Chapter I
INTRODUCTION

1.1 Introduction

Public transport is adopted to provide mobility to people who do not have access to private cars or offer an alternative option to individual mobility. Nowadays, cities are adopting public transportation for many Purposes, such as providing mass mobility, managing traffic congestion, controlling air pollution, reducing energy consumption, and creating developmental opportunities.

To collect transport fare efficiently, cashless payments on public bus transportation are additionally adopted and progressively prevalent and offer new opportunities for a public transport company to collect those fares.

The aim of this research was to evaluate passenger's acceptance of cashless payment system that is made available for them. In this research, technology acceptance and Technology readiness index models have been merged because these models are relevant to assess how a certain technology is embraced and accepted by users to evaluate passengers' acceptance of a cashless payment system adopted by a certain transportation company.

This research used the case of Kigali city (Rwanda) which has fully introduced a public bus transportation system and that bus is fully using cashless payment, and from that, we have found out that two variables are not significant (Attitude and Insecurity) and the remaining ones (Awareness, Discomfort, Intention to Use Cashless Payment System, Innovativeness, Optimism, Perceived ease of use and usefulness) are significant.

1.2 Necessity

Money takes a long time to realize it; also, very risks to take it along with and by most estimation. It is much expensive in the society. As for cashless payments, the introduction has shown a great important factor in increasing the economic and also to advance financial inclusion. The move by city public transport company, cashless payment has been adopted to cut off cost, promote road safety, and boost operator's revenues. However, this system has more advantages and disadvantages, especially for passengers' side, as they have criticized. It is true that cashless payment for public bus transport helps to reduce the inconvenience of carrying cash, especially changes (in terms of coins) for the bus fare for the part of commuters. There is no doubt that some government decisions are right, considering the way of implementation and how citizens are aware of the program is another issue.

The citizen's unawareness can cause resistance to use the technology and should be a major failure because they are not aware. The utilization of money to perform Payments brought about: comfort of transportation (rather than bargain things); high granularity (various groups make it suitable both for vast and little Payments); trust (permits prompt, last, repayment of the exchanges, and is generally hard to fake); unmistakable valuation standard (each grown-up in a general public knows about the average obtaining influence of the usual money units). Those that can be detached include granularity (which enables the utilization of money to effortlessly store any amount of cash); smallness (high esteemed coins or enormous section banknotes permit smaller stockpiling of much cash); strength (money is stable, durable – mainly coin-based money); low putting away costs; accessibility (money can be put away near the proprietor, so it is promptly accessible when required).

Other than evident focal points, for example, those recorded above, money likewise tackled progressively unobtrusive issues straddling capacity of significant worth and exchange settling. A model is the comfort of money to halfway complex numerous gathering exchanges. In the direct bargain, if a rancher represented considerable authority in creating apples needed to purchase a thing of attire, he would need to discover somebody selling that thing who might likewise acknowledge apples in return.

Utilizing money to transitional, he can offer his apples to anybody keen on them, get money consequently, and after that, he can Purchase the garments from any other individual in different money settled exchange. The main goal of this research study is to find a better research framework for measuring the relationship of contextual dimensions to multi-stage acceptance of cashless Payment System for public bus transportation by literature and quantitative research.

By merging technology acceptance and technology readiness index models and by revealing other possible factors by conducting interview to amend them on the existing Technology Readiness Index, will come up with the new model that will be used to measure the acceptance of cashless payment system for public bus transportation. In this research we will work under the objectives below: Develop and validate a conceptual model for passengers' acceptance on the public bus transport system based on literature and quantitative research to examine passengers' understanding and acceptance of the cashless payment for public bus transport in Kigali city.

To determine factors that would have been considered before adopting a new system to ensure users (Passengers) participation. To research passengers' preferences in the newly adopted system compared with the existing one.

Chapter II
LITERATURE SURVEY

2.1 Literature survey

This segment includes the audit of the past works identified with the subject of research by studying books, adroit articles, and some different sources relevant to a particular issue, an area of research and by doing, it gives a delineation, rundown, and fundamental evaluation of these works in association with these investigation issues being analyzed. Composing reviews are expected to give an outline of sources that we have examined while investigating a subject and to display to the scrutinizes of how research fits inside a huge field of study.

Referring to his article, "The cashless society", Worthington [4] portrays the cashless society, where cumbersome and costly to manage paper-based money and coins which are superseded by satisfactory cashless Payments began by different kinds of plastic smart cards is an alluring possibility for the twenty-first century. Humphrey [5] also led research entitled "Substitution of money via cards in US Purchase Payments" Creators use in recent years' time-arrangement information.

The creator feels that even though money is not anticipated to go to zero whenever. Considering the elaboration, the upsides of a cashless society in Indonesia could exceed the impediments. Thus, understanding the advancement of a cashless society will make a piece of knowledge to discover attention on further improvement. This examination from there on focuses out that the status pointer of a cashless transaction in Indonesia does not demonstrate quick progress.

In this way, an alternate way approach to quicken the adventure, for example, government initiative and inventive arrangement, is required [6]. We have chosen the variables according to literature review we did, and in their researches [7],[8],[9],[10],[11],[12],[13][14],[15],[16] have applied the Technology Readiness Index to assess the way people embrace new technology that is raised.

We also applied Davis 'technology acceptance mode to assess the perceived serviceability and usefulness to newly adopted technology for population [17],[7][18]. After that we did interview to strengthen our model and to bring new idea to the research carried, from that we confirmed a variable that was revealed by our interviewee. B. Theoretical framework as discussed previously, technology acceptance and readiness index models have been used to evaluate that passenger's acceptance and the way people embrace that technology.

TRI because it refers to people's tendency for accepting new technology and for accomplishing their goals in home life and their workplace. We have also chosen TAM because it shows how the technology users react to accept and use it. TAM shows a real perception on how somebody will perceive that technology is useful for what he wants to do.

2.2 Objectives

- ***Convenience***

It is inconvenient for customers to carry around bulky cash. In addition, keeping huge amounts of paper cash can be inconvenient for business owners. With a mobile device or smart card, cashless transactions make it easier to make large and small transactions without hard notes.

They save time and make transactions seamless, hance of these it will be main moto of this system.

- ***Security***

People are often afraid of carrying large sums of money home or making purchases because they fear armed robbers will follow. The cashless payment system allows one to have a large amount without anyone noticing. Mobile phones are always safer if you carry them around, and the digital payment industry has made them more secure by encrypting them at several levels to protect your data.

- ***Speed***

In cashless transport payment of ticket is done within seconds of times, so there is no worry about time delay or waiting in ticket queue. This makes life faster and easier.

In traditional system there are many more issues regarding time factor, thus it will make the system inconvenient for passenger's and quit a slower.

Chapter III

SYSTEM MODELLING

3.1 System development:

For developing any strong system lots of things are important. It includes components and their interconnectivity with each other. The block diagram of cashless transformation system is as below.

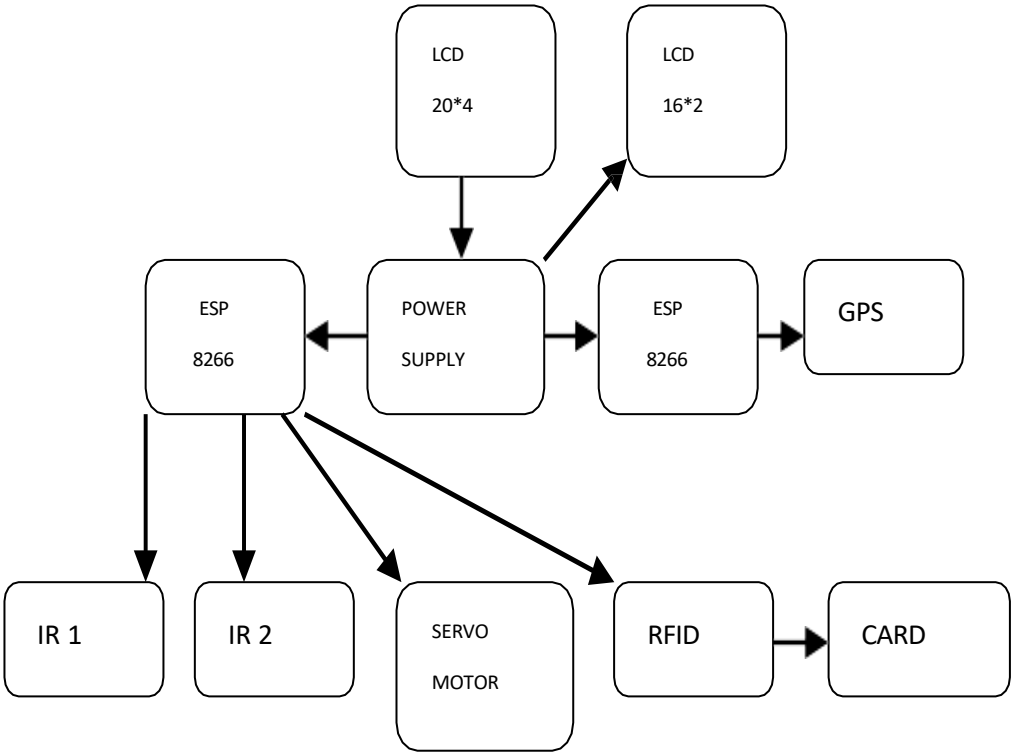


Fig.3.1 Block diagram of system

3.1.1 Main Components of the system

Developing any strong system requires lots of things, which play very important role in system in individual and with coordination of other components. It includes components and their interconnectivity with each other.

As shown in the block diagram of cashless transformation system (Fig 3.1), we can see, power supply is given to each and every component for further efficient work.

Each component has its own working principles and role in the system for desired task.

We will see, each and every component working principle one by one in detail.

Following is the list of most important components of the system.

