RFID Based Traffic Control and Security System

By

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In Partial Fulfillment of

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Pakistan.

DEDICATION

We dedicate our work to our dearly Parents and Friends, who helped us through out the project with motivation and time.

CERTIFICATE

Certified that the contents and form of project report entitled ***"RFID Based Traffic Control and Security System"*** submitted by Amna Mehmood and Adnan Bashir have been found satisfactory for the requirement of the degree.

Advisor: **Date**

Engr Arslan Qamar

_____ _____

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We at this point, will never forget the admiration of our friends, who stood by us both during joyous and gloomy moments.

Not forgetting the administration and lab staff, we would like to acknowledge the efforts made by them for us to work in the labs and issue resources whenever we needed them.

Last but not the least we would like to offer sincere thanks to our parents. Their criticism and encouragements were the means by which we have completed our project in time.

DECLARATION

We hereby declare that this is our own work and has not been submitted in any form for another degree or diploma at any university or other institution for tertiary education. Information derived from published or unpublished work of others has been acknowledged in the text and a list of references is given.

Project Team,

25 November 2010

ABSTRACT

The technology of radio frequency identification has emerged to a large extend through out the world replacing all the older technologies such as Barcodes, Magnetic strips etc. The technology of RFID is so flexible and secure that it could replace almost any technology in the world. This technology is based on the wireless medium hence making it even better then the older technologies. This technology is now a days used in libraries, shops, stores all around the world replacing the older technologies.

However the scope of this technology is still not clear to the ordinary man as it is mainly used for identification purposes. The technology is so flexible that it could be used in any field.

This project will reveal a new application of this technology to you as it is not only been used for the identification purposes but along with it the technology will be used as a tracking system. This technology will be implemented in one of the most complex and difficult department i.e. Traffic control and Management. Traffic control and management is so complex that even today when man has invented un manned air crafts, the need of the traffic sergeant is still in need and it is growing day by day.

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Chapter 1. Introduction

This chapter introduces the key aspects of the project. This project performs a useful application that automates the traditional way of controlling urban traffic. On every day, people in car take themselves in a situation when they get caught in serious traffic jam at cross junction. Traditionally, in Pakistan, the signal lights are controlled by full-time deployed police officers. Since the country has severe weather conditions as well, so sometimes, the availability of police men is not certain. Moreover, when the traffic gets too heavy, the signals normally turn off and the traffic is controlled manually. Instead of efficient controlling, the situation gets out of control that builds frustration amongst public, unnecessary fuel consumption, waste of precious time, etc.

To cater such situation, there are number of techniques that can be used. One of the techniques involve *Global Positioning System* (GPS) that keep the record of the traffic congestion at every cross junction. The reason of not using this system is described in the later section. The other approach is the use of Magnetic Field that will be built at every cross section and through which the number of cars can be found and the efficient way of controlling traffic can be done.

There is another cost efficient yet more powerful method to control urban traffic. This method is Radio Frequency Identification, shortly termed as RFID. The coming sections of this chapter will describe how this technique can be used to achieve the desired functionality.

1.2 Real World Problems

1.2.1 The Traffic Issue

As the world has developed and the lifestyles of people have standardized, this development has not only brought glory and happiness to the people but have also led to many problems.

According to statistics compiled by CNG Owners Association of Pakistan, the number of CNG-run cars have exceeded to 1.6 million throughout the country. According to BBC, the number of vehicles on the roads has increased five times in the past 20 years. In all the major cities of any country the traffic has been a huge issue. Even in Pakistan the traffic has turned out to be a very major problem and needs a well-organized and dynamic system to overcome this problem.

1.2.2 Current system:

The management of road signals according to the load of traffic has been the major problem. Even in Pakistan it is seen that during the time of heavy traffic police surgeons are placed on duties and work in extreme heat to maintain the flow of traffic. As the road signal works according to the time, every signal has its count time period to switch signal lights. This technique might be effective at low traffic areas but its usability is questionable at places where traffic load is very high.

The figure 2 shows the traffic jam at the roundabout and needs to be dealt seriously. A flexible and intelligent automated system must be deployed to overcome the issues just discussed.

Fig 1:Traffic jam in cities

1.2.3 Security and Tracking

The world is facing serious security threats from terrorist organizations all over the world. There has been a rapid increase in the terrorist organizations and many lives have been lost due to their sin full acts. No matter how secure is a country; there is always a chance that a terrorist could jeopardize people's innocent lives.

There is dire need of a system that can keep check on each and every person in its designated area. It is understood that the means of travelling of people is through road. So if we could keep a check on roads, we will easily be able to secure the area to a much greater extent. If a security system is able to locate any person at a specific time from any location, this is what is needed and by this system almost every aspect of security could be fulfilled.

The world is not only facing problems from the terrorists but other criminal acts are also on the peak. The top of crime list is car theft. Although there are certain tracking systems such as GPS for tracking of the stolen cars but it has its disadvantages. We need a system that could readily detect the stolen car and report back.

Fig 2: Criminal Committing Car Theft

1.3 Theme of Project

The technology of RFID could be used to sort out all of the problems mentioned in the previous section by simply placing the RFID readers at each cross section and making it mandatory for each vehicle to have a unique RFID tag embedded in its body. Now each RFID detector will be placed near the signal facing towards the traffic. The RFID detecting the most number of cars will be allowed to switch its respective signal green: hence letting the heavy traffic passes first. This is the same technique that a cop or police officer follows, so hence instead of humans this system will be doing the same job.

On the other hand as the RFID tags are embedded into the cars so we can track any car at any time. If the car passes through any signal, the car's unique ID will be recorded in to the database and we will know the location of specific car at any time.

On the other hand by this mechanism suspicious vehicles will be kept under observation and all of their travelling activities will be noted. We shall be able to track any vehicle at any time and with no delays, suitable actions can be taken to avoid unfavorable incident to occur.

This mechanism makes the security system better and also reduces a lot of man power. The security system will be covering a large amount of area and it will be really difficult to create a leak in this system as there is no other way to travel other than roads. On the other hand, the stolen cars could be recovered in seconds by this system. The location of every tag placed in a car could be found and from there one can easily recover a vehicle.

1.4 Radio Frequency Identification (RFID)

Radio frequency identification is one of the new technologies emerging up ahead. The technology uses wireless communication that employs Radio signals. Basically a simple RFID should contain:

- RFID Receiver, which is usually connected at the user end or to a computer. It detects the RFID tags and the received information is send to the computer or shown to the user for further process.
- RFID Tag which is a small tag that transmits certain information to the RFID Receiver when it comes in contact with it. Each tag has a unique piece of information and identity and only that information is transmitted to the reader.

The RFID Tags do come with different types. The types are distinguished from each other with respect to the methods of powering the tags. There are two major types of RFID tags mentioned below. *Active tags* come with additional battery connected with them. That is how such tags got their names since they get active from their own supply and kept emitting the signal to the longer range compared to passive tags. The battery life goes up till 2 years and then there is a need to change them. These tags emit signals as soon the reader comes in the range. The reason of selecting or deselecting this type will be discussed shortly. *Passive tags* have no battery along with them and because of that the tag needs external power supply to send and read the data to and from the RFID Reader. Normally, this power is supplied by the RFID reader. The tags are small and come with some internal memory. The detecting range of such tags is smaller than active tags' range because of the absence of internal power supply.

Now a days active RFID reader are widely used instead of passive. Although the Passive RFID (battery-less) is very popular in logistics for its low cost, it is subjective to too many constraints such as liquid and metal environment. Usually Passive RFID system requires careful trial testing and tuning. There are situations where items to be detected are very valuable, also the items might not be very RF friendly (liquid and metal). Sometimes, the tags have to be placed outside. In such situations, these tags may not work properly or more prune to noise or malfunctioning. Moreover, the Passive RFID tags have very less area coverage than Active RFID tags. So Active RFID tags have been used in the project.

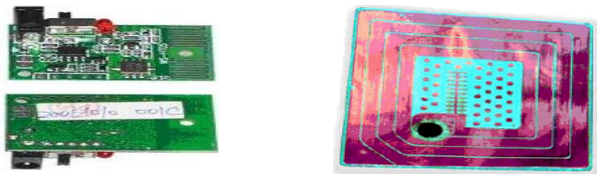


Fig 3: RFID Tags

1.5 Advantages of RFID over other Technologies

RFID being a very flexible and advance technology has a number of advantages over other technologies. Below are some comparisons given between RFID and other technologies.

1.5.1 RFID vs Barcode/Magnetic Strips

Barcodes and Magnetic Strips are older and unreliable technologies. As with Magnetic Strips on the exposure of the electromagnetic waves, the data can be corrupted and may lead to lose the data. These technologies can easily be tempered and changed. Both of the technologies have a disadvantage of low range and in order to read data the barcodes and strips need to be very close to the reader. Thus this technology cannot be used outside and hence cannot be used for traffic systems.

1.5.2 Global Positioning Systems

GPS is a very different beast from RFID. While it also uses radio waves to transmit data, it does so using the global positioning system of 24 satellites, as opposed to specialized scanners here on the ground. The group of satellites coordinates with the GPS receiver on Earth. The receivers can then triangulate their position relative to the satellites, and thus on the Earth's surface.

GPS being a new technology along with its advantages, it has a number of problems also. The GPS system is really expensive at the user end and not all people can afford it. The coming chapters shall describe how the application is built using RFID. The methodology will be discussed and the every phase of the project will be highlighted.

Chapter 2. System Overview & Specifications

In this chapter, the overview of the system will be presented along with the key components used in the project. A more detailed description of the technique and hardware components are written for the understanding purpose.

2.1 How did the idea float?

RFID is a new emerging technology which is used for detection purposes. The flexibility and good compatibility of this technology encouraged us to use it in a new field in which this technology has not been used yet. Now a days this technology is been used at libraries, stores etc. The use of RFID in traffic has never been used before and there was also a problem that at the beginning of this technology the range of readers were very less, hence making it limited to indoor applications. Now a days, the latest RFID readers can read the data several hundred meters which is best suited to apply in the field of traffic control and monitoring.

The technology is cheap and also over comes the issue of line of sight hence making it even better to be used in the department of traffic.

2.2 Major Components required

- RFID Readers
- RFID Tags
- Microcontroller
- Power supply for RFID readers
- Power supply for RFID tags
- Voltage regulators
- Max 232 and diode serial port interfacing
- Light emitting diodes for signals

2.3 RFID Basics

A basic RFID system consists of three components:

1. An antenna or coil
2. A transceiver (with decoder)
3. A transponder (RF tag) electronically programmed with unique information

2.3.1 An Antenna or Coil

The most important component of an RFID is the antenna that emits radio waves to be received by the RFID tag. This then activates the tag and the information can be written or read by the reader. Antennas come with different sizes and shapes. This depends on the type of application to be used i.e. the antenna can be fixed to a door frame to detect the ins and outs to the room, usually for the detection purposes. The multiple tags can be collected the continuously apply electromagnetic field by the antenna.

Transceiver is a device that transmits and receives data. The decoder is a device that can selects unique outputs based on the selection inputs. The antenna is made with transceiver and decoder to make a RFID reader. Here the decoder decodes all of the information stored in the tag in the encoded form as soon the tag comes in the range of Reader. This data will then be passed to PC for processing and numerous tasks can be performed accordingly.

2.3.2 Transceiver

The term transceiver is a device that performs, within one chassis, both transmitting and receiving functions that is in a common housing, sometimes designed for portable or mobile use, uses common circuit components for both transmitting and receiving which provides half-duplex operation.

2.3.3 Transponder

This is the third key component of the RFID system. Transponder is a device that receives the signals, amplifies the signal and then re transmits the received signal on a different frequency. The device has

already stored information to be transmitted whenever it is required to do so. This information is then transmitted on the occurrence of a pre-defined received signal.

The transponder might have got the name from the fact that it is a Transmitter plus a Responder hence it is called Transponder. The transponder also named as RFID Tags that stores the information and respond to the requests for the data from the reader. The communication certainly in a wireless medium i.e. air.

2.3.3.1 Types of Transponder

The transponders can be of different types i.e. Read only tags, Read/Write Tags and Digital Signal Transponders. All these types can be categorized on their structure.

The Read only tags come with a unique factory fitted code and that code will be decoded by the reader and helping detecting the object.

The Read/Write tags allow the programmer to re-program the codes burnt in the tags. The user can write any information without exceeding the memory range and this information must be visible by the reader.

Digital Signal Transponders (DST) provides enough memory to maintain the history. This helps in tracking of the object. The memory addition helps improving the standard of information that can be stored inside the tag and more authorization can be implement.

