. To address these deficiencies, suppose we adopt a policy of erasing unique serial numbers at the point of sale. Consumer held tags would still contain product code information, but not unique identification numbers. Unfortunately, tracking is still possible by associating “constellations” of particular tag types with holder identities. For example, a unique penchant for RFID-tagged Gucci shoes, Rolex watches and Cohiba cigars may betray your anonymity. Furthermore, this design still offers no trust mechanism. Providing the stated security goals requires implementing access control and authentication. Public key cryptography offers a solution. A particular (type of) reader’s public key and a unique private key may be embedded into each tag. During interrogation, tags and readers may mutually authenticate each other with these keys using well understood protocols. To prevent eavesdropping within the interrogation zone, tags may encrypt their contents using a random nonce to prevent tracking. Unfortunately, supporting strong public key cryptography is beyond the resources of low cost (US$0.05-0.10) tags, although solutions do exist for more expensive tags [13] . Symmetric message authentication requires each tag to share a unique key with a reader or for a key to be shared among a batch of tags. To support a unique key per tag, a complex key management overhead is necessary. If keys are to be shared, tags must be resilient to physical attacks described in [18]; otherwise, compromising a single tag effective compromises an entire a batch. Implementing secure memory on a low cost tag with a logic gate count in the hundreds is a daunting task, especially in light of the difficulty in securing memory on relatively resource abundant smart cards. Even supporting strong symmetric encryption is a challenge in the short term.

## 4.11. APPLICATIONS OF RFID

RFID technology is employed in many industries to perform such tasks as:

* Inventory management
* Asset tracking
* Personnel tracking
* Controlling access to restricted areas
* ID badging
* Supply chain management
* Counterfeit prevention (e.g., in the pharmaceutical industry)

Although RFID technology has been in use since World War II, the demand for RFID equipment is increasing rapidly, in part due to [mandates issued by the U.S. Department of Defense (DoD)](http://www.abrfid.com/DoD-RFID-Compliance-Mandate?ck=JylIvMoCAucPgjAn&vid=JylIvMoCAvAPgrHb&cktime=131786) and Wal-Mart requiring their suppliers to enable products to be traceable by RFID.

Whether or not RFID compliance is required, applications that currently use barcode technology are good candidates for upgrading to a system that uses RFID or some combination of the two. RFID offers many advantages over the barcode, particularly the fact that an RFID tag can hold much more data about an item than a barcode can. In addition, RFID tags are not susceptible to the damages that may be incurred by barcode labels, like ripping and smearing.

## 4.12. Some Approaches to RFID Protection

Accepting short-term limitations on low-cost tag resources, we discuss a simple RFID security scheme based on a one-way hash function. In practice, a hardware optimized cryptographic hash function would suffice, assuming it may be implemented with significantly fewer resources than symmetric encryption. In this design, each hash-enabled tag contains a portion of memory reserved for a “meta-ID” and operates in either an unlocked or locked state. While unlocked, the full functionality and memory of the tag are available to anyone in the interrogation zone. To lock a tag, the owner computes a hash value of a random key and sends it to the tag as a lock value, i.e. lock=hash(key). In turn, the tag stores the lock value in the meta-ID memory location and enters the locked state. While locked, a tag responds to all queries with the current meta-ID value and restricts all other functionality. To unlock a tag, the owner sends the original key value to the tag. The tag then hashes this value and compares it to the lock stored under the meta-ID. If the values match, the tag unlocks itself. Each tag always responds to queries in some form and thus always reveals its existence. Tags will be equipped with a physical self-destruct mechanism and will only be unlocked during communication with an authorized reader. In the event of power loss or transmission interruption, tags will return to a default locked state. A trusted channel may be established for management functions, such as key management, tag disabling or even tag writes, by requiring physical contact between a control device and a tag. Requiring physical contact for critical functionality helps defend against wireless sabotage or denial of service attacks. The hash-based lock mechanism satisfies most of our privacy concerns. Access control to tag contents is restricted to key holders. Individuals may both locate and disable tags they may be carrying since tags always respond to queries. Long-term associations can be avoided since locked tags only respond with the correct meta-ID. One caveat is that stale meta-ID values may be used to build tracking associations over time. This necessitates periodically refreshing meta-ID values by unlocking and re-locking tags. Although authenticating readers and providing a trusted channel satisfies some of our trust requirements, this design does sacrifice several security properties to save costs; specifically tag authentication. Tag MAC functionality would allow tags to authenticate themselves, but is beyond current low-cost tag resources. Lacking authentication exposes tags to man-in-the-middle attacks since an attacker can query tags for meta-IDs, rebroadcast those values to a legitimate reader, and later unlock the tags with the reader’s response keys. Many key-less car entry systems currently possess the same vulnerability. Regardless, attackers without access to an authorized reader cannot access tag contents outside physical channels

# CHAPTER 5

# RESULTS AND CONCLUSION

The objectives of this project have been achieved. The hassle in searching for available parking slots has been completely eliminated by reserving the slots beforehand via the SMS system and RFID System. These system helpes users reduce the wasting time of search parking slot and also improve the parking slot utilization. Designed as a system to give complete solution for transport related problems such as accident alert, Vehicle surveillance.

* Extended with small changes for Toll gate control, traffic signal control, traffic rules violation control, parking management, vehicle theft and special zone alert using the latest RFID technology.
* Low cost optimized solution using RFID and GSM mobile technology. This is in line with the developed countries like USA, England, German and Japan, where RFID, GPS and GSM technologies are widely used for traffic management.
* No automated system for transport management in India due to prohibitive cost. Keeping this in mind , this is the proposed system at low cost.

System we designed will facilitate users and a secure way of parking can be done:

* Tracks entry of unwanted vehicles.
* At the exit of a paid parking facility, parking tickets can be crossed checked versus the vehicle captured in the system. This prevents a parker from exiting the facility with a different parking ticket.
* In case of lost parking ticket, operator can easily track entry time of vehicle to identify exact amount to be paid.
* For season parker membership using transponder cards, RFID helps ensure that the card is only used by the registered vehicle in the membership system.

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