- NODE MCU
- IR SENSORS
- RFID CARD READER
- 16*2 LCD DISPLAY
- SERVO MOTOR

3.2 Model Development:

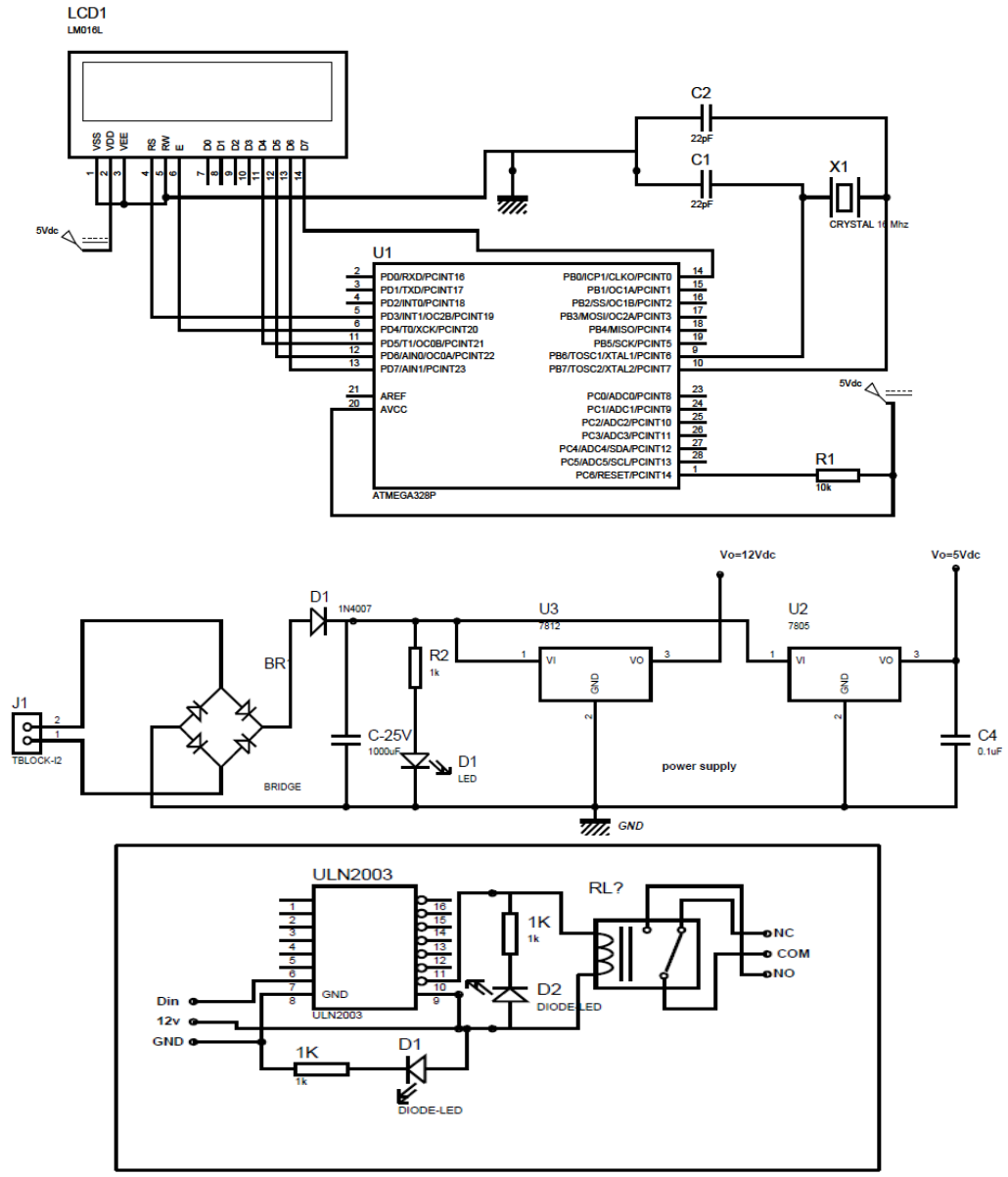


Fig.3.2 Circuit Diagram

3.2.1 Introduction to Microcontroller

Microcontroller is a true computer on a chip. Microprocessors are intended to be general-purpose digital computers whereas micro controllers are intended to be special purpose digital controllers. Generally, microprocessors contain a CPU, memory- addressing units and interrupt handling circuits. Micro controllers have these features as well as timers, parallel and serial I/O and internal RAM and ROM.

Like the microprocessor, a microcontroller is a general-purpose device, but one that is meant to read data, and controls its environmental base on those calculations. The contrast between a microcontroller and a microprocessor is based exemplified by the fact that microprocessors have many operational codes for moving data from external memory to CPU; microcontrollers may have one or two. Microprocessors may have one or two types of bit-handling instructions; micro controllers will have many. The microprocessor is concerned with the rapid movement of code and data from external addresses to the chip, the microcontroller is concerned with rapid movements of bits within the chip. The microcontroller can function as a computer with the addition of no external digital parts; the microprocessor must have many additional parts to be operational. Generally, 8bit microcontrollers are intended for use in large volumes as true 1-chipcomputers. Typical applications consist of appliances and toys.

Eight-bit micro controllers represent a transition zone between the dedicated, high volume, 4-bit micro controllers and the high performance, 16 and 32-bit units. Eight-bit micro controllers are very useful word size for small computing tasks.

16-bit controllers have also been designed to take the advantages of high-level programming languages in the expectation that very little assembly language programming will be done when employing these controllers in sophisticated applications. 32-bit controllers are also used in high-speed control and signal processing applications.

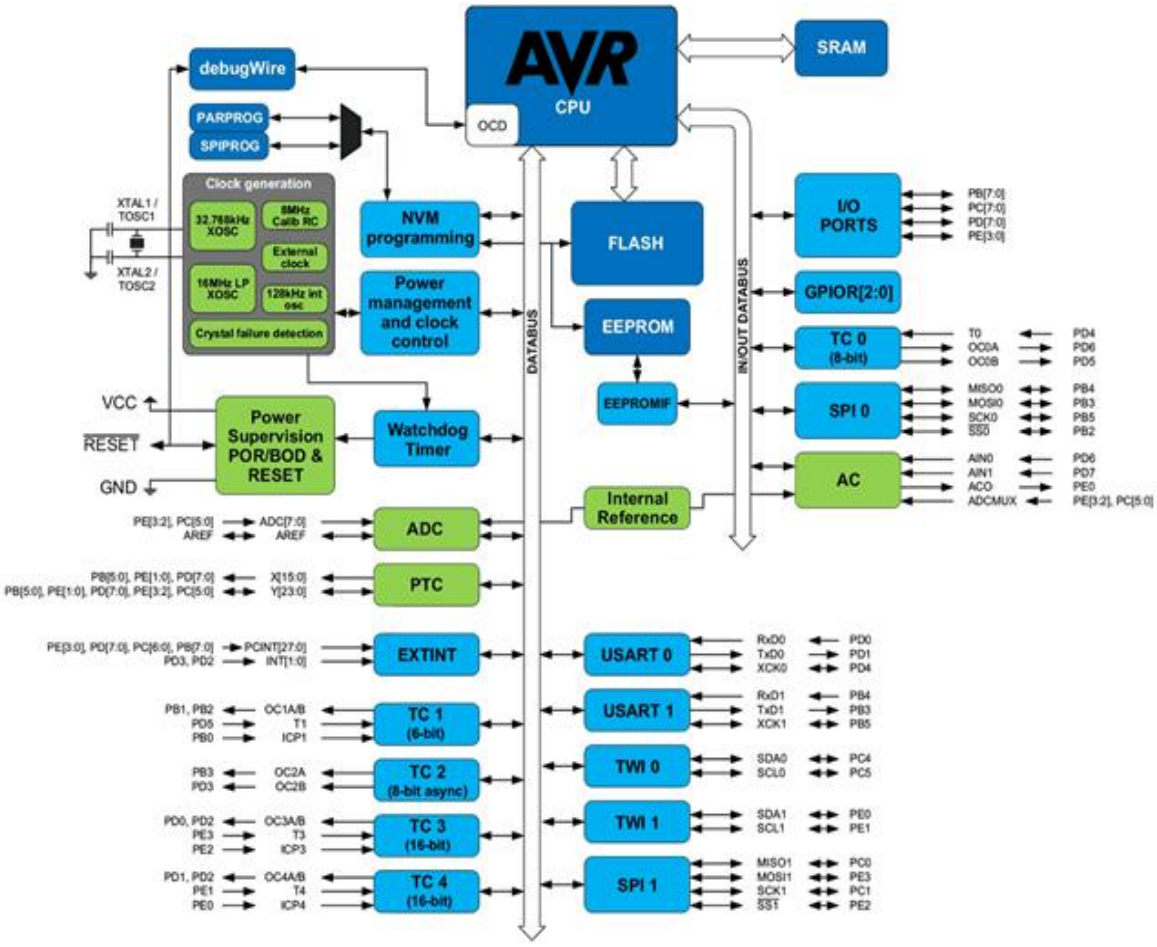


Fig.3.2.1 AVR Microcontroller

On-Chip Memory

This refers to any memories (Code, RAM or other) that physically exist on the Microcontroller itself. On- Chip memory can be of several types. The 328P has a bank of 512 bytes if Internal RAM. This internal RAM available and it is also the most flexible in terms or reading, writing, and modifying its contents. Internal RAM is volatile, so when the 328 is rest this memory is cleared.

The first 8 bytes (00h-07h) are "register bank 0". By manipulating memory is certain SFRs, a program may choose to use register banks 1, 2 or 3. These alternative register banks are located in internal RAM in addresses 08h through 1Fh. Bit memory also lives and is part of internal RAM. The 80 bytes remaining of Internal RAM, from addresses 30h through 7Fh, may be used by user variables that need to be accessed frequently or at a high speed.This area is also utilized by the microcontroller as a storage area for the operating stack. This fact severely limits the 328's stack since, as illustrated in the memory map, the area reserved for the stack is only 80 bytes and usually it is less since these 80 bytes has to be shared between stack and user.

External Code Memory

This is code (or program) memory that resides off-chip. This is often in the form of an external (EPROM). Code Memory is the memory that holds the actual 328 program that is to be run. This memory is limited to 64K and comes in many shapes and sizes. Code Memory may be found on-chip, either burned in to the microcontroller as ROM or EPROM.

Code may also be stored completely off-chip in an external ROM or, more commonly, an external EPROM. Flash RAM is also another popular method of storing program. Various combinations of these memory types may also be used-that is to say, it is possible to have 4K of code memory on-chip and 64K of code memory off-chip in an EPROM.

When the program is stored in-chip the 64K maximum is often reduced to 4K, 8K or 16K. This varies depending on the version of the chip that is being used. Each version offers how much ROM/EPROM spacer the chip has. However, code memory is most commonly implemented as off-chip EPROM. This is especially true in low-cost development systems.

External Ram

This RAM memory resides off-chip. This is often in the form of standard static RAM or Flash RAM. As an obvious of Internal RAM, the 8051 also supports what is called External RAM. As the name suggests, External RAM is any random-access memory which is found off chip. Since the memory is off-chip it is not as flexible in terms of accessing, and is also slower.

For example, to increment an Internal RAM location by 1 requires only 1 instruction and 1 instruction cycle. To increment a 1-byte value stored in External RAM requires 4 instructions und 7 instruction cycles. In this case, external memory is 7 times slower. The external RAM loses in speed and flexibility it gains in quantity. While internal RAM is limited to 512 bytes (256 bytes with a 328P); the 328P supports External RAM up to 64K.

Features

- Compatible with MCS-51 Products
- 8K Bytes of In-System Reprogrammable Flash Memory
- Endurance: 1,000 Write/Erase Cycles
- Fully Static Operation: 0 Hz to 24 MHz
- Three level Program Memory Lock
- 256 x 8-Bit Internal RAM
- 32 Programmable I/O Lines
- Three 16-bit Timer/ Counters
- Eight Interrupt Sources
- Programmable Serial Channel
- Low Power Idle and Power Down Modes

3.2.2 Description of ATMEGA328 Microcomputer

The ATMEGA328 is a low-power, high-performance CMOS 8bit microcomputer with 8K bytes of Flash programmable and erasable read only memory (PEROM). The device is manufactured using Atmel's high-density nonvolatile memory technology and is compatible with the industry-standard MCS-51 instruction set and pin out.