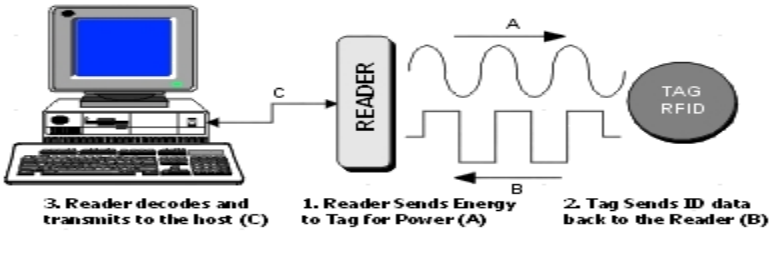


Fig 4: Communication between RFID system and Tag

2.4 RFID Tags

The tags can be of different kinds and sizes. The tags attached to skin can be very small and be able to transmit their information over a longer distance. The screw-shaped tags can be used to identify the physical objects like table, chairs and woods etc. The shops contain goods that are fixed with plastic tags to avoid being stolen. This is a very useful activity to work against robbers. The heavy machineries like Trucks, cars or machines placed inside the industry must be secured and thus heavy duty transponders are used to detect and track such machineries. This helps performing different functions like controlling traffic, keeping records and efficient parking system etc.

2.4.1 Active RFID tags

Active tags are powered from the internal battery and are able to write and read information. These tags' memory varies from few bytes to 1 megabyte. This depends on the application requirements. For this project, the tag memory is not a big issue and tags of smaller memory can be used. These tags have

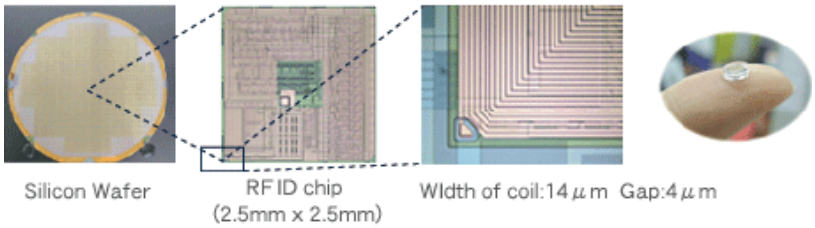


Fig 5: Tag Types

reading range greater than the passive tags because they have internal memory to power the tags. On the other hand, these tags are of larger size and greater cost. They have limited operational life as the tags are always active. These tags emit the rays no matter the reader is in the range or not. As soon the reader comes in the range, the tags share information. For this project, the active RFID tags will be used.

2.4.2 Passive RFID tags

Passive tags operate with no active power supply. As soon they come in the range of reader, they start emitting the rays and share the information with the reader. They are smaller in size and thus quite

lighter. They are in expensive tags compared to active tags. They are less active than active tags thus have greater life time than active tags. One of the drawbacks is that they are shorter in range and not suitable for the applications needing longer range of communication. The size of passive tags ranges from 32 to 128 bits.

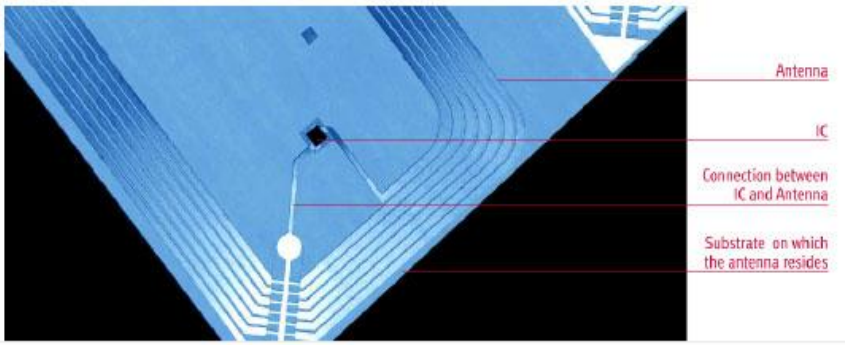


Fig 6: Tag Architecture

2.5 Frequency Ranges

RFID system operates on different range of frequencies depending on the kind of the application. For the low range applications, lower frequencies can be used and vice versa.

2.5.1 Low Frequency System

Low Frequency systems work in between the frequency range of 30 kHz to 500 kHz. Such systems are more applicable to applications requiring low range of communication i.e. door locking/unlocking. They are normally used in places involving security threats, door locking/ unlocking, object detection, ticketing/poling. Such systems posses low cost and the cost rises with the range of communication.

2.5.2 High-frequency Systems

High Frequency systems work in between the frequency ranges of 850 MHz to 950 MHz and 2.4 GHz to 2.5 GHz. Such systems are more applicable to applications requiring mid range of communication i.e. speed checking. They are normally used in places where the Human errors considered to be ignored i.e.

car tracking, speed checking, counting animals in Farm, collecting number of items in a big truck. Such systems posses high cost as the performance of the system increases with increase in the frequency used.

	Frequency	Distance & Cost	Example Application
LF	125 kHz	Few cm, ¢	Auto-Immobilizer
HF	13.56 MHz	1m, 50¢	Building Access
UHF	915 MHz	7m, 50¢	Supply Chain / retail / CPG
µwave	2.4 GHz	10m, $'s	Traffic Toll

Table 1: RFID systems and their frequency ranges and applications

2.6 RFID Characteristics

There are in total six characteristics that can affect the communication between the transmitter i.e. Tag and receiver i.e. Reader. These characteristics are highlighted in the following text.

2.6.1 Range

Range is the maximum distance and reading distance for the communication. This distance varies device to device based on the type of antenna and frequency used. Very short range varies up to 60cm. The short range varies up to few meters. The long range varies from few meters to 100 meters approximately.

2.6.2 Range Adjustment

The range can be adjusted to a specific distance. This helps avoiding the interference as the device range is defined and the tags outside this range would be impossible to detect. Thus communication will be

destined inside the range defined. Also this adjustment helps avoiding the cases where poor signal is reached by the tags and the wrong information can be communicated.

2.6.3 Propagation

The RFID's full use must be achieved by making the communication possible through the objects, materials. Radio frequency can penetrate and thus making the contact-less actions easier to perform. The rays can also penetrate through Human tissues that can bring issues regarding human health but certain frequencies do not harm tissues and should be used i.e. 13.56MHz. The ways of propagation distinguish RFID technology from Barcode technology.

2.6.4 Directionality

Directionality is achieved through Directional antennas. The use of correct type of antenna helps targeting the object in the right direction and with a more focussed communication. There are two types of antennas fall under this category.

2.6.4.1 Directional

The Uni directional RFID readers are used where the user has to read the tags in a specific direction neglecting all the other surrounding tags. The radiation pattern of RFID depends upon the type of the antenna used, usually the radiation pattern of the uni directional RFID is about 20 to 50 degrees from the reader as shown in the diagram. With the help of such antennas, the target can be focused more effectively while looking into a specific direction as shown in the following figure.

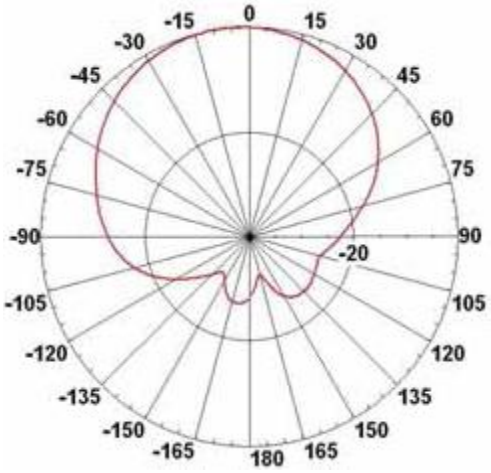


Fig 7: Radiation pattern Uni direction RFID

2.6.4.2 Omni directional

The Omni directional RFID readers create a circular pattern in a fixed radius not depending upon the direction of the antenna. In this project we are using the multi directional RFID instead of Uni Directional. The drawback of such antennas is that the RF coverage is restricted to smaller range as the signal is transmitted in all directions.

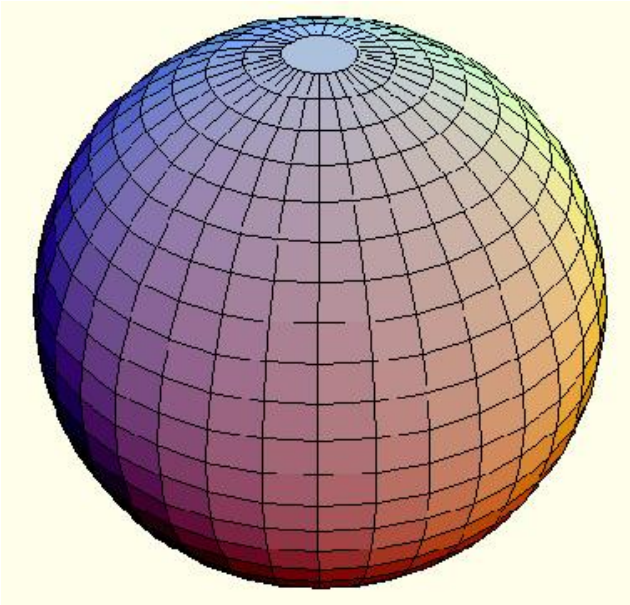


Fig 8 :Multi Directional RFID Radiation Pattern

2.6.5 Multi-tag collection

One of the useful features of the RFID technology is that the reader can collect more than one tag in it range. Compared to Barcode technology, number of tags can be detected and dealing the time issues involved in Barcode technology.

2.6.6 Memory

The RFID tags contain spaces for the information to be stored. This information will be used by the reader to detect the object. There are tags available that can only allow reading the information stored in them. Few tags allow writing the information as well. Tags come with different memory sizes i.e. 16bits and 512k bytes.

2.6.7 Working of RFID System

This section shows the working of the RFID system. As explained earlier, there are two basic components of the system i.e. Tags and Readers. The tags are mounted on any kind of objects that needed to be tracked or detected. The tags contain a unique code that must be detected and received by the reader in order to get acquainted of the product. The reader equipped with the antenna, decoder and transceiver gets the information and process the information to achieve the functionality. This will happen when the tag is in the range of the reader. The range of the reader depends on the size, power and frequency of the reader. If the tags are active, the tags are always active and emits rays when fall inside the range. The passive tags get active on the call of RFID reader.

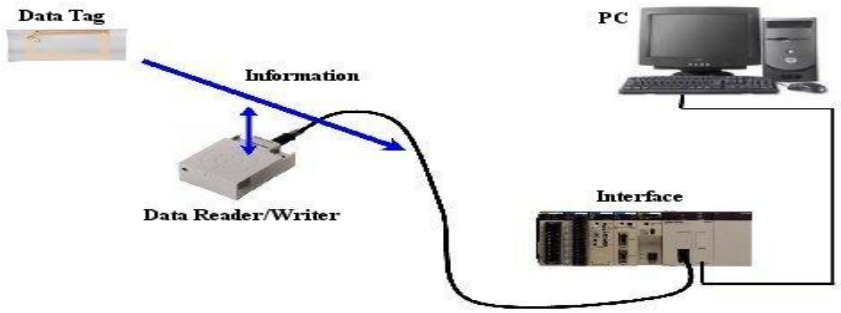


Fig 9: Working of RFID systems

2.7 Microcontrollers

A microcontroller is a perfect example of a micro-computer that contains all of the necessary components of a PC i.e. microprocessor, RAM memory, input output peripherals, timers and interrupts etc. Timers are additional functionality of the device that gives a more flexibility in the usage of the options available. This is an integrated chip with numerous functions. The important thing about microcontroller is that they are programmable leaving us an opportunity to implement functionalities with zero error. Now a days, microcontrollers have been used in everywhere in the industry where time, cost and space issues present. "In short the microcontrollers are the heart and soul of many everyday appliances".

The following block diagram shows exactly the capability of modern day microcontrollers. It can interface to motors, LCDs, read external devices, communicate with other devices like PC either through serial or parallel mode of communication etc.

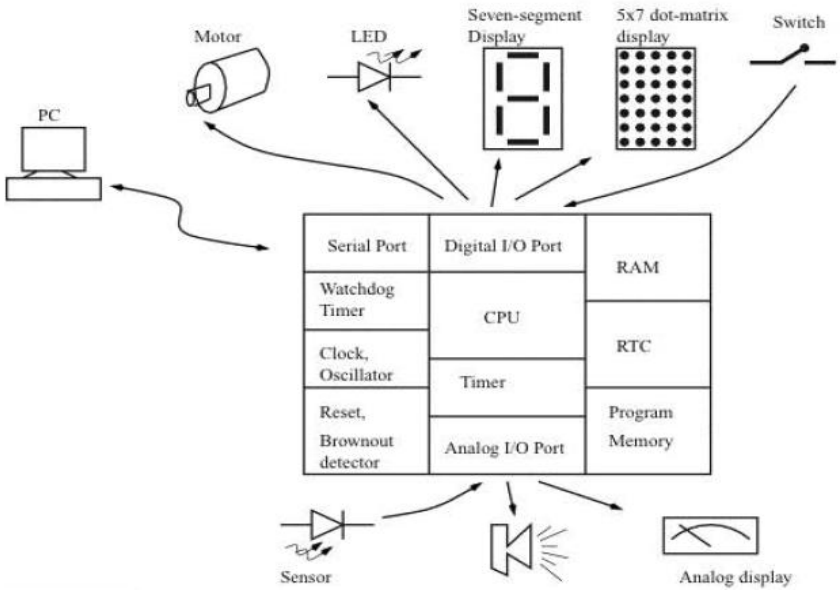


Fig 10: A Microcontroller Interfaced With Other Components

With the input ports, the microcontroller can be interfaced with the external world. The external events' outputs can be connected to the inputs of the microcontroller and the programming allows the controller to perform useful tasks and address the result to be shown on the output ports. There are usually four input/output ports. The cost efficient nature of the controller makes it best suitable for custom designed applications.