The on-chip Flash allows the program memory to be reprogrammed in-system or by a conventional nonvolatile memory programmer. By combining a versatile 8-bit CPU with Flash on a monolithic chip, the Atmel ATMEGA328 is a powerful microcomputer which provides a highly flexible and cost-effective solution to many embedded control applications.

3.2.2.1 Pin Diagram and Its Description

The ATmegu48P/SSP/16SP/328P is a low-power CMOS 8-bit microcontroller based on the AVR enhanced RISC architecture. By executing powerful instructions in a single clock cycle, the ATmega48P/88P/168P/328P achieves throughputs approaching 1 MIPS per MHz allowing the system designed to optimize power consumption versus processing speed.

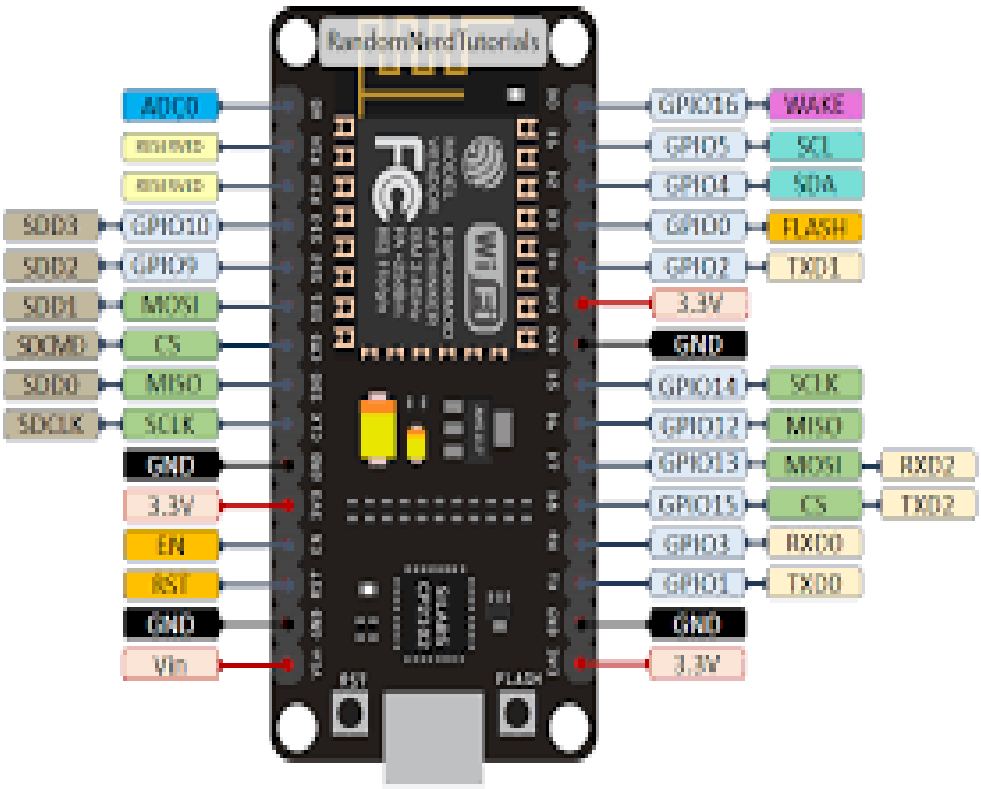


Fig.3.2.2.1 Pin Diagram of ATMEGA328

VCC: Digital supply voltage.

GND: Ground.

Port B (PB7:0) XTAL1/XTAL2/TOSC1/TOSC2

Port B is an 8-bit bi-directional I/O port with internal pull-up resistor (selected for each bit). The port B output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port B pins that are externally pulled low will source current if the pull-up resistors arc activated. The port B pins are tri-stated when a reset condition becomes active, even if the clock is not running. Depending on the clock selection fuse setting, PB6 can be used as input to the inverting Oscillator amplifier and input to the internal clock operating circuit depending on the clock selection fuse setting, PB7 can be used as output from the inverting oscillator amplifier. If the internal calibration RC oscillator is used as chip clock source, PB7.6 is used as TOSC2.1 input for the Asynchronous Timers/Counters2 if the AS2 bit in ASSR is set.

PORT C (PC5:0)

Port C a 7-bit bi-directional I/O port with internal pull-up resistor (selected for each bit). The PC5.0 output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, port C pins that are externally pulled low will source current if the pull-up resistor is activated. The port C pins are tri-stated when a reset condition becomes active, even if the clock is not running.

PC6/RESET

If the RSTDISBL fuse is programmed, PC6 is used as an I/O pin. Note that the electrical characteristics of PC6 differ from those of other pins of port C. If the RSTDISBL fuse is

unprogrammed, PC6 is used as a reset input. A low level on this pin for longer than the minimum pulse length will generate a RESET; even if the clock is not running... shorter pulses are not guaranteed to generate a reset.

Port D (PD7:0)

Port D is an 8-bit bi-directional I/O port with internal pull-up resistor (selected for each bit). The port D output buffers have symmetrical drive characteristics with both high sink source capabilities. As inputs, port D pins that are externally pulled low will source current if the pull-up resistor is activated. The port D pins are tri-stated when a reset condition becomes active, even if the clock is not running.

AVCC

AVCC is the supply voltage pin for the A/D convertor, PC3:0, and ADC7:6. It should be externally connected to VCC, even if the ADC is not used. If the ADC is used, it should be connected to VCC through a low pass filter. Note that PC6.4 use digital supply voltage, VCC.

AREF

AREF is the analog reference pin for the A/D Converter.

ADC7:6 (TQFP and QFN/MLF Package Only)

In the TQFP and QFN/MLF package, ADC7:6 serve as analog inputs to the A/D Converter. These pins are powered from the analog supply and serve as 10-bit ADC channels.

Resistor

A resistor is a passive two-terminal electrical component that implements electrical resistance as a circuit element. In electronic circuits, resistors are used to reduce current flow, adjust signal levels, to divide voltages, bias active elements, and terminate transmission lines, among other uses. High-power resistors that can dissipate many watts of electrical power as heat may be used as part of motor controls, in power distribution systems, or as test loads for generators. 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.

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. The nominal value of the resistance falls within the manufacturing tolerance, indicated on the component. The behaviour of an ideal resistor is dictated by the relationship specified by Ohm's law: V=I\ R Ohm's law states that the voltage (V) across a resistor is proportional to the current (I), where the constant of proportionality is the resistance ®.

Crystal Oscillator

A crystal oscillator is an electronic oscillator circuit that uses the mechanical resonance of a vibrating crystal of piezoelectric material to create an electrical signal with a precise frequency.[1][2][3] This frequency is often used to keep track of time, as in quartz wristwatches, to provide a stable clock signal for digital integrated circuits, and to stabilize frequencies for radio transmitters and receivers.

The most common type of piezoelectric resonator used is the quartz crystal, so oscillator circuits incorporating them became known as crystal oscillators, but other piezoelectric materials including polycrystalline ceramics are used in similar circuits.

A crystal oscillator, particularly one using a quartz crystal, works by distorting the crystal with an electric field, when voltage is applied to an electrode near or on the crystal. This property is known as electrostriction or inverse piezoelectricity. When the field is removed, the quartz – which oscillates in a precise frequency – generates an electric field as it returns to its previous shape, and this can generate a voltage. The result is that a quartz crystal behaves like an RLC circuit, but with a much higher Q.

3.2.3 Node MCU

Node MCU is an open-source Lua based firmware and development board specially targeted for IoT based Applications. It includes firmware that runs on the ESP8266 Wi-Fi SoC from Espressif Systems, and hardware which is based on the ESP-12 module.

Node MCU ESP8266 Specifications & Features

- Microcontroller: Tensilica 32-bit RISC CPU Xtensa LX106
- Operating Voltage: 3.3V
- Input Voltage: 7-12V
- Digital I/O Pins (DIO): 16
- Analog Input Pins (ADC): 1
- UARTs: 1
- SPIs: 1

- I2Cs: 1
- Flash Memory: 4 MB
- SRAM: 64 KB
- Clock Speed: 80 MHz
- USB-TTL based on CP2102 is included onboard, Enabling Plug n Play
- PCB Antenna
- Small Sized module to fit smartly inside your IoT projects

Programming Node MCU ESP8266 with Arduino IDE

The Node MCU Development Board can be easily programmed with Arduino IDE since it is easy to use Programming Node MCU with the Arduino IDE will hardly take 5-10 minutes. All you need is the Arduino IDE, a USB cable and the Node MCU board itself. You can check this Getting Started Tutorial for Node MCU to prepare your Arduino IDE for Node MCU.

Uploading your first program

Once Arduino IDE is installed on the computer, connect the board with the computer using the USB cable. Now open the Arduino IDE and choose the correct board by selecting Tools>Boards>NodeMCU1.0 (ESP-12E Module), and choose the correct Port by selecting Tools>Port. To get it started with the Node MCU board and blink the built-in LED, load the example code by selecting Files>Examples>Basics>Blink. Once the example code is loaded into your IDE, click on the ‘upload’ button given on the top bar. Once the upload is finished, you should see the built-in LED of the board blinking.

3.2.3.1 ESP8266 Wi-Fi module

ESP8266 is a complete and self-contained Wi-Fi network solution that can carry software applications, or through another application processor uninstall all Wi-Fi networking capabilities. ESP8266 when the device is mounted and as the only application of the application processor, the flash memory can be started directly from an external Move. Built-in cache memory will help improve system performance and reduce memory requirements.

Another situation is when wireless Internet access assumes the task of Wi-Fi adapter, you can add it to any microcontroller-based design, and the connection is simple, just by SPI / SDIO interface or central processor AHB bridge interface.

Processing and storage capacity on ESP8266 Powerful piece, it can be integrated via GPIO ports sensors and other applications specific equipment to achieve the lowest early in the development and operation of at least occupy system resources.

The ESP8266 highly integrated chip, including antenna switch balloon, power management converter, so with minimal external circuitry, and includes front-end module, including the entire solution designed to minimize the space occupied by PCB.

The system is equipped with ESP8266 manifested leading features are: energy saving VoIP quickly switch between the sleep / wake patterns, with low-power operation adaptive radio bias, front-end signal processing functions, troubleshooting and radio systems coexist characteristics eliminate cellular / Bluetooth / DDR / LVDS / LCD interference.

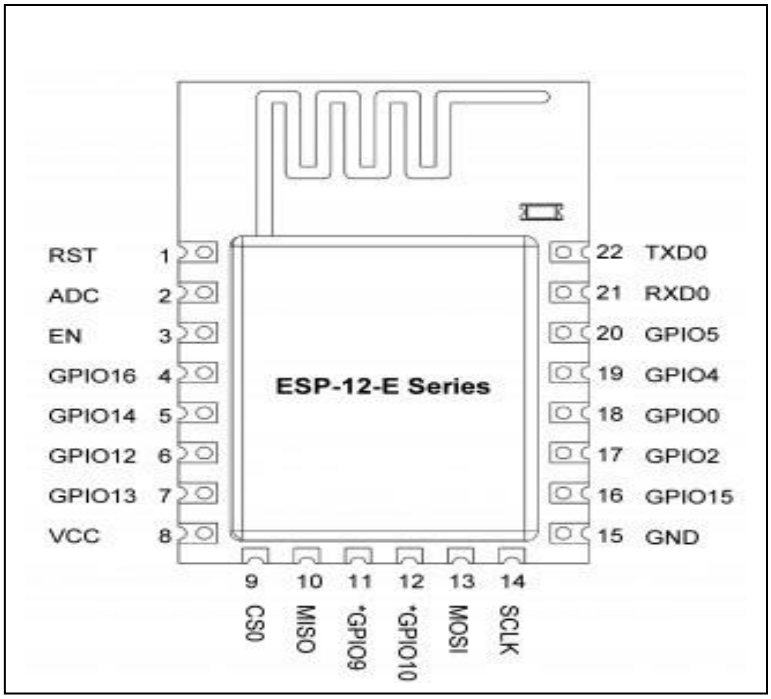


Fig 3.2.3.1a Pin Diagram of ESP8266

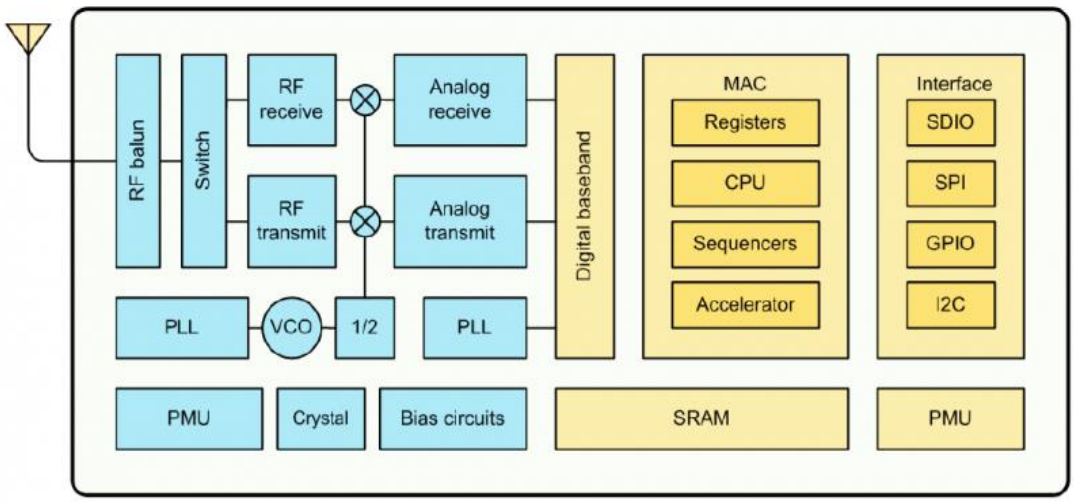


Fig 3.2.3.1b Block Diagram of ESP8266

3.2.3.2 Characteristics of ESP8266

a) 802.11 b / g / n

b) Wi-Fi Direct (P2P), soft-AP

c) Built-in TCP / IP protocol stack

d) Built-in TR switch, balun, LNA, power amplifier and matching network

e) Built-in PLL, voltage regulator and power management components

f) 802.11b mode + 19.5dBm output power

g) Built-in temperature sensor

h) Support antenna diversity

i) Off leakage current is less than 10uA

j) Built-in low-power 32-bit CPU: can double as an application processor

k) SDIO 2.0, SPI, UART

l) STBC, 1x1 MIMO, 2x1 MIMO

m) A-MPDU, A-MSDU aggregation and the 0.4 within wake

n) 2ms connect and transfer data packets

o) Standby power consumption of less than 1.0mW (DTIM3)

3.2.3.3 ESP8266 Applications

ESP8266 is used in Smart Power Plug for wireless charging. It is also used in home automation for security purpose. In industry to control and monitor the process IoT based devices are used so for better internet or Wi-Fi connection ESP8266 is used.

For network camera such as camera used for traffic monitor which information should be transmitted to the control room for better management and security of city. Wireless location-aware devices and positioning system signals.

The ESP8266 is a low-cost Wi-Fi chip with full TCP/IP stack and microcontroller capability produced by Shanghai-based Chinese manufacturer, Express if. These were the first series of modules made by third-party manufacturer, AI-Thinker with the ESP8266 and remain the most widely available. This small module allows microcontrollers to connect to a Wi-Fi network and make simple TCP/IP connections using Hayes-style commands.

3.2.3.4 Explore ESP8266 Wi-Fi Module

The ESP8266 ESP12E Wi-Fi Module is more user friendly with the Explore ESP8266.Wi-Fi Module. It fits on a breadboard with all pins taken out. The module goes into programming mode with a single reset switch. Features of ESP8266 are as follows

a) Fits on a breadboard, Programs can easily dump using USB to TTL converter.

b) Single button 'Reset' switch for programming. Uses MOSFET's to put the module in programming mode.

c) All pins of ESP12E taken out.

d) Separate serial pins breakout compatible with FTDI cable layout.

f) Works with Arduino IDE for ESP8266.

Board ID	Pins	Pitch	LEDs	Antenna	Dimensions mm
ESP-01	8	.1“	Yes	Etched-on PCB	14.3 x 24.8
ESP-02	8	.1”	No	None	14.2 x 14.2
ESP-03	14	2mm	No	Ceramic	17.3 x 12.1
ESP-04	14	2mm	No	None	14.7 x 12.1
ESP-05	5	.1“	No	None	14.2 x 14.2
ESP-06	12+GND	Misc	No	None	?
ESP-07	16	2mm	Yes	Ceramic	20.0 x 16.0
ESP-08	14	2mm	No	None	17.0 x 16.0
ESP-09	12+GND	Misc	No	None	10.0 x 10.0
ESP-10	5	2mmm?	No	None	14.2 x 10.0
ESP-11	8	1.27mm	No	Ceramic	17.3 x 12.1
ESP-12	16	2mm	Yes	Etched-on PCB	24.0 x 16.0
ESP-12-E	22	2mm	Yes	Etched-on PCB	24.0 x 16.0
ESP-13	18	1.5mm	-	Etched-on PCB	-
ESP-14	22	2mm	1	Etched-on PCB	24.3 x 16.2
WROOM-02	18	1.5mm	No	Etched on PCB	20.0 x 18.0
WT8266-S1	18	1.5mm	1	Etched on PCB	15.0 x 18.6

Table.3.2.3.4 ESP Modules

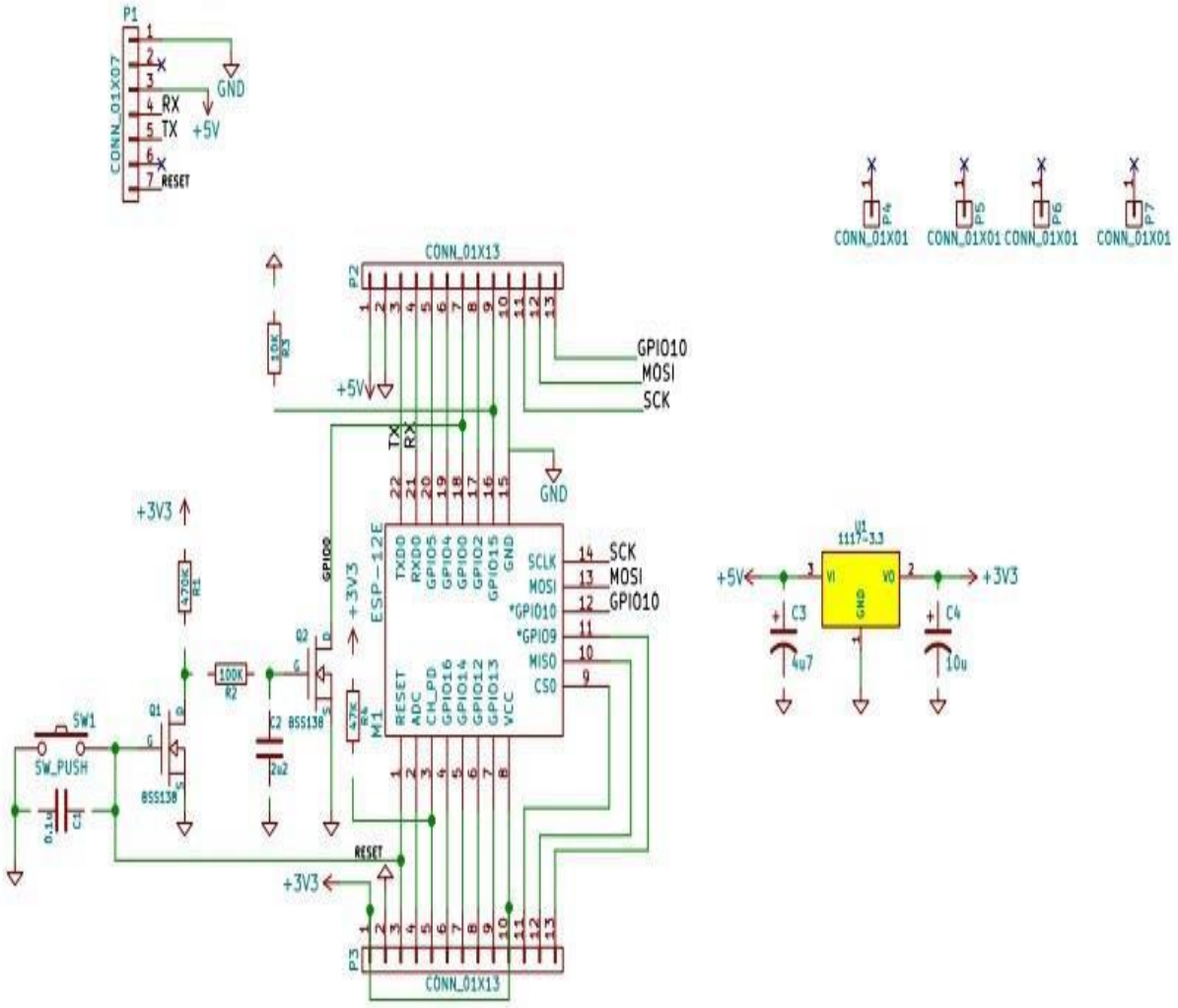


Fig.3.2.3.4 Schematic Diagram of Explore ESP8266 Wi-Fi Module

3.2.3.5 AT Commands

ESP8266, in its default configuration, boots up into the serial modem mode. In this mode you can communicate with it using a set of AT commands. AT commands are based on the Hayes Command Set.