The typical components of a controller includes Direct Memory Access (DMA) controller, Interrupt Controller, Serial interfaces (i.e. asynchronous and synchronous). In the coming section, one of the models of controller i.e. PIC series microcontroller is discussed briefly. 89c51 microcontroller is a good choice for the project but since the PIC series is emerging now a days, so the PIC series were preferred over 89c51 Atmel microcontroller.

2.7.1 PIC Microcontrollers

PIC is a family of Harvard architecture specialized in microcontroller design. This is made by famous Microchip Technology. The PIC stands for 'Programmable Interface Controller'.

Due to its low cost and easy availability, the device is very famous amongst men at industry and engineers in the institutes. Re-programming can also be done with Flash Memory. This feature was not present in 89c51 microcontroller. The development tools and programmers are available widely.

2.7.2 PIC Core Architecture

The core architecture of all PIC microcontrollers is same which include:

- PIC architecture includes following key features that make the device versatile performing number of functions.
- The spaces for code and data are different. This helps the time efficiency of the device.
- The device is RISC based architecture i.e. It has fewer number of instructions.
- Most of the instructions complete in just one cycle.

- The hardware stack is used to store return address.
- The data space is used to map CPU and peripheral registers including program counter register too.
- A typical 256 bytes addressable data space is available.
- RAM is used to do job for memory space and registers of the device leaving no distinction between them.

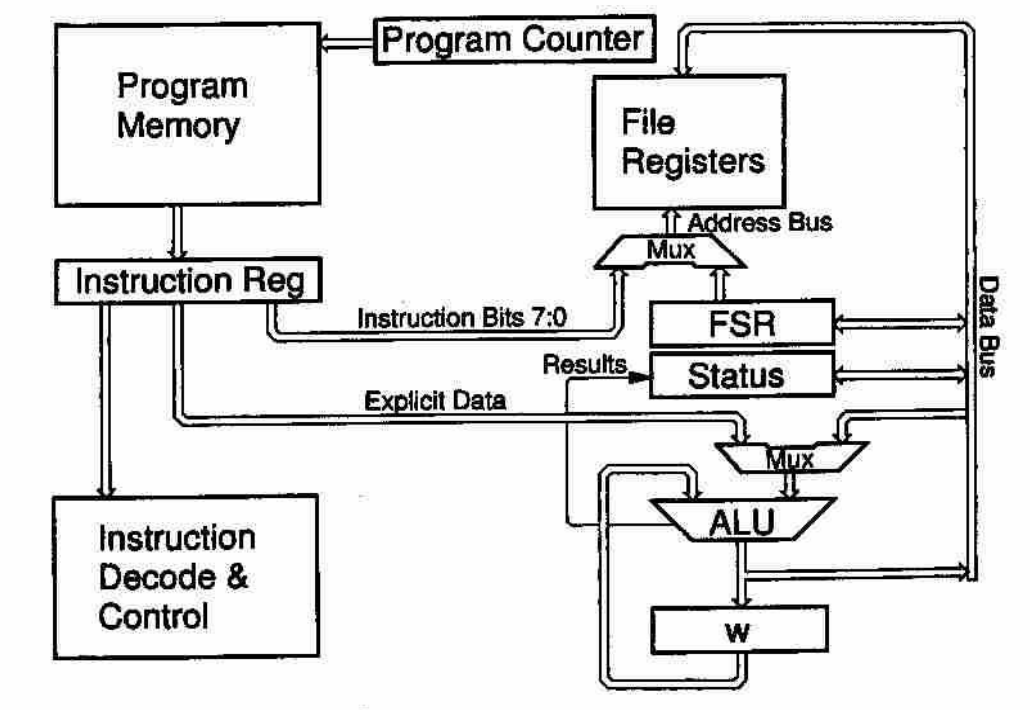


Fig 11:Pic microcontroller Architecture

2.8 Power Supply

2.8.1 Power supply for RFID readers

As the RFID readers will be connected to the signals so they will be powered up with an external power supply. In Pakistan 240v is standard voltage given. So if the RFID reader runs with 240v supply, it will be

given directly. If it runs at less voltage supply then additional step down transformer or voltage regulators will be used which are discussed later in this chapter.

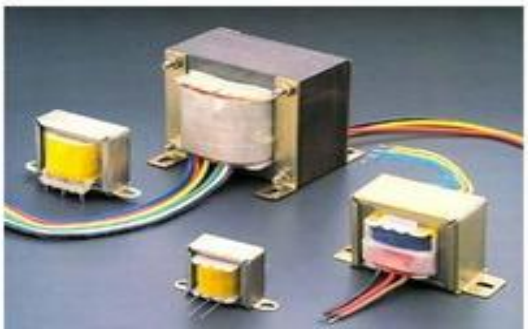


Fig 12: Step down Transformers

2.8.2 Power supply for RFID tags

There are two possibilities for the power management of the RFID tags

- independent battery connected to tags
- external power supply from cars battery

However to make the system better it is suggested that both of the options should be used. The RFID tags should be connected to the rechargeable batteries along with the cars battery supply. The batteries could be made to recharge from the car's power supply and if the battery is disconnected the tags could still run on the recharge able batteries. However we have to keep in mind the voltage issue as mostly the tags are run by 12 volts or 5 volts so we have to install voltage regulators and step down transformers.

2.8.3 Voltage Regulators

The LM7805 is simple to use. You simply connect the positive lead of your unregulated DC power supply (anything from 9VDC to 24VDC) to the Input pin, connect the negative lead to the Common pin and then when you turn on the power, you get a 5 volt supply from the Output pin. The bread boarded circuit is shown below.

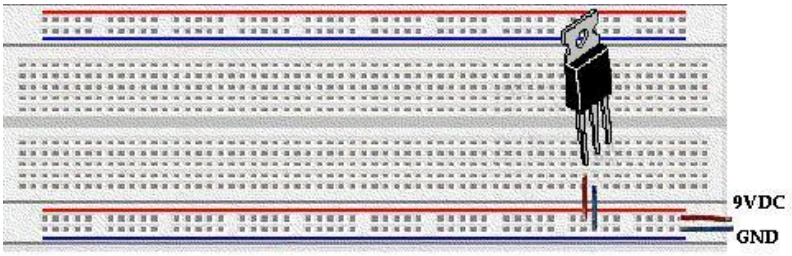


Fig 13 : Regulated Power Supply

2.9 Serial Port Interfacing

2.9.1 Max 232

The MAX232 is essentially a converter to transform the signals coming from RS-232 to signals likely to be used by TTL compatible devices. The TTL devices operate on 5V logic and thus a mechanism is needed to convert the signal accordingly. This IC converts RX, TX CTS and RTS signals. These signals from RS-232 serial port consist of voltage as high as ± 15 V and can be converted to 5V TTL level.

The table is shown below to show how the inputs from RS-232 relate to TTL voltage level of the logic device.

RS232 Line Type & Logic Level	RS232 Voltage	TTL Voltage to/from MAX232
Data Transmission (Rx/Tx) Logic 0	+3V to +15V	0V
Data Transmission (Rx/Tx) Logic 1	-3V to -15V	5V
Control Signals (RTS/CTS/DTR/DSR) Logic 0	-3V to -15V	5V
Control Signals (RTS/CTS/DTR/DSR) Logic 1	+3V to +15V	0V

2.9.2 Transistor serial interfacing

There is one another method to make a serial port connection. This is done using two any general purpose transistors and resistors. In our project as we are only transmitting data from the microcontroller to the computer so we will need only one transistor and a resistor to build our serial

interface. We will need a resistor with a greater value such as 10 kilo ohms so that our transistor is not affected by the excess of voltage. As our transistor will turn on at 0.7 voltage, that's our threshold voltage. It will basically change the negative voltage into positive voltage i.e. it will be converting the 0 volts coming from the microcontroller into positive voltage. As RS 232 port requires only +/-3 volts to completely recognize data so it will be not a big issue for this circuit design. On the other hand if the microcontroller sends 5 volts the transistor will turn off and DB9 will not receive any voltage hence sending the PC a negative voltage. This design is the cheapest and is also reliable. For Mass production we will ne needing to put this design into work instead of using Max-232 IC.

Chapter 3.Design Implementation

In this chapter, the design of the project will be discussed in detail. The major components will be highlighted and the functionality of these components will be talked about.

3.1 Power management

3.1.1 Components

1. Step down transformer
2. Diodes
3. 1000 micro faraday capacitor
4. Wires
5. Connectors
6. LM 7805 IC
7. 104 Pico faraday capacitor
8. LEDs
9. Resistors
10. Batteries

3.1.2 Step down Transformers

Now for the RFID reader the power supply was to be taken directly from the power supply cable so we had to put the suitable step down transformers to decrease the voltage supply as the power cables in Pakistan are giving 220 volts where as the RFID reader and microcontrollers work on 5 volts. Allowing 220 volts to pass through these components would have damaged the ICs and the RFID reader both.

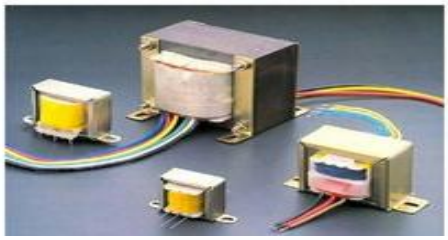


Fig 14: Step down Transformer

The above picture shows a number of different Step Down Transformers. Keeping in mind the voltage supply of our country we choose a transformer which can convert 220 volts into 12 volts. A suitable transformer was obtained from the market.

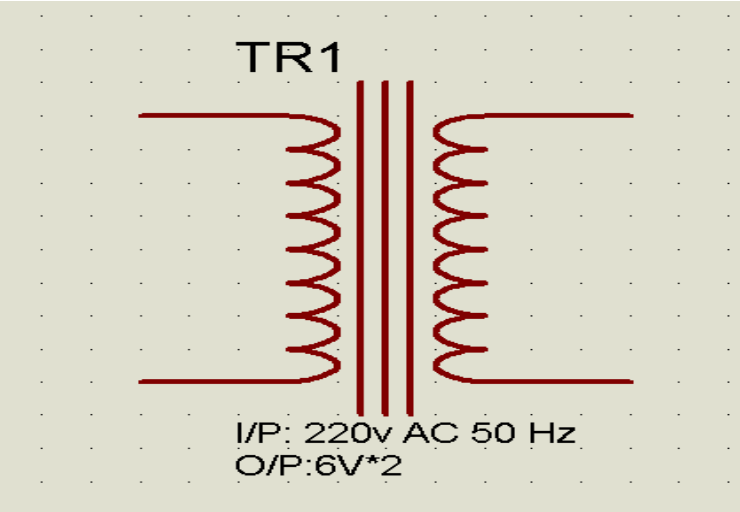


Fig 15:Step down Transformer circuit

3.1.3 Issues in power Management

Problem was that the supply voltage was 220 volts AC that is alternative current but on the other side the RFID reader and microcontrollers were to be given DC supply that is direct current. Giving them alternative current would also have damage the devices both the microcontroller and the RFID reader.

So now we were obtaining the 12 volts AC supply at the end of the transformer. Now the problem was to change it into Direct current. So we build a full wave rectifier to over come this problem. We used diodes and 1000 micro faraday capacitor to build it.

3.1.4 1N 4007 MIC diodes

The diodes used to build this rectifier are 1n 4007 MIC diodes. Below is a picture shown of this diode. Diode's basic purpose it to ensure one way current and stop the flow of back ward current. The diodes used have the following characteristics

- Maximum Recurrent Peak Reverse Voltage = 1000v.
- Maximum Average Forward Rectified Current = 1.0 A

The maximum recurrent peak reverse voltage indicates the maximum reverse-bias voltage that may be applied to a diode without causing junction breakdown.

The maximum average forward rectified current stands for the maximum current that will be given on the output of the diode.

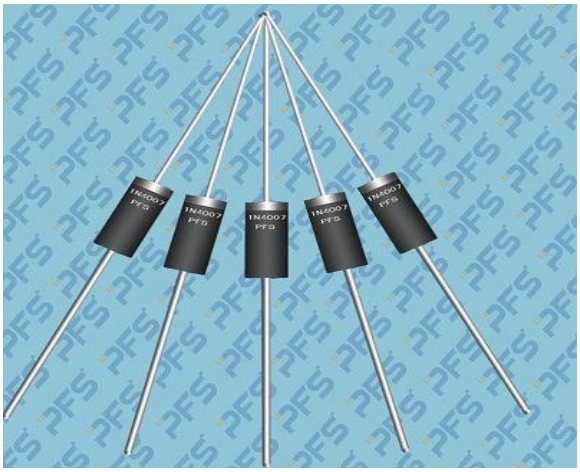


Fig 16:1n4007 MIC diode

3.1.5 Full Wave Rectifier

Four diodes are arranged in the form of bridge to rectify the alternative current into direct current. The diodes will give a 1 Amp current as the output which is perfect to be used with LM7805 which will further reduce the voltage to 5v.

Below is the circuit diagram of how the circuit was built.