Asic	Wi-Fi layer	TCP/IP Layer
AT	AT+CWMODE	AT+CIPSTATUS
AT+RST	AT+CWJAP	AT+CIPSTART
AT+GMR	AT+CWLAP	AT+CIPSEND
AT+GSLP	AT+CWQAP	AT+CIPCLOSE
ATE	AT+CWSAP	AT+CIFSR

Table 3.2.3.5 AT commands

3.2.4 Diode

A diode is a two-terminal electronic component that conducts current primarily in one direction (asymmetric conductance); it has low (ideally zero) resistance in one direction, and high (ideally infinite) resistance in the other. A diode vacuum tube or thermionic

diode is a vacuum tube with two electrodes, a heated cathode and a plate, in which electrons can flow in only one direction, from cathode to plate.

A semiconductor diode, the most common type today, is a crystalline piece of semiconductor material with a p–n junction connected to two electrical terminals. Semiconductor diodes were the first semiconductor electronic devices.

The discovery of asymmetric electrical conduction across the contact between a crystalline mineral and a metal was made by German physicist Ferdinand Braun in 1874.

Today, most diodes are made of silicon, but other materials such as gallium arsenide and germanium are used.

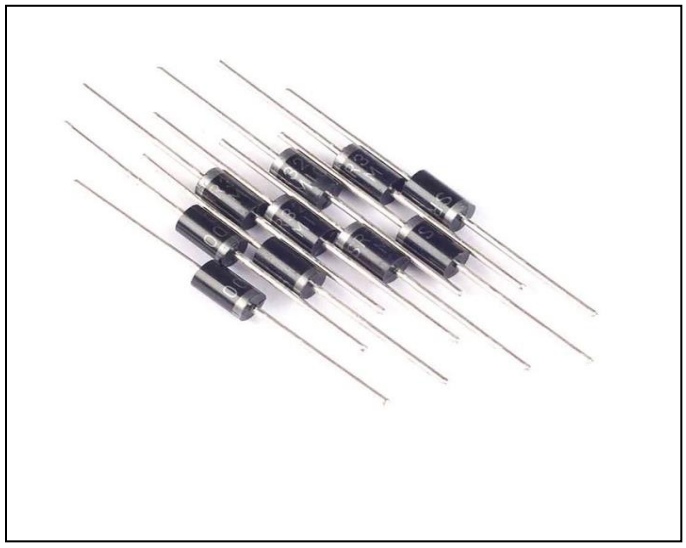


Fig.3.2.4 Diodes

The most common function of a diode is to allow an electric current to pass in one direction (called the diode's forward direction), while blocking it in the opposite direction (the reverse direction). As such, the diode can be viewed as an electronic version of a check valve. This unidirectional behaviour is called rectification, and is used to convert alternating current (ac) to direct current (dc). Forms of rectifiers, diodes can be used for such tasks as extracting modulation from radio signals in radio receivers.

However, diodes can have more complicated behaviour than this simple on–off action, because of their nonlinear current-voltage characteristics. Semiconductor diodes begin conducting electricity only if a certain threshold voltage or cut-in voltage is present in the forward direction (a state in which the diode is said to be forward-biased). The voltage drop across a forward-biased diode varies only a little with the current, and is a function of temperature; this effect can be used as a temperature sensor or as a voltage reference. Also, diodes' high resistance to current flowing in the reverse direction suddenly drops to a low resistance when the reverse voltage across the diode reaches a value called the breakdown voltage.

A semiconductor diode's current–voltage characteristic can be tailored by selecting the semiconductor materials and the doping impurities introduced into the materials during manufacture. These techniques are used to create special-purpose diodes that perform many different functions. For example, diodes are used to regulate voltage (Zener diodes), to protect circuits from high voltage surges (avalanche diodes), to electronically tune radio and TV receivers (varactor diodes), to generate radio-frequency oscillations (tunnel diodes, Gunn diodes, IMPATT diodes), and to produce light (light-emitting diodes). Tunnel, Gunn and IMPATT diodes exhibit negative resistance, which is useful in microwave and switching circuits.

Diodes, both vacuum and semiconductor, can be used as shot-noise generators.

- ***Current Voltage Characteristics***

A semiconductor diode's behaviour in a circuit is given by its current–voltage characteristic, or I–V graph (see graph below). The shape of the curve is determined by the transport of charge carriers through the so-called depletion layer or depletion region that exists at the p–n junction between differing semiconductors.

When a p–n junction is first created, conduction-band (mobile) electrons from the N-dope region diffuse into the P-doped region where there is a large population of holes (vacant places for electrons) with which the electrons "recombine". When a mobile electron recombines with a hole, both hole and electron vanish, leaving behind an immobile positively charged donor (dopant) on the N side and negatively charged acceptor (dopant) on the P side. The region around the p–n junction becomes depleted of charge carriers and thus behaves as an insulator.

3.2.5 Voltage Regulator

Voltage sources in a circuit may have fluctuations resulting in not providing fixed voltage outputs. A voltage regulator IC maintains the output voltage at a constant value. 7805 IC, a member of 78xx series of fixed linear voltage regulators used to maintain such fluctuations, is a popular voltage regulator integrated circuit (IC). The xx in 78xx indicates the output voltage it provides. 7805 IC provides +5 volts regulated power supply with provisions to add a heat sink. All voltage sources cannot able to give fixed output due to fluctuations in the circuit.

For getting constant and steady output, the voltage regulators are implemented. The integrated circuits which are used for the regulation of voltage are termed as voltage regulator ICs. Here, we can discuss about IC 7805.
The **voltage regulator IC 7805** is actually a member of 78xx series of voltage regulator ICs. It is a fixed linear voltage regulator. The xx present in 78xx represents the value of the fixed output voltage that the particular IC provides. For 7805 IC, it is +5V DC regulated power supply. This regulator IC also adds a provision for a heat sink.

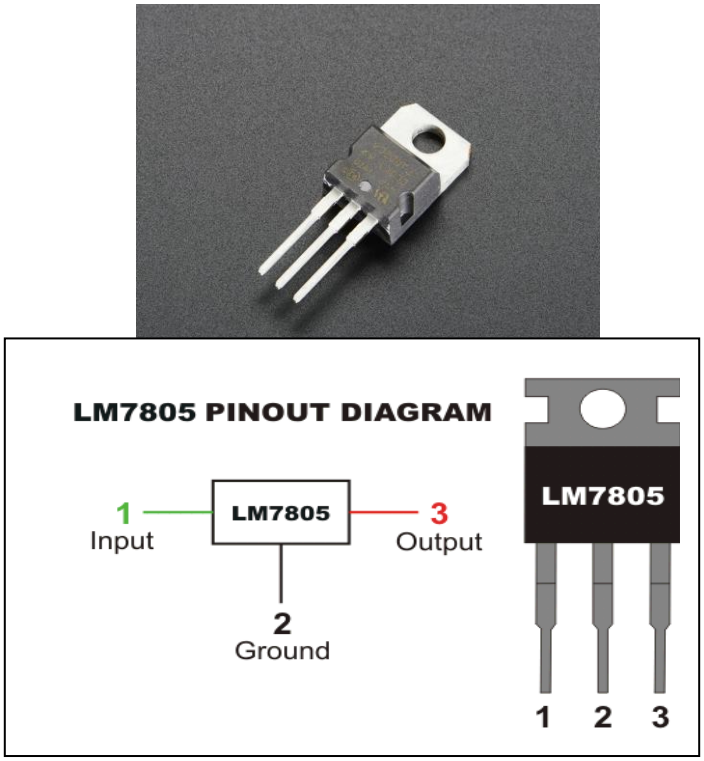


Fig.3.2.5.a Pin Diagram

Pin 1- Input

The function of this pin is to give the input voltage. It should be in the range of 7V to 35V. We apply an unregulated voltage to this pin for regulation. For 7.2V input, the PIN achieves a maximum efficiency.

Pin 2- Ground

We connect the ground to this pin. For output and input, this pin is equally neutral (0V).

Pin 3- Output

We connect the ground to this pin. For output and input, this pin is equally neutral (0V).

Heat Dissipation in IC 7805

In IC 7805 voltage regulator, lots of energy is exhausted in the form of heat. The difference in the value of input voltage and output voltage comes as heat. So, if the difference between input voltage and the output voltage is high, there will be more heat generation. Without a heat sink, this too much heat will cause malfunction. We call, the bare minimum tolerable difference between the input and output voltage to keep the output voltage at the proper level as dropout voltage. It is better to keep the input voltage 2 to 3V greater than the output voltage, or a suitable heat sink should be placed to dissipate excess heat. We have to calculate the heat sink size properly. The following formula will give an idea of this calculation.

Heat Generated= (Input Voltage-5) x Output current

Internal Block Diagram of 7805 Voltage Regulator

The internal block diagram of IC 7805 is represented in figure below: The block diagram comprises of an error amplifier, series pass element, current generator, reference voltage, current generator, starting circuit, SOA protection and thermal protection.

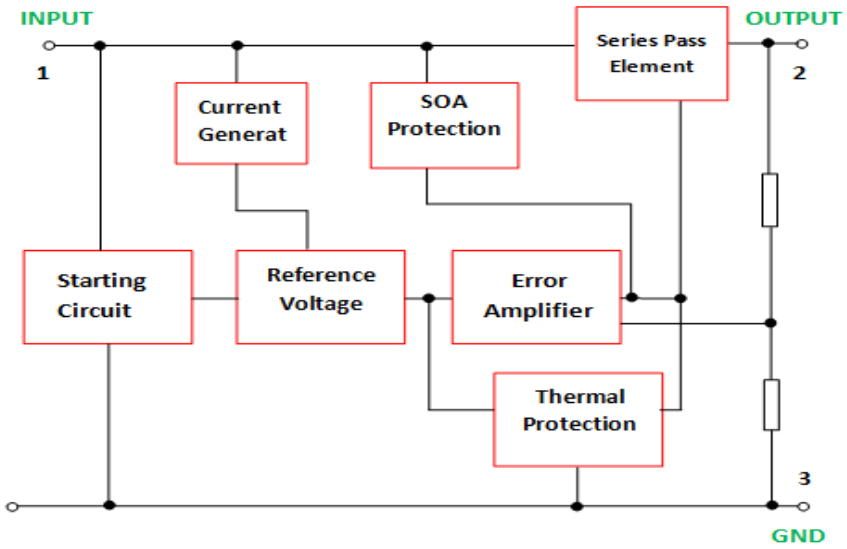


Fig.3.2.5.b Internal Block Diagram of 7805

3.2.6 ULN 2003A

The ULN2003A is an array of seven NPN Darlington transistors capable of 500 amps, 50 V output. It features common-cathode flyback diodes for switching inductive loads. It can come in PDIP, SOIC, SOP or TSSOP packaging. In the same family are ULN2002A,

ULN2004A, as well as ULQ2003A and ULQ2004A, designed for different logic input levels.

The ULN2003A is also similar to the ULN2001A (4 inputs) and the ULN2801A, ULN2802A, ULN2803A, ULN2804A and ULN2805A, only differing in logic input levels (TTL, CMOS, PMOS) and number of in/outputs (4/7/8) **ULN2003** is a relay driver IC consisting of a Darlington array. It is made up of seven open collector darlington pairs with common emitter. Moreover, **ULN2003A** has a capability of handling seven different Relays simultaneously. A single darlington pair consists of two bipolar transistors and operates in the range of 500mA to 600mA current.