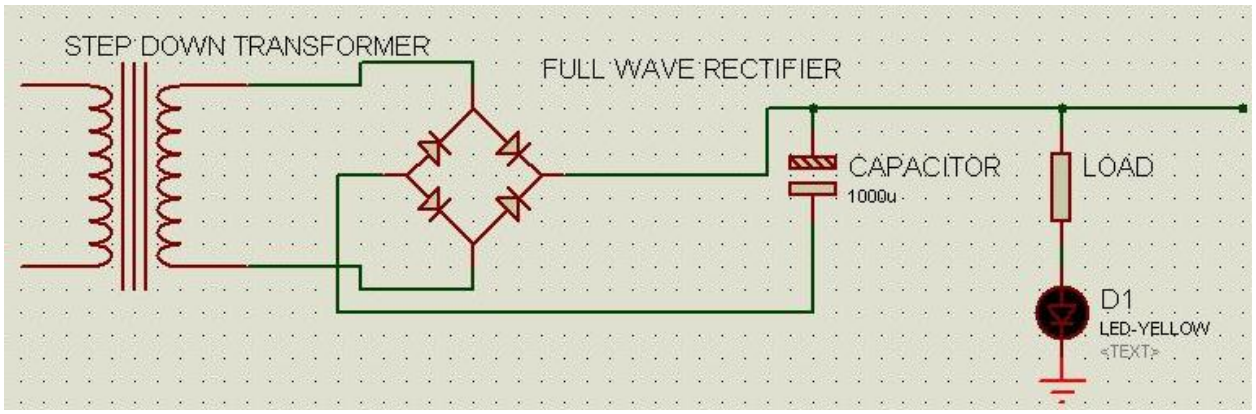


Fig 17: Power Management Circuit

After completing the analysis and design of the circuit used for the power management, we finally built our own circuit which is now used in our project. Below is the picture taken of the original circuit build by us.

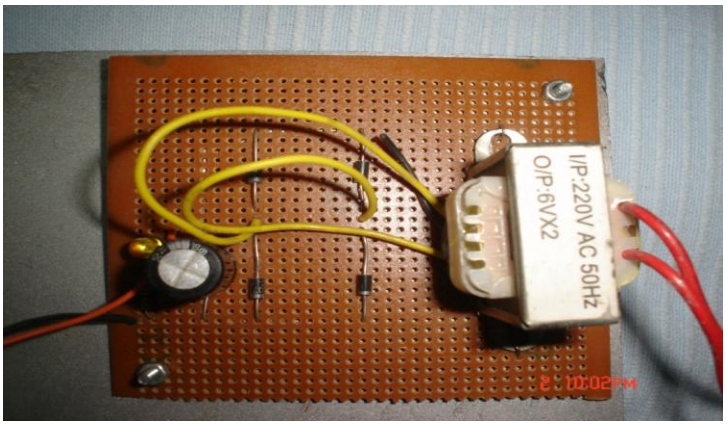


Fig 18: Power Management Original circuit

3.2 Voltage Regulation

The components used for this module are as following

- LM7805
- 1n4005 diode
- 104 Pico farad capacitor
- Resistors

Now we have a voltage of 12 volts and we wanted it to be 5 volts. So there was a need of voltage regulator which could efficiently regulate the voltage, taking input as 12 volts and giving an output of 5 volts. The most commonly known regulators come from the family of LM7800.

3.2.1 LM 7805

The member of this family and most commonly used regulator is LM7805. It is designed to produce an output of 5 volts when ever it is given an input of 7volts to 20 volts and from 5mA current to 1A current.

As in our case as discussed before the current generated from the rectifier and diodes is at maximum 1A which is best suitable for the LM7805 and on the other hand the output voltage of the rectifier was 12 volts so it is best suited conditions for the LM7805 to run perfectly.

LM7805 is a three terminal device which are

1. Input
2. Ground
3. Output

The first terminal is the input which in our case is coming from the rectifier and is 12 volts. The input is well in the range of the device and applying it will have no bad effect on the device. However if the device is applied to an input out of its range it may get damaged.

The second terminal is of ground or common. It is just to provide the device a link to ground. However the third terminal is of output which in our case will be 5 volts as the device is fixed voltage regulator so any voltage from 7 volts to 20 volts will be converted into 5 volts.

Below is a picture shown of LM7805

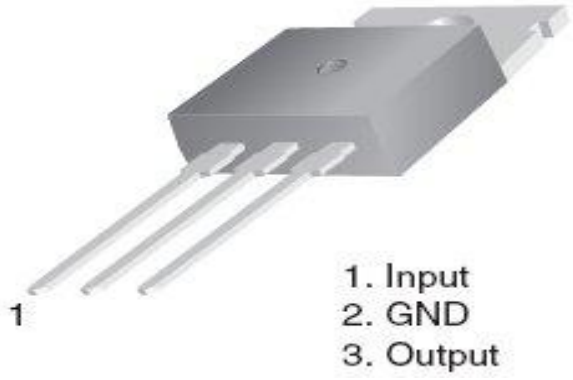


Fig 19:LM7805

Now as the device is selected we needed to place it into an effective circuit so that the device and other components work properly and every type of chance of failure is neglected. After doing a deep study we came up with the following conclusions

- the LM7805 device works with 1 A current or less then that, it is a chance that the wire may get short circuited or the current coming from the power supply may increase so this can lead to damage the LM7805 device resulting in other components to be effected as well.

- One wire from the output is sent to the reset pin of the PIC microcontroller along with it a resistor is connected to limit the current flow
- In order to make sure that there no external noise which may come through ground we needed to add a capacitor at that place so that the noise could be neglected.

3.2.2 1N4005 diode

We are using 1N4005 diode for this purpose as it ensures 1 A current and also comes with the maximum recurrent peak reverse voltage of 600 volts. It is best for us as it allows the maximum current of just 1 A to flow through it. As the average maximum current of the diode is 1A so it is best suited for our circuit.

Below is the picture of the diode

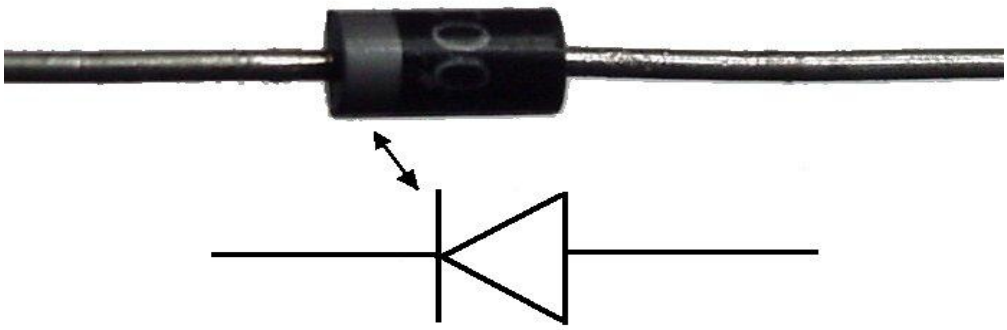


Fig 20: 1N4005 Diode

Now after setting everything in mind, doing the risk management we set of to build up the circuit of our project.

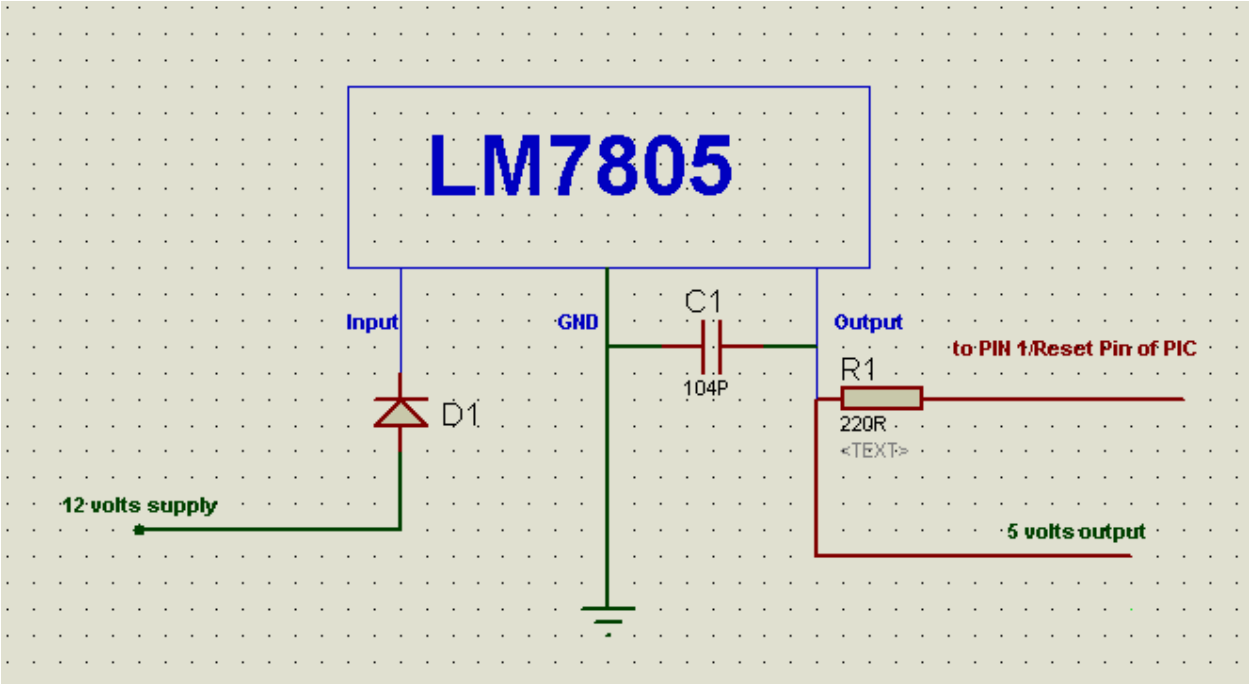


Fig 21: LM7805 Circuit Diagram

As you can see we have put all the necessary components in our design in order to make sure the risk factor is minimal. You will see the diode, the two resistors and the capacitor used in our circuit diagram.

After the reviewing of the circuit design we finally build our own circuit. The following is the picture for the circuit that we build.

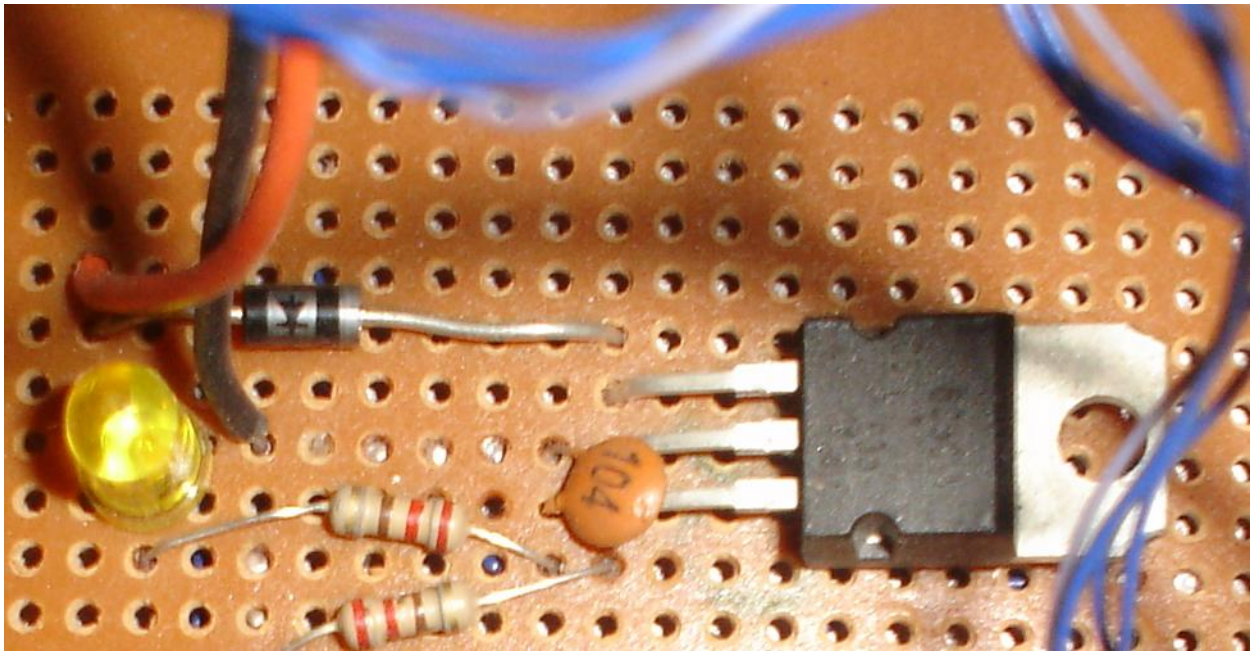


Fig 22: Voltage Regulator Picture

3.3 Transistor Serial Interfacing and Max 232

The components used for this module are as following:

- MAX 232 IC
- A1015 Transistor
- 10 microfarad capacitors
- Resistors
- MS 232 Connector

As our project requires data transfer between the computer and RFID readers so we needed a serial port interface between the two. Serial RS-232 (V.24) communication works with voltages -15V to +15V for high and low. On the other hand, TTL logic operates between 0V and +5V.

So in order to make them both communicate we need to make add MAX 232 IC in between the two. MAX 232 has the build in function and works for both the computer to Microcontroller communication and on the other hand from microcontroller to computer communication.

Below is a picture given for MAX 232 IC

Fig 23:Max 232 IC

As our project requires only the data transfer from the microcontroller to the computer because we are receiving the value from the RFID and saving it in a data base so we will be needing the external circuit which will help amplify the signal.

On the other hand MAX IC has total of 16 pins. In which pin 16 is given Voltage, pin 15 is given the ground or common. The pins from 1 to 6 are used for the capacitors which help amplify the voltage and the pin 9 and 10 are used for the communication between the microcontroller and the MAX 232. The pin 10 is used to receive the data from the microcontroller and pin 9 is used to transmit the data to the microcontroller.

Now on the other hand pin 7 and 8 are used for the communication between the RS 232 port and the MAX 232. Pin 8 is used for the receiving of the data from the RS 232 port which is further connected to a computer and on the other hand pin 7 is used for transmitting the data to the RS 232 port, in other words to the computer. We will be using the pin 7 but as no data is coming from the computer so we will not use pin 8.

Same will be the case with the pin 9 and 10. As there is no data being transmitted by the MAX 232 IC to the microcontroller so will not be using the pin 9. Although we will need the pin 10 as data is transferred from the microcontroller to the MAX 232 IC.

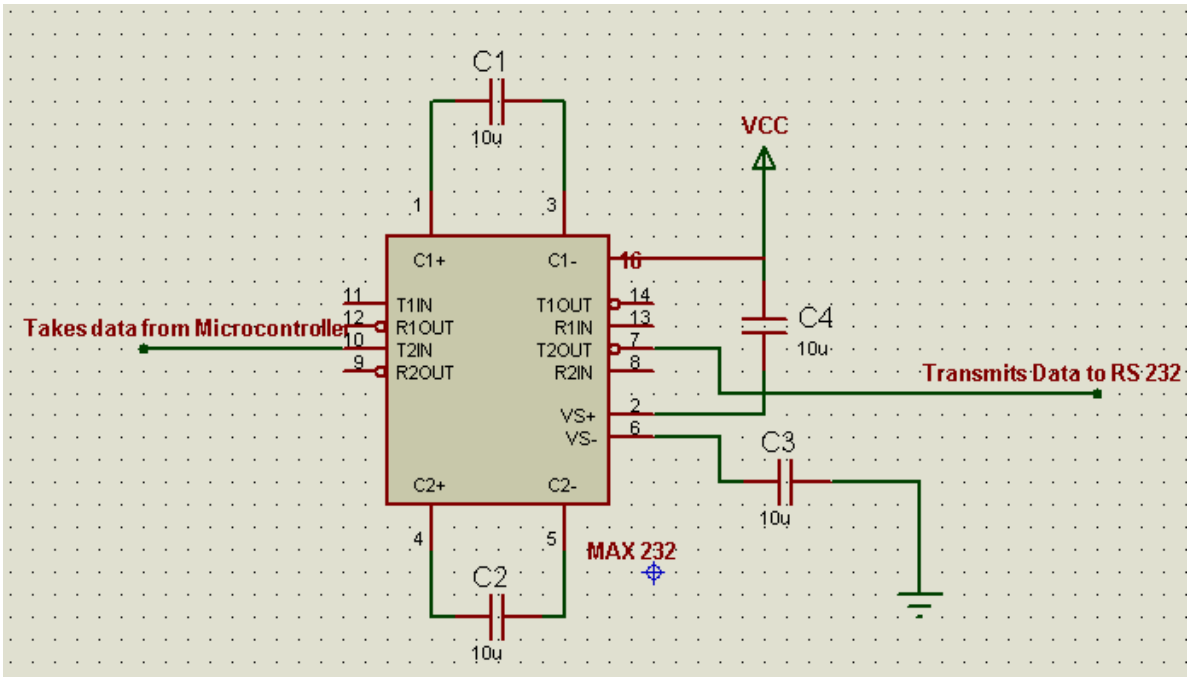


Fig 24: MAX 232 Circuit

3.3.1 Transistor Serial Port Interfacing

Although the circuit was initially working correctly but after some time it started to throw garbage data. The Max IC from the market was not working correctly. We changed two ICs but the problem stayed there. So in order to make sure that our project should run perfectly we switched to the transistor solution for the serial port interfacing.

However we were also purposing the solution for mass production, it was time for us to see if it really could work. We could have used any general purpose PNP transistor; in this case we used A1015. The circuit we came up with was really easy and small but it worked perfectly. It was also very cheap and economical so it was better then the MAX 232 IC circuit.

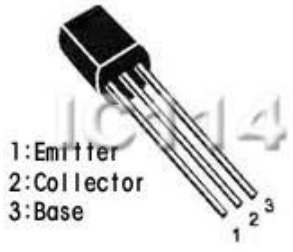


Fig 25: Transistor Picture

Now as we have discussed everything in detail. We have come up with the final design for the complete Serial port and MAX 232 interface.

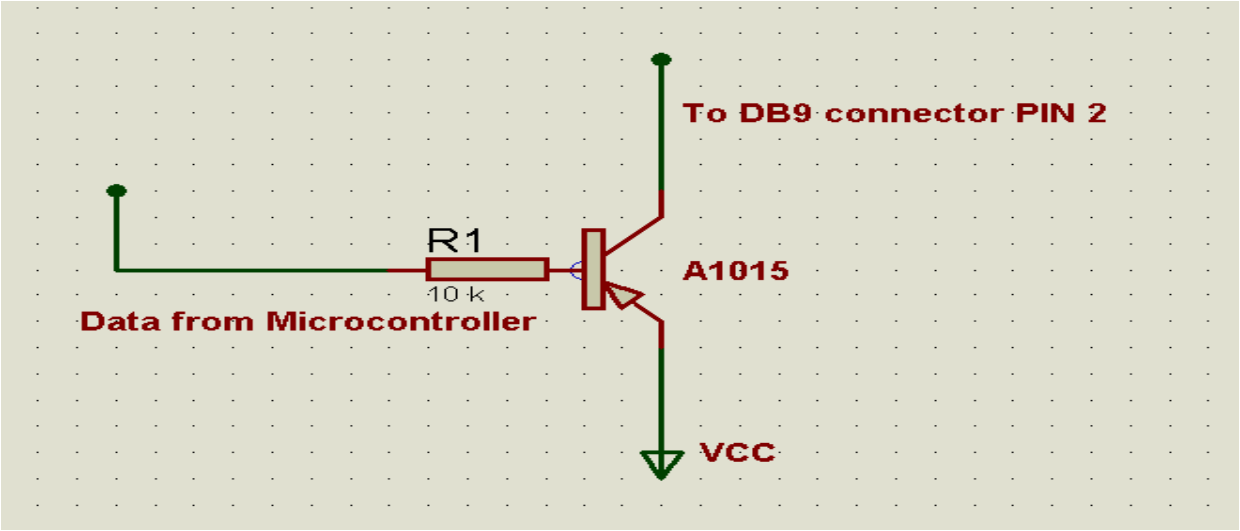


Fig 26: Circuit Diagram Transisitor Serial port interfacing

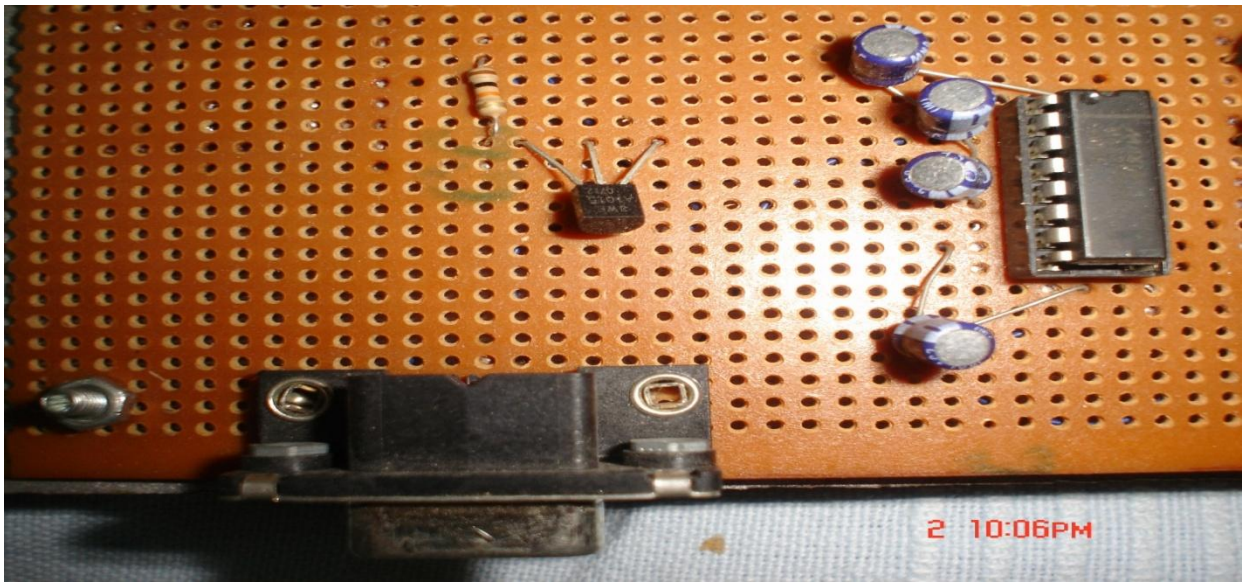


Fig 27: MAX 232 and Transistor interfacing Picture

3.4 Micro Controller and RFID Interfacing

The microcontroller being used in this project is one of the latest from the family of PIC. As discussed above about the PIC microcontrollers. Let us now have a look at specifically at the 18 F452 series of this family. The 18 F452 series is powerful 10 MIPS (100 nanosecond instruction execution) yet easy-to-

program (only 77 single word instructions) CMOS FLASH-based 8-bit microcontroller packs Microchip's powerful PIC® architecture into an 40- or 44-pin package and is upwards compatible with the PIC16C5X, PIC12CXXX, PIC16CXX and PIC17CXX devices and thus providing a seamless migration path of software code to higher levels of hardware integration.

Parameter Name	Value
Program Memory Type	Flash
Program Memory (KB)	32
CPU Speed (MIPS)	10
RAM Bytes	1,536
Data EEPROM (bytes)	256
Timers	1 x 8-bit, 3 x 16-bit
ADC	8 ch, 10-bit
Temperature Range (C)	-40 to 125
Operating Voltage Range (V)	2 to 5.5
Pin Count	40

Table PIC 18F452

Well after discussing the important features of the micro controller used, now we must move forward to the main module of our project which is microcontroller interfacing. We need to divide this section into parts to explain the module fully.

3.4.1 Microcontroller and RFID

First we will discuss that how we have connected RFID and Microcontroller. The microcontroller has been programmed according to negative logic. The micro controller used has 40 pins in total below is a picture shown of the microcontroller

Fig 28: Pic 18F452

Now first let us look at the basic circuit of the PIC microcontroller. The basic circuit which enables the microcontroller to run properly has the following components:

- 12 MHZ Crystal
- 27 PICOFARAD capacitors
- 5 volts supply
- Ground

The PIC microcontroller has 40 pins. At the pin number 13 and 14 of the microcontroller 12 MHZ crystal is connected. The pin 11 is supplied with the VCC which is 5 volts and pin 12 is connected with ground or common. Pin 1 is the reset Pin of the Microcontroller

The two 27 PICOFARAD capacitors are connected with the crystal to reduce noise. The two capacitors act as noise filters and make sure that crystal is not affected by noise.

3.4.2 27 MHz RFID Reader

The active RFID used in our project gives two bits output that is 00, 01, 10, and 11 with respective of which RFID tag has came in its range. We connected the RFID with 23 number pin and 24 number pin. Where as it is been provided with VCC and ground to make it run.

As the microcontroller works on negative logic so we set the RFID accordingly. We connected two LEDs with it as well to make sure the RFID tag signal is received by the RFID reader.

Below is the picture of the RFID reader that has been used.