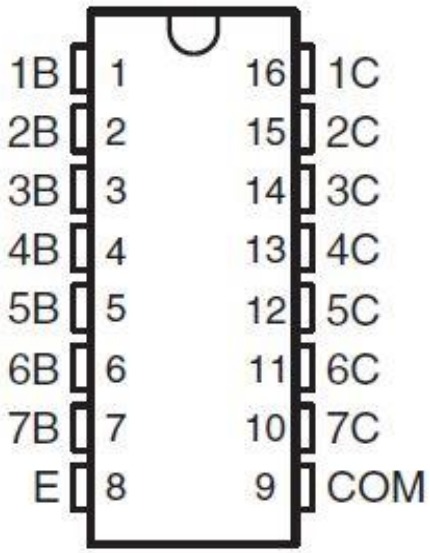


Fig.3.2.6 ULN 2003A

The ULN2003 is known for its high-current, high-voltage capacity. The drivers can be paralleled for even higher current output. Even further, stacking one chip on top of another, both electrically and physically, has been done.

Generally, it can also be used for interfacing with a stepper motor, where the motor requires high ratings which cannot be provided by other interfacing devices.

Main specifications:

- 500 mA rated collector current (single output)
- 50 V output (there is a version that supports 100 V output)
- Includes output flyback diodes
- Inputs compatible with TTL and 5-V CMOS logic

Application

Typical usage of the ULN2003A is in driver circuits for relays, lamp and LED displays, stepper motors, logic buffers and line drivers.

3.2.7 LED

A light-emitting diode (LED) is a semiconductor light source that emits light when current flows through it. Electrons in the semiconductor recombine with electron holes, releasing energy in the form of photons. This effect is called electroluminescence. The colour of the light (corresponding to the energy of the photons) is determined by the energy required for electrons to cross the band gap of the semiconductor.

White light is obtained by using multiple semiconductors or a layer of light-emitting phosphor on the semiconductor device. Appearing as practical electronic components in 1962, the earliest LEDs emitted low-intensity infrared light. Infrared LEDs are used in

remote-control circuits, such as those used with a wide variety of consumer electronics. The first visible-light LEDs were of low intensity and limited to red. Modern LEDs are available across the visible, ultraviolet, and infrared wavelengths, with high light output. Early LEDs were often used as indicator lamps, replacing small incandescent bulbs, and in seven-segment displays. Recent developments have produced white-light LEDs suitable for room lighting. LEDs have led to new displays and sensors, while their high switching rates are useful in advanced communications technology.

LEDs have many advantages over incandescent light sources, including lower energy consumption, longer lifetime, improved physical robustness, smaller size, and faster switching. Light-emitting diodes are used in applications as diverse as aviation lighting, automotive headlamps, advertising, general lighting, traffic signals, camera flashes, lighted wallpaper and medical devices.

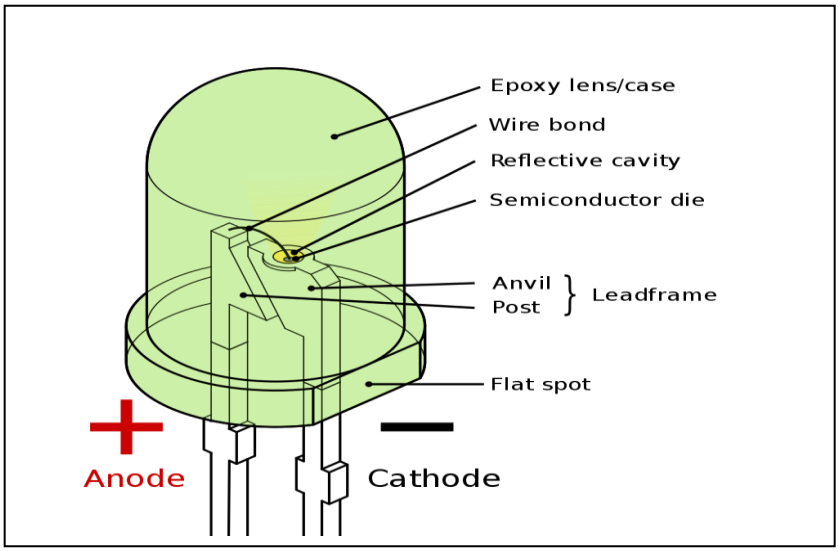


Fig.3.2.7 LED

Unlike a laser, the colour of light emitted from an LED is neither coherent nor monochromatic, but the spectrum is narrow with respect to human vision, and functionally monochromatic.

- ***Advantages***

Efficiency: LEDs emit more lumens per watt than incandescent light bulbs. The efficiency of LED lighting fixtures is not affected by shape and size, unlike fluorescent light bulbs or tubes.

Colour: LEDs can emit light of an intended colour without using any colour filters as traditional lighting methods need. This is more efficient and can lower initial costs.

Size: LEDs can be very small (smaller than 2 mm) and are easily attached to printed circuit boards.

Warm up time: LEDs light up very quickly. A typical red indicator LED achieves full brightness in under a microsecond. LEDs used in communications devices can have even faster response times.

Cycling: LEDs are ideal for uses subject to frequent on-off cycling, unlike incandescent and fluorescent lamps that fail faster when cycled often, or high-intensity discharge lamps (HID lamps) that require a long time before restarting.

Dimming: LEDs can very easily be dimmed either by pulse-width modulation or lowering the forward current. This pulse-width modulation is why LED lights, particularly headlights on cars, when viewed on camera or by some people, seem to flash or flicker. This is a type of stroboscopic effect.

Cool light: In contrast to most light sources, LEDs radiate very little heat in the form of IR that can cause damage to sensitive objects or fabrics. Wasted energy is dispersed as heat through the base of the LED.

Slow failure: LEDs mainly fail by dimming over time, rather than the abrupt failure of incandescent bulbs.

Lifetime: LEDs can have a relatively long useful life. One report estimates 35,000 to 50,000 hours of useful life, though time to complete failure may be shorter or longer. Fluorescent tubes typically are rated at about 10,000 to 25,000 hours, depending partly on the conditions of use, and incandescent light bulbs at 1,000 to 2,000 hours. Several DOE demonstrations have shown that reduced maintenance costs from this extended lifetime, rather than energy savings, is the primary factor in determining the payback period for an LED product.

Shock resistance: LEDs, being solid-state components, are difficult to damage with external shock, unlike fluorescent and incandescent bulbs, which are fragile.

Focus: The solid package of the LED can be designed to focus its light. Incandescent and fluorescent sources often require an external reflector to collect light and direct it in a usable manner.

For larger LED packages total internal reflection (TIR) lenses are often used to the same effect. However, when large quantities of light are needed many light sources are usually deployed, which are difficult to focus or collimate towards the same target.

- ***Disadvantages***

Temperature dependence: LED performance largely depends on the ambient temperature of the operating environment – or thermal management properties. Overdriving an LED in high ambient temperatures may result in overheating the LED package, eventually leading to device failure. An adequate heat sink is needed to maintain long life. This is especially important in automotive, medical, and military uses where devices must operate over a wide range of temperatures, which require low failure rates. Toshiba has produced LEDs with an operating temperature range of −40 to 100 °C, which suits the LEDs for both indoor and outdoor use in applications such as lamps, ceiling lighting, street lights, and floodlights.

Voltage sensitivity: LEDs must be supplied with a voltage above their threshold voltage and a current below their rating. Current and lifetime change greatly with a small change in applied voltage. They thus require a current-regulated supply (usually just a series resistor for indicator LEDs).

Colour rendition: Most cool-white LEDs have spectra that differ significantly from a black body radiator like the sun or an incandescent light. The spike at 460 nm and dip at 500 nm can make the colour of objects appear differently under cool-white LED illumination than sunlight or incandescent sources, due to metamerism, red surfaces being rendered particularly poorly by typical phosphor-based cool-white LEDs. The same is true with green surfaces.

Area light source: Single LEDs do not approximate a point source of light giving a spherical light distribution, but rather a Lambertian distribution. So, LEDs are difficult to apply to uses needing a spherical light field; however, different fields of light can be

manipulated by the application of different optics or "lenses". LEDs cannot provide divergence below a few degrees.

Light pollution: Because white LEDs emit more short wavelength light than sources such as high-pressure sodium vapor lamps, the increased blue and green sensitivity of scotopic vision means that white LEDs used in outdoor lighting cause substantially more sky glow.

Efficiency droop: The efficiency of LEDs decreases as the electric current increases. Heating also increases with higher currents, which compromises LED lifetime. These effects put practical limits on the current through an LED in high power applications.

Impact on insects: LEDs are much more attractive to insects than sodium-vapor lights, so much so that there has been speculative concern about the possibility of disruption to food webs.

3.2.8 Bridge Rectifier

A diode bridge is an arrangement of four (or more) diodes in a bridge circuit configuration that provides the same polarity of output for either polarity of input. When used in its most common application, for conversion of an alternating-current (AC) input into a direct-current (DC) output, it is known as a bridge rectifier. A bridge rectifier provides full-wave rectification from a two-wire AC input, resulting in lower cost and weight as compared to a rectifier with a 3-wire input from a transformer with a centre-tapped secondary winding.

The essential feature of a diode bridge is that the polarity of the output is the same regardless of the polarity at the input. The diode bridge circuit was invented by ppolished Karol Pollack and patented in December 1895 in Great Britain and in January

1896 in Germany. In 1897, the German physicist Leo Graetz independently invented and published a similar circuit. Today the circuit is still often referred to as a Graetz circuit or Graetz bridge.

Prior to the availability of integrated circuits, a bridge rectifier was constructed from "discrete components", i.e., separate diodes. Since about 1950, a single four-terminal component containing the four diodes connected in a bridge configuration became a standard commercial companioned is now available with various voltage and current ratings. Diodes are also used in bridge topologies along with capacitors as voltage multipliers.

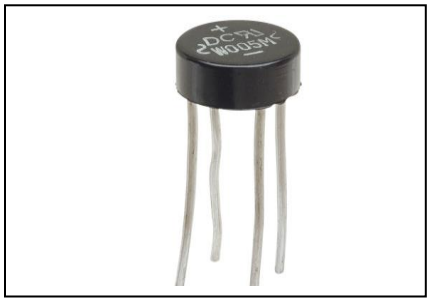


Fig.3.2.8 Bridge Rectifier

3.2.9 Liquid-crystal display (LCD)

A liquid-crystal display (LCD) is a flat-panel display or other electronically modulated optical device that uses the light-modulating properties of liquid crystals.

Liquid crystals do not emit light directly, instead using a backlight or reflector to produce images in colour or monochrome. LCDs are available to display arbitrary images (as in a general-purpose computer display) or fixed images with low information content, which

can be displayed or hidden, such as preset words, digits, and seven-segment displays, as in a digital clock.

They use the same basic technology, except that arbitrary images are made up of a large number of small pixels, while other displays have larger elements. LCDs can either be normally on (positive) or off (negative), depending on the polarizer arrangement.

For example, a character positive LCD with a backlight will have black lettering on a background that is the colour of the backlight, and a character negative LCD will have a black background with the letters being of the same colour as the backlight. Optical filters are added to white on blue LCDs to give them their characteristic appearance.

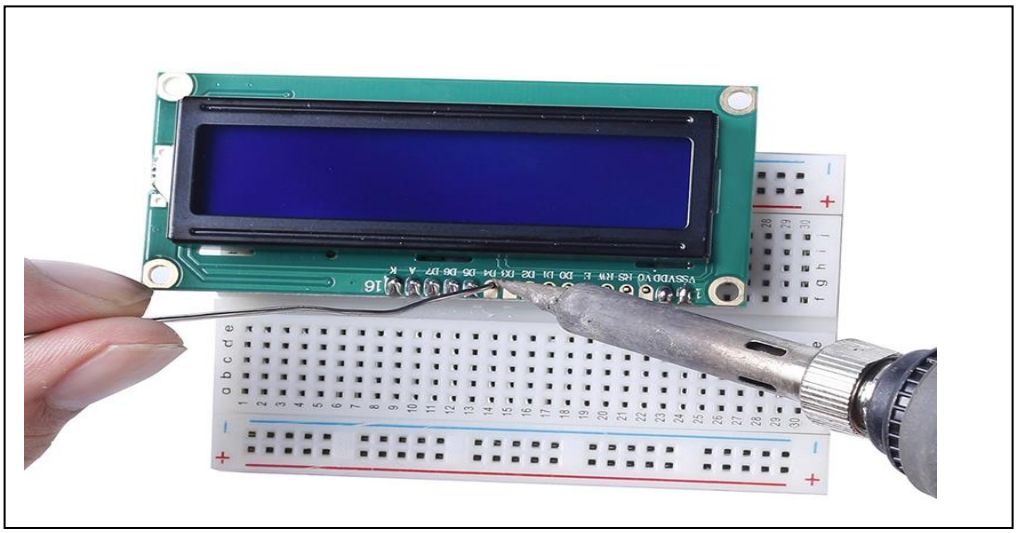
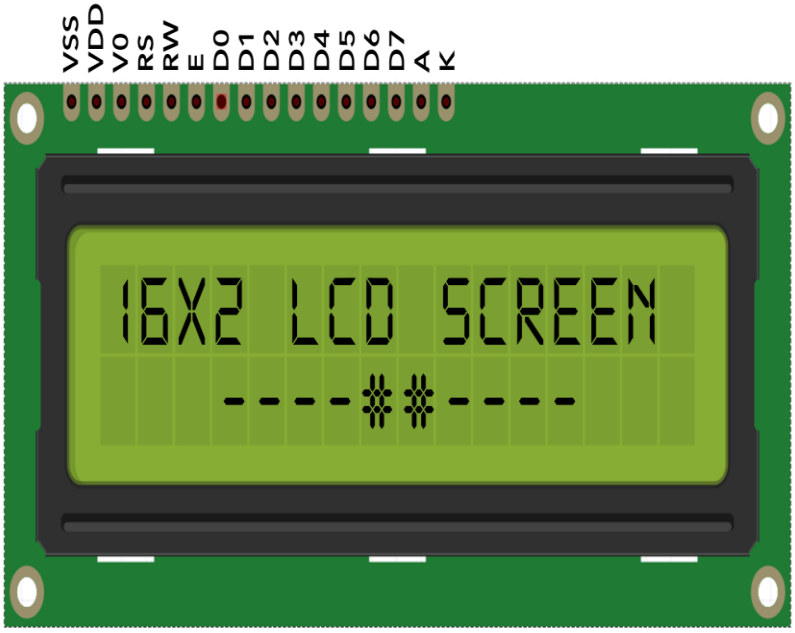


Fig.3.2.9.a LCD

LCDs are used in a wide range of applications, including LCD televisions, computer monitors, instrument panels, aircraft cockpit displays, and indoor and outdoor signage.

Small LCD screens are common in portable consumer devices such as digital cameras, watches, calculators, and mobile telephones, including smartphones.

LCD (Liquid Crystal Display) screen is an electronic display module and find a wide range of applications. A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. LCD screens are also used on consumer electronics products such as DVD players, video game devices and clocks. LCD screens have replaced heavy, bulky cathode ray tube (CRT) displays in nearly all applications. LCD screens are available in a wider range of screen sizes than CRT and plasma displays, with LCD screens available in sizes ranging from tiny digital watches to very large television receivers.



No	Symbol	Function
1	VSS	Ground
2	VDD	5V +
3	V0	Contrast
4	RS	Register
5	RW	Read/Write
6	E	Enable
7	D0	Data bus
8	D1	Data bus
9	D2	Data bus
10	D3	Data bus
11	D4	Data bus
12	D5	Data bus
13	D6	Data bus
14	D7	Data bus
15	A	Anode (5V+)
16	K	Cathode (GND)

Fig.3.2.9.b Pin Description of LCD

LCDs are slowly being replaced by OLEDs, which can be easily made into different shapes, and have a lower response time, wider colour gamut, virtually infinite colour contrast and viewing angles, lower weight for a given display size and a slimmer profile (because OLEDs use a single glass or plastic panel.

whereas LCDs use two glass panels; the thickness of the panels increases with size but the increase is more noticeable on LCDs) and potentially lower power consumption (as the display is only "on" where needed and there is no backlight).

These modules are preferred over seven segments and other multi segment LEDs. The reasons being: LCDs are economical; easily programmable; have no limitation of displaying special & even custom characters (unlike in seven segments), animations and so on.

A 16x2 LCD means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix.

This LCD has two registers, namely, Command and Data. The command register stores the command instructions given to the LCD. A command is an instruction given to LCD to do a predefined task like initializing it, clearing its screen, setting the cursor position, controlling display etc. The data register stores the data to be displayed on the LCD.

The data is the ASCII value of the character to be displayed on the LCD. Click to learn more about internal structure of a LCD.

Pin No	Function	Name
1	Ground (0V)	Ground
2	Supply voltage; 5V (4.7V – 5.3V)	VCC
3	Contrast adjustment; through a variable resistor	VEE
4	Selects command register when low; and data register when high	Register Select
5	Low to write to the register; High to read from the register	Read/write
6	Sends data to data pins when a high to low pulse is given	Enable
7	8-bit data pins	DB0
8		DB1
9		DB2
10		DB3
11		DB4
12		DB5
13		DB6
14		DB7
15	Backlight VCC (5V)	Led+
16	Backlight Ground (0V)	Led-

Table 3.2.9 Pin Description of LED

3.2.10 Servo Motor

As our technology advances, the use of robots and other autonomous applications in our daily lives increases as well. While cheaper robots use stepper or brushed DC motors, more advanced robotics require the use of servo motors. But what is a servo motor and why are they used in most industrial applications?

Fig.3.2.10 Servo Motor

A servo motor is a self-contained electrical device that moves parts of a machine with high efficiency and great precision. A servo motor is a BLDC motor with a sensor for positional feedback. This allows the output shaft to be moved to a particular angle, position, and velocity that a regular motor cannot do.

However, a servo motor is only one part of a closed-loop motion control system. A complete motion system includes an amplifier, control circuit, drive gears, potentiometer, shaft, and either an encoder or resolver as well as the servo motor.

Servo Or Stepper?

What makes a servo motor different from a stepper motor? While both kinds of motors can control speed and position, they are both designed for very different applications. Stepper motors have built-in steps allowing the controller to signal how many steps to make, however, this only works if the controller knows the position of the output shaft. Because of this, when a stepper motor is powered up the controller moves the output shaft to a known position or until it activates an end limit switch.

A servo motor uses a sensor to know the position of its output shaft so that when it is powered on it can immediately go to the desired position. The design of a stepper motor limits its performance due to the limited feedback sensors. Another differentiation between a servo and a stepper motor is their top speed and torque at speeds. A stepper motor provides the most torque when it is not moving, referred to as holding torque. As the speed of the output shaft increases, the torque is drastically reduced. A servo motor has a much higher top speed than a stepper motor and will be able to provide more torque at speed.

3.2.10.1 Advantages of Servo Motors

Servo motors offer several advantages over other types of motors, including:

- **Precision Control**: Servo motors provide precise control of position, speed, and torque, making them ideal for applications where accuracy and repeatability are critical.

- **High Torque**: Servo motors are designed to provide high torque at all speeds, which makes them well-suited for applications that require high starting torque and move loads at high speeds.
- **Fast Response Time**: Servo motors have a very fast response time, which makes them ideal for applications that require rapid acceleration.
- **Wide Speed Range**: Servo motors are capable of operating at a wide range of speeds, from very slow to very fast, without losing accuracy or precision.

3.2.10.2 Servo Motor Applications

Servo motors are used in a wide range of industrial and commercial applications that require precise control of motion, including:

- **Robotics**: Servo motors are commonly used in robotics for precise control of joint movements, as well as for grippers and end effectors.
- **CNC Machines**: Servo motors are widely used in computer numerical control (CNC) machines for precision positioning and motion control of cutting tools.
- **Packaging Machinery**: Servo motors are used in packaging machinery to control the movement of conveyor belts, as well as for the precise positioning and movement of packaging materials.
- **Aerospace**: Servo motors are used in aerospace applications for precise control of aircraft components, such as flaps and landing gear.
- **Autonomous Guided Vehicles**: Servo motors are used to power and steer the wheels in autonomous guided vehicles.

- **Medical Equipment**: Servo motors are used in medical equipment for precise control of medical devices, such as surgical robots, prosthetics, and other medical devices.
- **Printing and Paper Processing**: Servo motors are used in printing and paper processing equipment for precise control of paper feeding, cutting, and folding.
- **Industrial Automation**: Servo motors are used in a wide range of industrial automation applications, including conveyor systems, material handling, and assembly lines.

3.2.10.3 Servo Customizations

What sets us apart from other manufacturers is our extensive ability to optimize and customize our motors for your specific application needs. We can ensure that our motors are optimized to deliver the required performance for your specific application, whether it's increasing torque at a specific speed range, reducing noise or vibration, or optimizing for minimal power consumption. We can customize the housing to match your application or replace an old motor.

3.2.11 IR Sensor

IR sensor is an electronic device, that emits the light in order to sense some object of the surroundings. An IR sensor can measure the heat of an object as well as detects the motion. Usually, in the infrared spectrum, all the objects radiate some form of thermal radiation. These types of radiations are invisible to our eyes, but infrared sensor can detect these radiations.

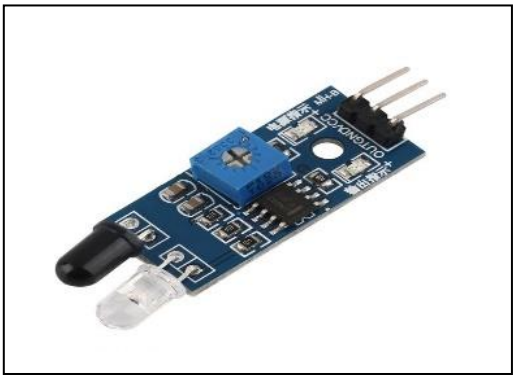


Fig.3.2.11 IR Sensor

The emitter is simply an IR LED **(Light Emitting Diode)** and the detector is simply an IR photodiode. Photodiode is sensitive to IR light of the same wavelength which is emitted by the IR LED. When IR light falls on the photodiode, the resistances and the output voltages will change in proportion to the magnitude of the IR light received.