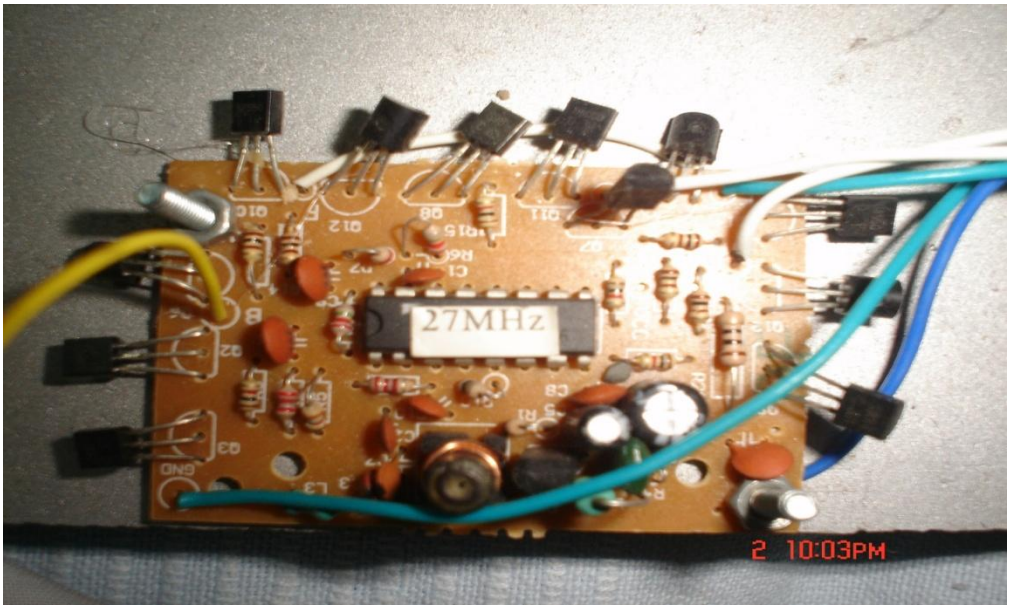


Fig 29: RFID Reader Picture

The RFID works on 27 MHZ frequency with a range of about a meter. As we have discussed above that the micro controller has been made to work on the negative logic so we needed to design a circuit for the connectivity of micro controller and RFID.

This was not a difficult task as we have been designing these types of circuits previously, although designing with negative logic becomes a bit tricky but on the other hand with the negative logic the circuit works perfectly, LEDs are bright and all the components are provided full voltage.

However we came up with the following design of the circuit that was required to communicate between RFID reader and the microcontroller.

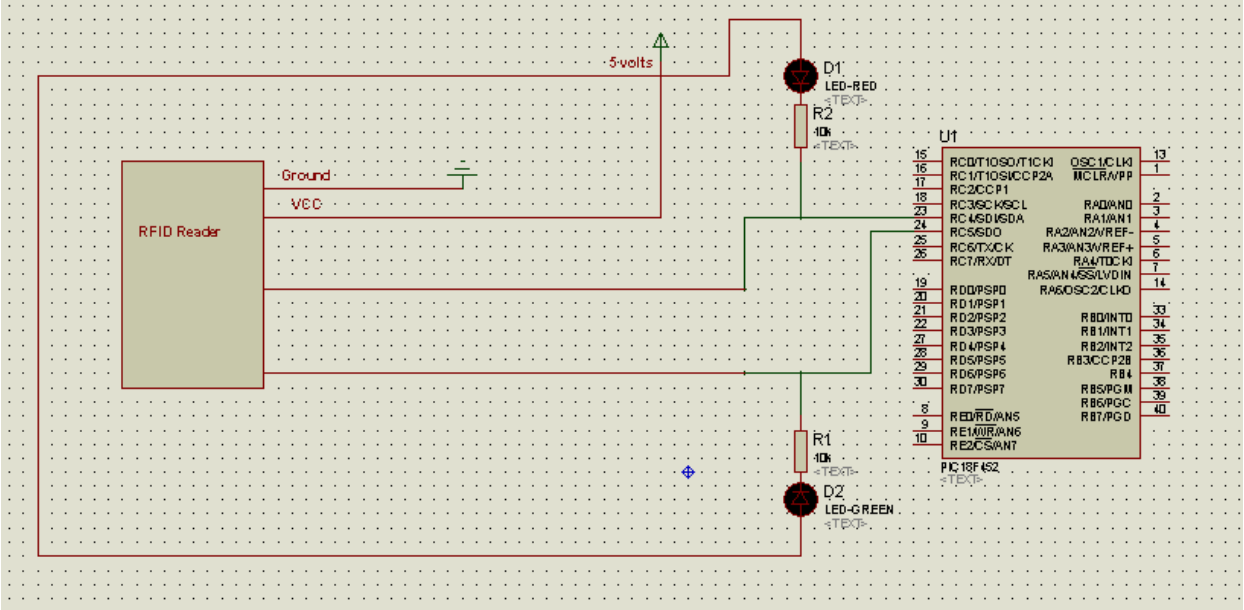


Fig 30: Micro controller and RFID interfacing

3.4.3 Push buttons installation

Now as the micro controller and the RFID have been fully connected and interfaced with each other we had to install the switches for the other three signals. As discussed before due to insufficient resources we only managed to get one RFID receiver and two tags so in order to show the main theme of the project we came up with the idea that instead of using RFID, we can install switches for the other three signals. These switches will generate interrupts just as the RFID reader generates when it receives or detects a RFID tag with in its range.

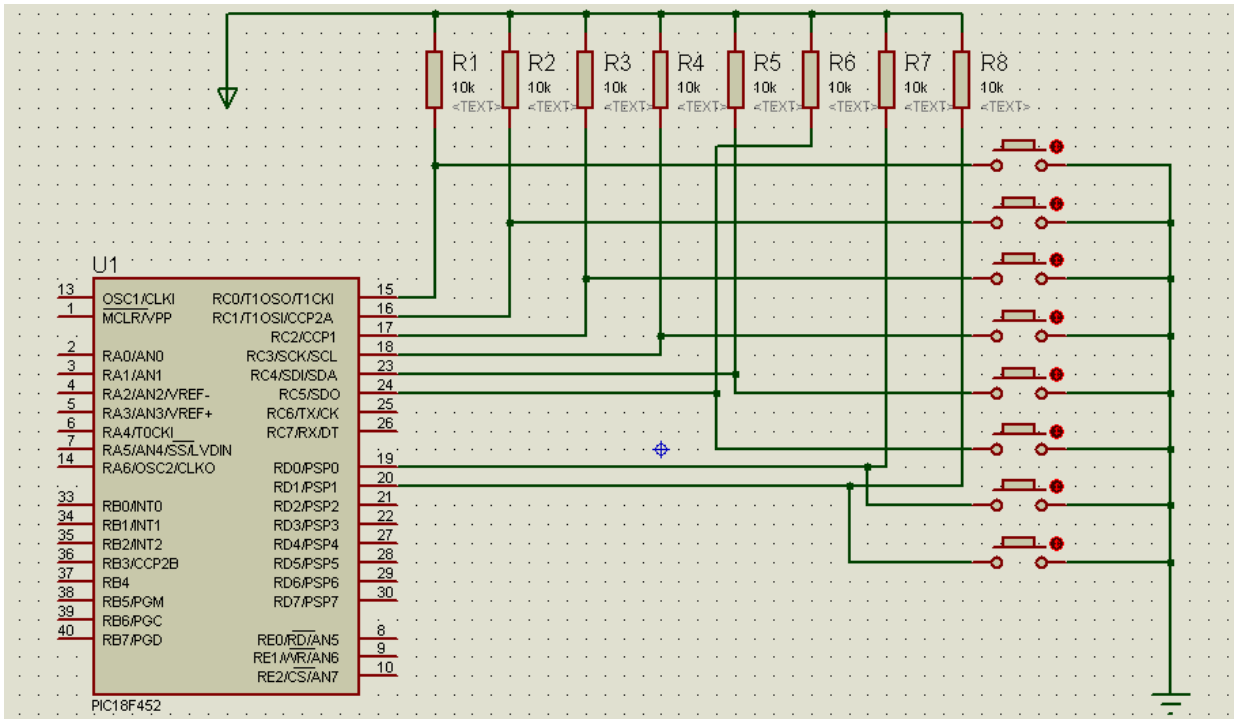


Fig 31: Micro controller circuitry with push buttons

As you can see in the diagram clearly that we installed 8 push button, two buttons for each signal. The logic is still negative. The pins are given 5 volts originally and push buttons are grounded. As soon as a button is pressed interrupt is generated at that specific pin. As you can see in the diagram that we also have connected pin 23 and 24 with the push buttons. This was done just for the test basis and to see it work manually. The buttons are still installed just to check the circuit manually.

Below is a picture taken from the original project of this part of the module.

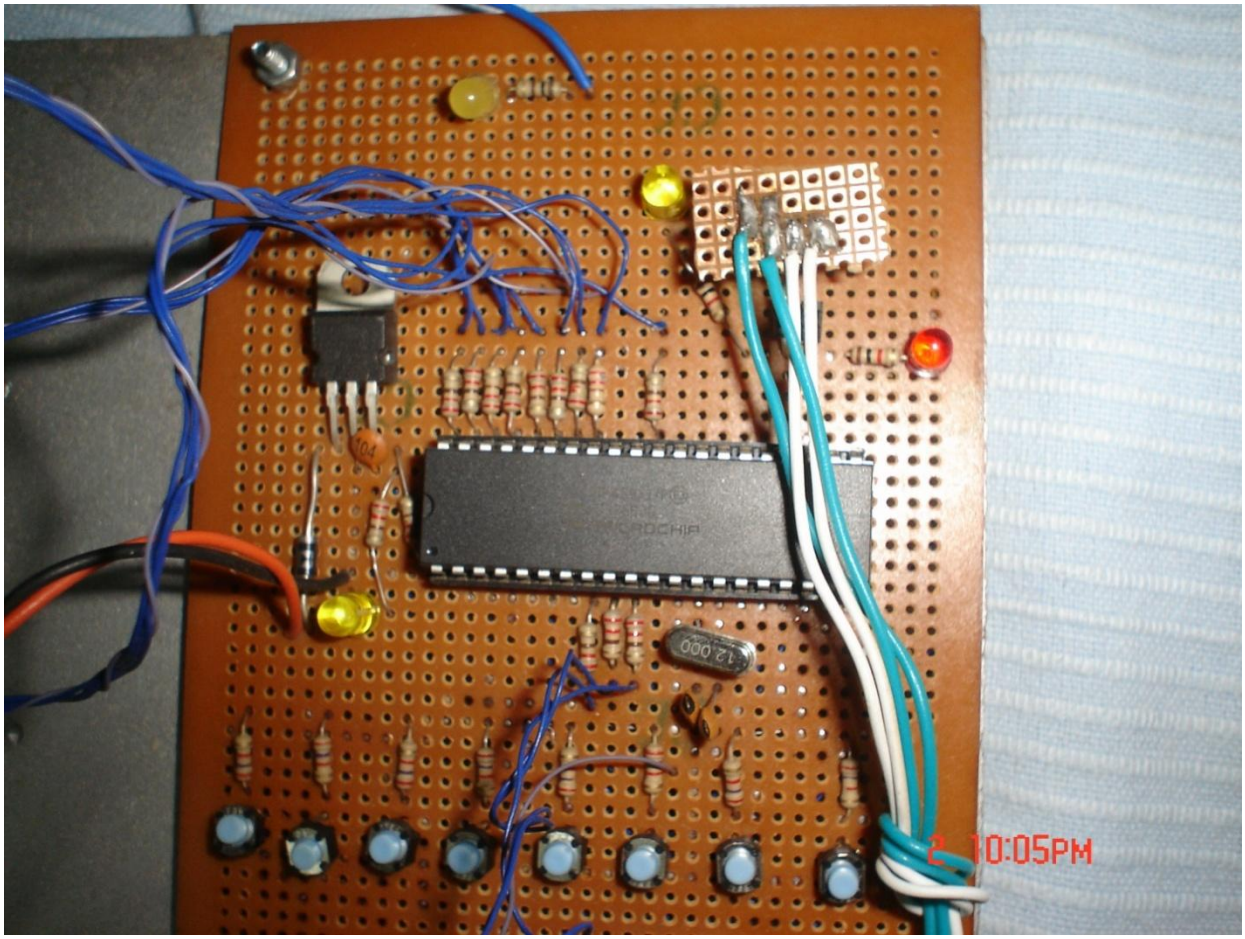


Fig 32: Push buttons connectivity with Microcontroller

3.4.4 Signal LEDs Installation

Now as we are through the interrupt architecture and RFID interfacing it was time that we should build signal architecture to fully demonstrate our theme of project. The components required to build this architecture were just LEDs. We used three different colored LEDs that are Red to represent red signal, Yellow to represent yellow signal and Green to represent green signal.

All of them combined in number were of total of 12 LEDs and each was to be connected to the microcontroller. However for this we didn't use the negative logic, instead we used positive. In the

programming as it will be explained in the later chapter we initialized each Led light with 0 and then changed the lights according to the concept that was used in the code.

All LEDs were given common ground at one end and were also connected in series with 100 ohms resistors in order to limit the current flow.

Below is a diagram showing the circuitry and port connectivity of the signals.

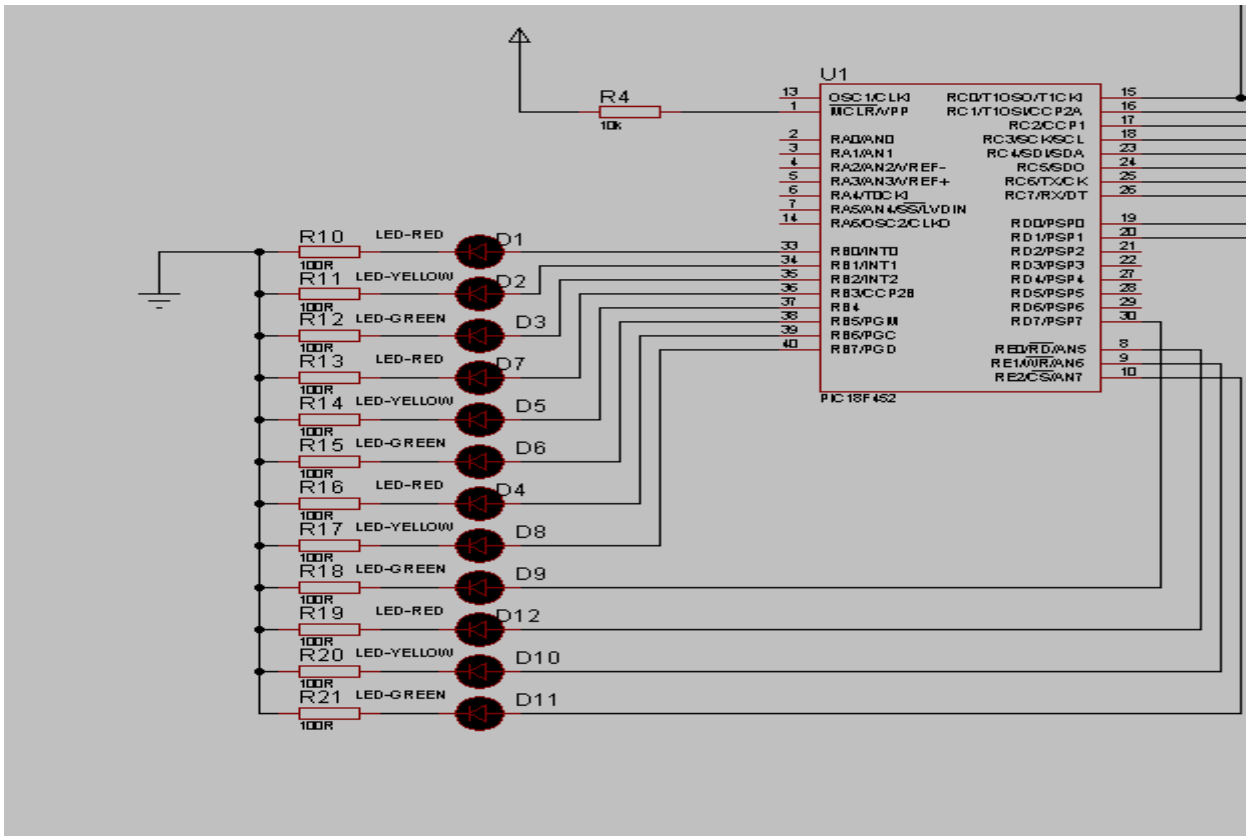


Fig 33:Traffic signal Circuit Diagram

After finalizing the design we implemented it in our project the final look of all the circuitry when integrated together looked like the picture shown below.

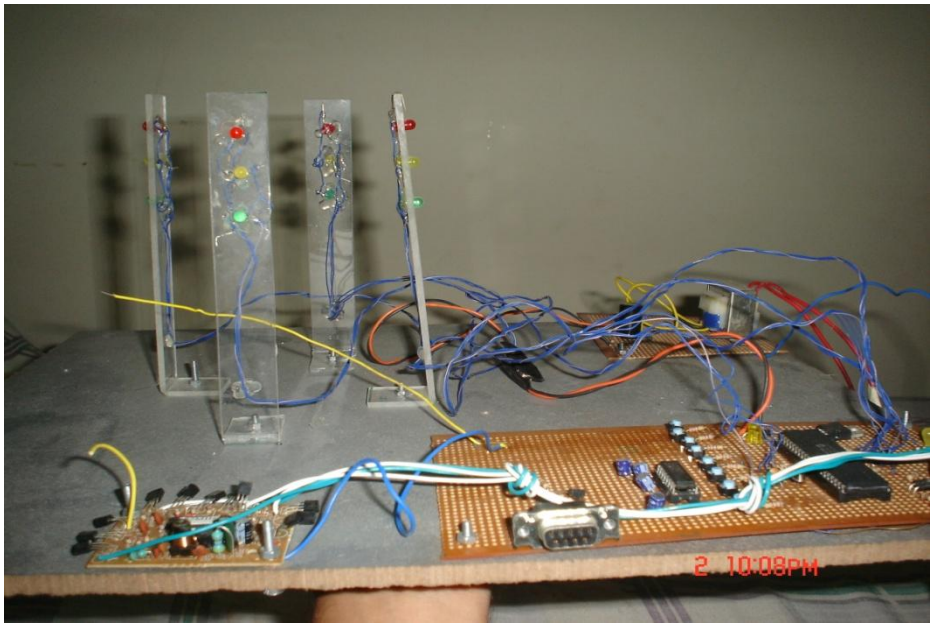


Fig 34: Final Circuit Picture

3.4.5 Complete Circuit Diagram

On the next page is the complete circuit diagram of the project.

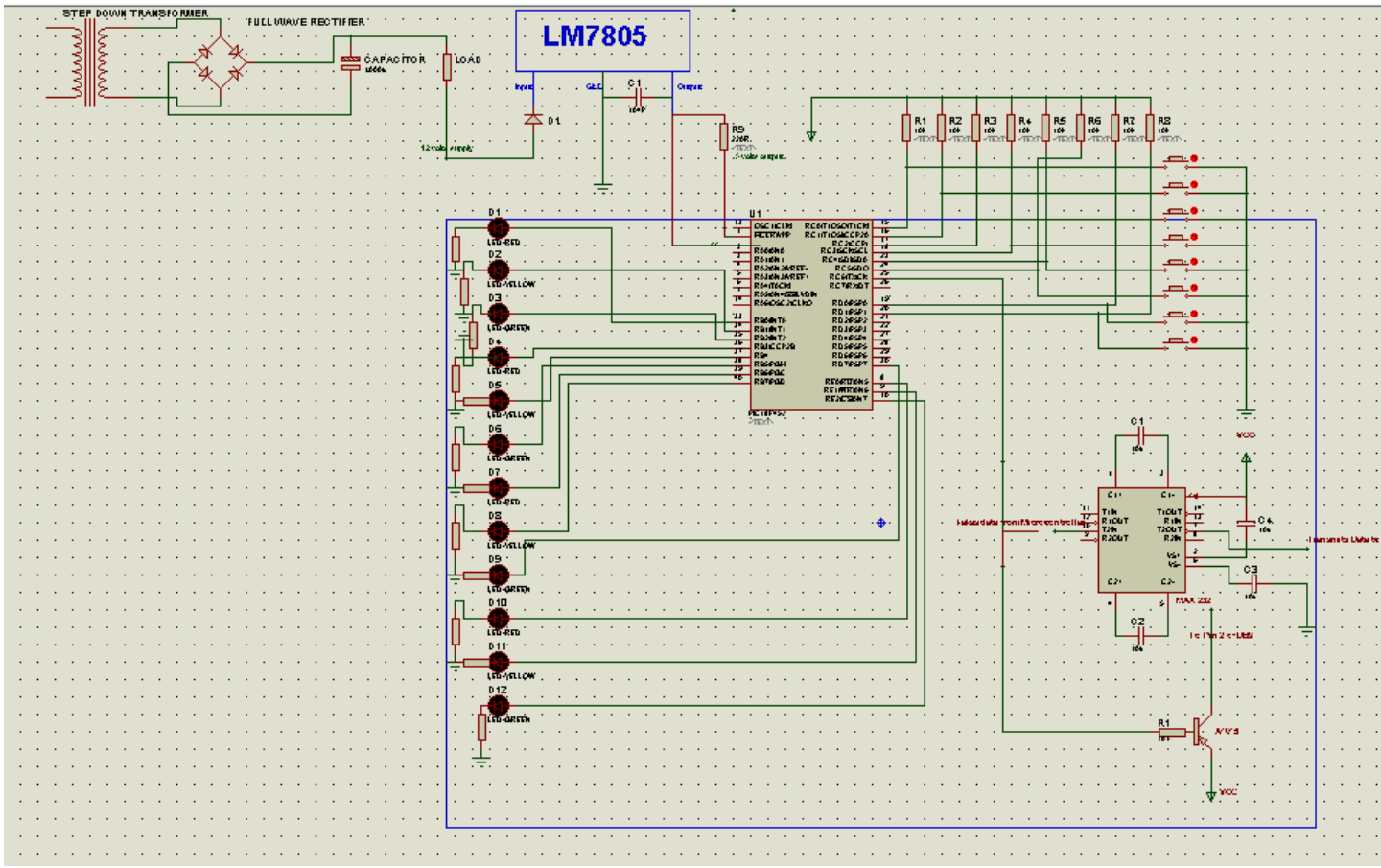


Fig 35: Full circuit Diagram

3.4.6 Active RFID tags

As discussed above the RFID tags used are only two. These tags come with four touch buttons; each transmits information which is 00, 01, 10, 11. We had to make sure that each tag transmits a unique id as our theme of the project is based on it. So we short circuited one button from each tag making it to transmit only one code. We choose to short circuit 01 from tag 1 and 10 from tag 2. Now we had finally what we needed the pictures of the RFID tag is given below.

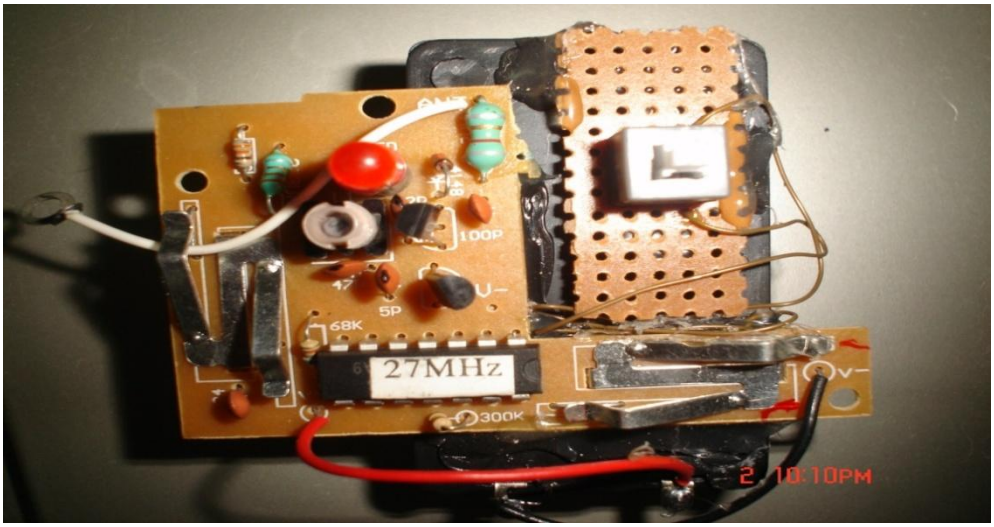


Fig 36: RFID Tag Picture

Chapter 4.Software Methodology

In this chapter, the design functionality will be discussed. The algorithm of controlling the traffic effectively will be presented. The different cases of traffic congestion will be dealt and a reasonable solution to those cases will be presented.

4.1 Controlling Urban Traffic

The reason of using RFID technology is to automate the process of controlling the traffic signals effectively with less or no human effort.

4.1.1 Readers Deployment

Readers are deployed at the crossings and at the road sides. Thus the readers are placed at locations that are critical to the application so as to help it in the execution of the tasks i.e. Congestion alleviation, Security etc. A four-way cross section (see figure 4.1) is included in our software implementation as the major traffic jams are noticed at four-way cross sections.

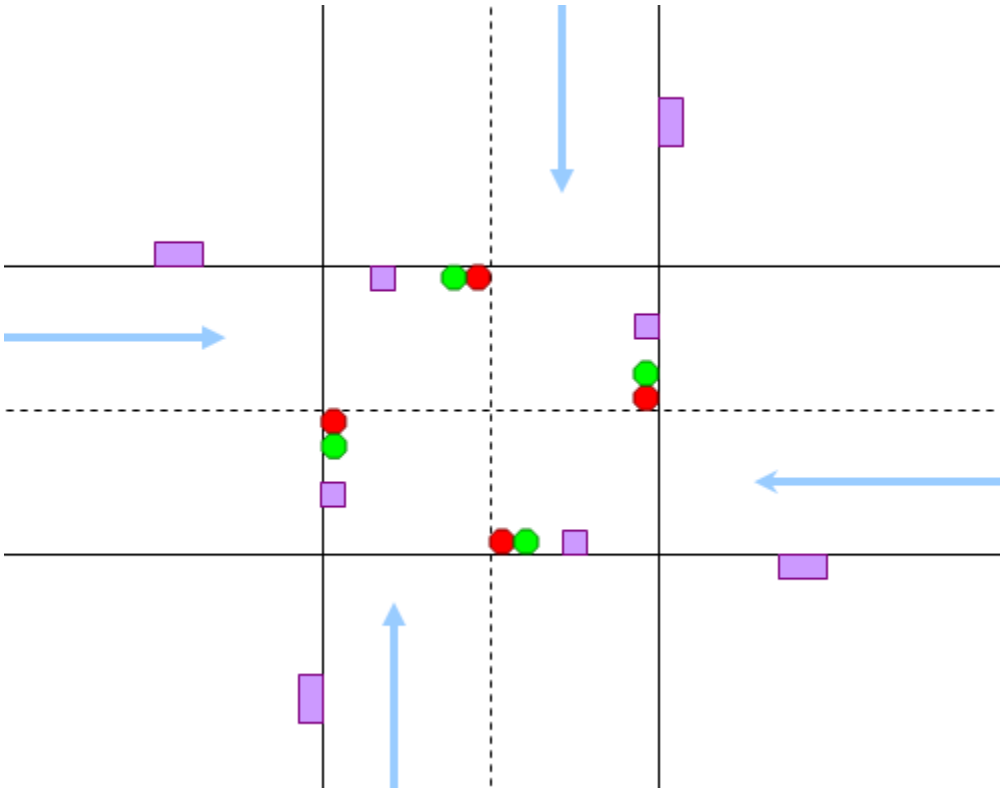


Fig 37: A Four-way Cross Section

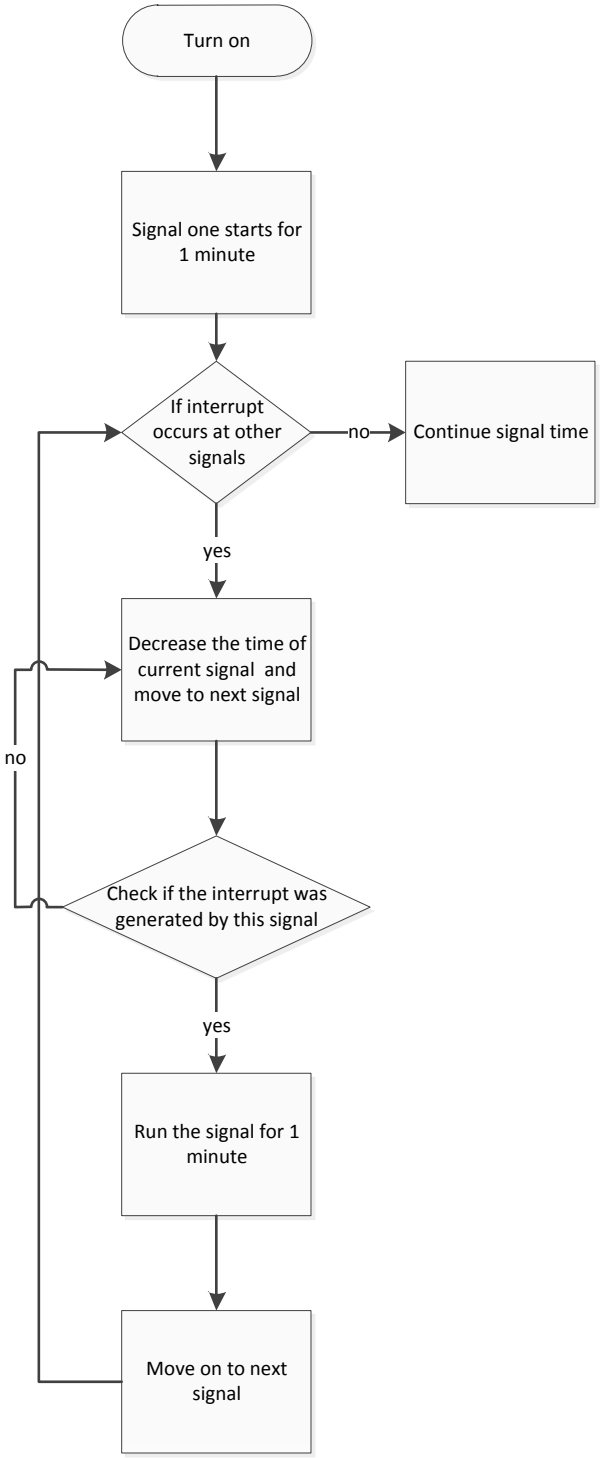
At each way out of the Four-way cross section, an RFID reader will be placed in such a way that it could read only those tags which are present at that signal. Since we are using RFID multi directional readers so we have to place them in such a way that their range does not go beyond the RFID tags present at that specific signal. The effective range of one RFID must not be affected by the active range of the other three RFID readers. One of the effective ways of placing the RFID readers is at the side of the Road. Although, it will try to look for tags at the no-tag zone too but there is no disadvantage in doing so.

After the deployment of all the RFID readers, the total number of cars present at each signal can be calculated by the number of interrupts generated by the tags. The tags placed inside each car will transmit signals back to the reader helping reader in detection. Once the total number of cars found at each signal, the decision of turning ON the appropriate signal light will be done.

There can be different cases of congestion and each will be discussed individually. The first case is when one out of four sides of a cross section has maximum number of cars located. For this case, more time is allocated to that side and less time to the signals at which the traffic load is less. Thus, the system will use the comparison techniques to compare the number of vehicles at each signal and then will intelligently allocate the times to each signal. One minute will be set for the side of maximum load. After this time, the switching will be done while following a clockwise sequence. This will let major portion of the congestion going through while keeping the major side less time waiting. To avoid having deadlock, the proper timing must be assigned to this side. This will let the rest of the signals be entertained too.

The second case is when two out of four sides of a cross section have found nearly equal number of active tags in the range. If only one side is giving most of the time, then more possibly, a deadlock will be occurred. Thus, the time distribution must be in a way so that both sides will get equal amount of time. The sequence is again clockwise in this case. If the two sides are the opposite sides to each other at the cross section, then after giving 1 minute time to first side, the switching will be done by entertaining the signal with the less number of cars coming in the clockwise sequence. The signal will remain open for very short duration of time. After that, the switching to the second heavy traffic side will be done and so on. This can only be done if the number of cars at each side is calculated at regular intervals.

4.1.2 Flow chart traffic control system



4.1.3 Database Design

Database must have to be maintained to keep the record of the car owners. The RFID used are active so it will also keep check on the arriving vehicles automatically. The tags are containing information i.e. Name, Address and License Number etc. This information will be retrieved as soon the car arrives at the signal and reaches in the range of the RFID reader and will instantly generate the interrupt.

4.1.3.1 Security and Tracking System

All the RFIDs placed at each signal will not only manage the signal control but will also perform the security check and the tracking of the vehicles also. Each RFID placed at each signal will keep on gathering the RFID tags and sending it into computer through serial port and then storing to a database. As soon as the car arrives at a signal and comes in the range of RFID reader, the RFID tag transmits its tag information to the RFID reader and RFID reader passes it on to the microcontroller and microcontroller to the serial port and to the hyper terminal. From the hyper terminal the data is saved on to a file. Each RFID tag id along with the time is saved on to the file.

The RFID tag as discussed before has a unique identity number. There is an option for the programmers to set the identity number by themselves. So we can set chassis number or the registration number which ever suits us to every car. By this method it will be easy to identify the vehicle. It is suggested that each car should have a build in RFID tag in it hidden from the human eye from the car manufacturing company.

Now as the car passes through each signal it will keep on leaving its trail behind. As each RFID will be detecting it and will create a map along with the time from where the car has been travelling to and currently where it is. All the data will be stored in a file along with the time.

This mechanism will make the security check for the police officers very easy. They can easily keep an eye on the suspected vehicles and trace them any time they want. They can also use this information as evidence. This mechanism will provide the police officers a luxury to sit in their office comfortably and keep an eye on their suspects.

On the other hand as this mechanism can be used as the tracking system, so if a car is stolen one can easily locate it location and retrieve the car. As the car will leave trail behind it will make easy for the police officers to search the car as the search radius will be very small and car can be retrieved easily.

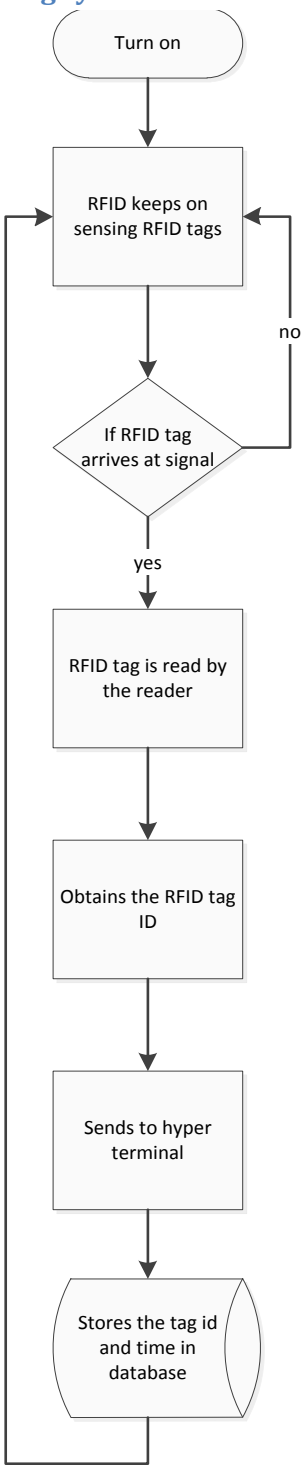
As suggested before the RFID tags should be hidden from the human eye at special places by the manufacturing company so the thieves would not be able to remove it. RFID tags being small in size can

be hidden anywhere in the car and be easily made invisible to the human eye. So as the thieves will travel in the car and pass through any signal they will be leaving behind their trail behind and making it easy for the police officers and the original owner to track them down.

With the introduction of this mechanism there will be a huge reduction in the car theft cases and a more secure environment will be given to the normal people.

If there is a non-registered car with an active RFID tag, the car will be registered as at the center, there will be no record found for that particular RFID. So the registration can be done for future record.

4.1.4. Flow chart security and tracking system



Chapter 5: Project Limitations

In this section we will discuss about the ways and concepts that we have used to complete the functionalities and modules of the project. As the project is just a student level so we have tried to complete the functionalities in our limited resources and budget. The main idea of the project had been taken and modified a little bit because of the limited resources. However the main concept of the project and main idea has been fully implemented in our project.

5.1 Radio frequency identification device

The original concept of our project required four RFIDs to be used at an intersection. In our project due to lack of budget we have only used one RFID device. In order to cater the other three RFID's a number of ideas were floated initially.

Among them one was to use one RFID in a way that first it should be connected to the first signal then when all the data has been successfully transferred then disconnect it and connect it to signal two and transfer all the data. Then do the same thing with the signal three and signal four.

This mechanism was put down as it was not a good and attractive way to show the working of our hardware and secondly for this we had to connect and disconnect the components which would have taken a lot of time. The other problem was that the comparison for the signal control could not been done properly. So the main theme and idea by using this method would have been affected.

After a lot of discussions we came up with an idea of using push buttons. In this method we will use the RFID at one signal and that is signal four in our case. The other three signals will be connected with the push buttons. In order to show cars at any signal other than the one connected with the RFID we just have to push the buttons and interrupts will be generated just like it is generated when RFID reader detects a RFID tag.

By this we can show the comparison done for the signal control. The numbers of interrupts generated are calculated and then time is allocated to each signal comparing the number of the interrupts.

5.2 Radio frequency identification tags

The tags used in our project are only two due to unavailability of tags. However they were enough to show the complete working of the project. The main theme and concept of the project have been achieved completely. The tags have been attached with switches in order to turn them on to transmit signals when we need. The other three signals have been attached to two push buttons each. The tags transmit a fixed code which was initially short circuited. One tag is fixed for vehicle one and the other one is for the vehicle two.

5.3 Microcontroller

There are other microcontrollers also but the reason for the choosing the PIC 18 series was because it comes with a range of 40 pins to the 80 pins. So if the number of the vehicle code exceeds the number of pins it could be changed from 40 pins to 80 pins easily. These PIC microcontrollers are easily compatible with new upgraded microcontrollers. However we have used only a 40 pin microcontroller as 80 pin was not required by our project, in case it goes out in the market 80 pin microcontroller may be used.

Chapter 6: Future Enhancements & Conclusion

6.1. Future Enhancements

1. The same technique of RFID technology can be used to keep check on the speed control and to look that a particular car is following the traffic rules or not. The tags given will be having unique ids with them, which will enable the police to keep check on the traffic.
2. This technique can be used to build an automated speed control system, that can monitor the speed of an individual car, and if some one over speeds, a fine is given to them.
3. This technique can also be used to check the signal violation and other traffic violations just sitting in a room. The violators list could be generated automatically and fines sent to their addresses.
4. One other advancement could be that instead of using the wired medium, the system could be converted into wireless medium. The data is made to transfer wirelessly from the signals to the place where the data base is kept
5. A wide research is being made on injecting the RFID tags inside human body. This could help deal with the security and terrorist issue. Every single person's location could be tracked. Wearing these identification tags could help police and security agencies a lot.

6.2 Conclusion

The project implements an application of controlling Urban traffic through RFID technology. Traditionally, the controlling of signals at cross section is done manually or by setting the fixed time for each signal. The approach used in the report will let the signals be controlled automatically and more efficiently. The important issues contributing to traffic congestions will be dealt e.g. the time given to each signal is decided by detecting the tags in the range. The detection of tags will let how much time must be given to each signal to avoid unnecessary waiting of deadlock.

The security is one of the problems that the underdeveloped nations currently facing. Through the RFID, the security is achieved by maintaining the log file of the all cars passing through the signal. This will help tracking the suspicious or stolen cars easily. This technique was preferred over GPS and other techniques as it is cost efficient and reliable.

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