There are five basic elements used in a typical infrared detection system: an infrared source, a transmission medium, optical component, infrared detectors or receivers and signal processing. Infrared lasers and Infrared LEDs of specific wavelength used as infrared sources.

The three main types of media used for infrared transmission are vacuum, atmosphere and optical fibres. Optical components are used to focus the infrared radiation or to limit the spectral response.

Types of IR Sensor

There are two types of IR sensors are available and they are,

- Active Infrared Sensor
- Passive Infrared Sensor

3.2.11.1 Active Infrared Sensor

Active infrared sensors consist of two elements: infrared source and infrared detector. Infrared sources include the LED or infrared laser diode. Infrared detectors include photodiodes or phototransistors. The energy emitted by the infrared source is reflected by an object and falls on the infrared detector.

3.2.11.2 Passive Infrared Sensor

Passive infrared sensors are basically Infrared detectors. Passive infrared sensors do not use any infrared source and detector. They are of two types: quantum and thermal. Thermal infrared sensors use infrared energy as the source of heat. Thermocouples**,** pyroelectric detectors and bolometers are the common types of thermal infrared detectors. Quantum type infrared sensors offer higher detection performance. It is faster than thermal type infrared detectors. The photo sensitivity of quantum type detectors is wavelength dependent.

3.2.11.3 IR Sensor Working Principle

There are different types of infrared transmitters depending on their wavelengths, output power and response time. An IR sensor consists of an IR LED and an IR Photodiode, together they are called as Photocoupler or Optocoupler.

IR Transmitter or IR LED: Infrared Transmitter is a light emitting diode (LED) which emits infrared radiations called as IR LED's. Even though an IR LED looks like a normal LED, the radiation emitted by it is invisible to the human eye.

The picture of an Infrared LED is shown below.

IR Transmitter or IR LED

IR Receiver or Photodiode

Infrared receivers or infrared sensors detect the radiation from an IR transmitter. IR receivers come in the form of photodiodes and phototransistors. Infrared Photodiodes are different from normal photo diodes as they detect only infrared radiation. Below image shows the picture of an IR receiver or a photodiode,

IR Receiver or Photodiode

Different types of IR receivers exist based on the wavelength, voltage, package, etc. When used in an infrared transmitter – receiver combination, the wavelength of the receiver should match with that of the transmitter.

The emitter is an IR LED and the detector is an IR photodiode. The IR photodiode is sensitive to the IR light emitted by an IR LED. The photo-diode's resistance and output voltage change in proportion to the IR light received. This is the underlying working principle of the IR sensor.

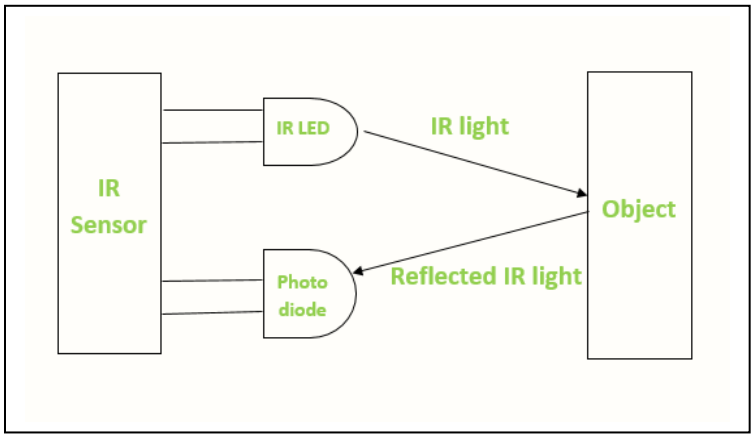


Fig.3.2.11.3 IR Working Principle

When the IR transmitter emits radiation, it reaches the object and some of the radiation reflects back to the IR receiver. Based on the intensity of the reception by the IR receiver, the output of the sensor defines.

3.2.11.4 Applications of IR Sensor

IR sensors use in various projects and also in various electronic devices. They all are as follow,

- **Night Vision Devices**

An Infrared technology implemented in night vision equipment if there is not enough visible light available to see unaided. Night vision devices convert ambient photons of light into electrons and then amplify them using a chemical and electrical process before finally converting them back into visible light.

- **Radiation Thermometers**

IR sensos uses 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

- **Infrared Tracking**

An Infrared tracking or Infrared homing, is a missile guidance system which operates using the infrared electromagnetic radiation emitted from a target to track it.

- **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 uses for thermal imagers, night vision devices etc.

Other Key Application Areas

Other key application areas that use infrared sensors include:

- Climatology
- Meteorology
- Photo biomodulation
- Flame Monitors
- Gas detectors
- Water analysis
- Moisture Analyzers
- Anesthesiology testing
- Petroleum exploration
- Rail safety
- Gas Analyzers

Chapter IV

RESULT AND DISCUSSION

4.1 Demo model execution and Discussion

In addition to introducing innovative features, the suggested technique raises India's public transport bus system to the level of the rest of the world by introducing an Automated Fare Collection System (AFCS) and Contactless Fare Media Technology (CFMT)..

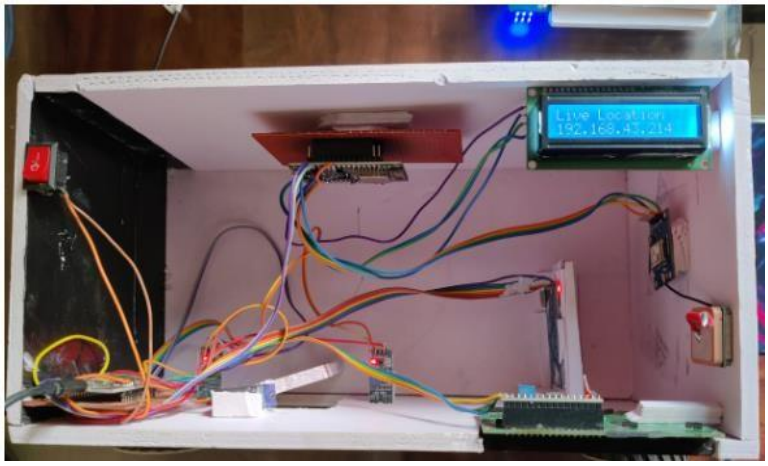


Fig.4.1.a Demo Model of system

There were numerous malfunctions, nasty arguments among the public, and corruption in the current ticketing system. Additionally, it seeks to lessen income loss and fraud associated to fees by using open, standard, secure transaction technologies.

According to my project "GPS based automatic bus fare collecting system using electronic Ticket," if the user has previously specified the locations he plans to visit, a system that utilizes the same RFID-based location information will provide navigational indications based on his current location. Bus moment timing may be predicted using collected data to deliver improved service.

We have entry and exit Sencers at door of bus, due to that a fixed number of passengers can only travel through the bus comfortably. Because one of the motoes of project is about comfort of passengers. We fix the seats for 30 passengers only if the more peoples are trying to travel then it will throw a message on display that bus is already full.

Instead of utilizing RFID and GPS, we may locate the entry and exit points for passengers by employing smart cards. We can determine the amount and distance travelled by using the location.

After swapping the card amount of ticket as per place will be deducted, and entry Sencer counted one by one. Door of bus, open with each swap taken place.

The smart card used to withdraw the money and this system is programmed using a microcontroller that interfaces with a smart card and GPS. This approach is used to establish effective ticketing and decrease the use of loose currency.

This paper's goal is to count passengers using an infrared sensor, calculate each passenger's automated trip distance using a motor and a u-slot sensor, and debit the appropriate amount from the passenger's RFID card. The signals that a passenger receives will stop as they cross, and fare collection will happen automatically.

This RFID tag is rechargeable; however, it can be charged at the closest retail store or bus terminal.

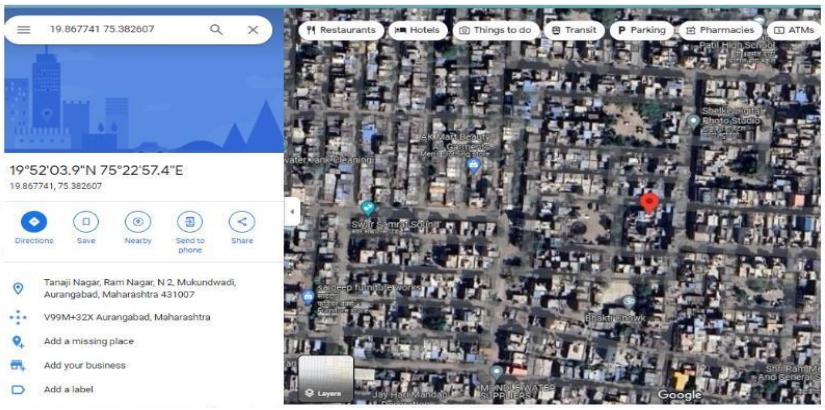


Fig.4.1.b Exact location of the bus

The RFID tag data and the location's latitude and longitude are saved by the ESP 8266 device for later use upon a passenger's initial card punch.

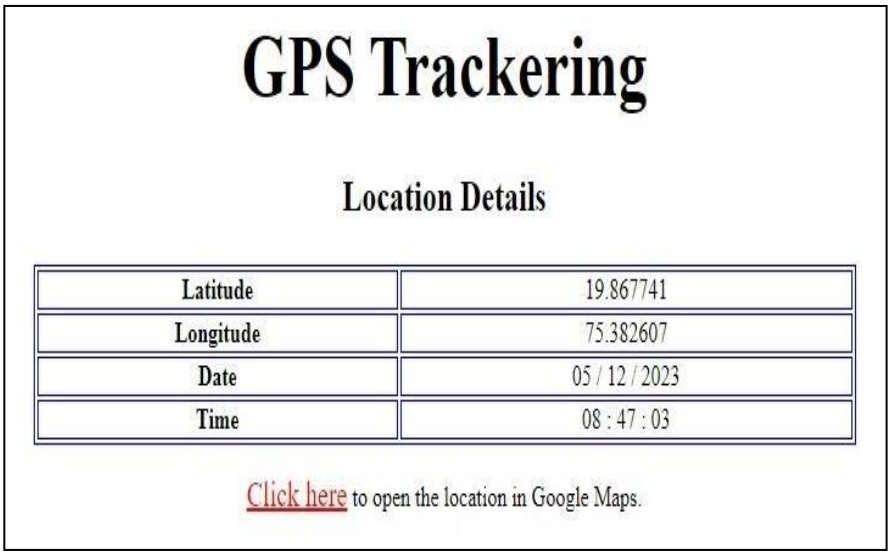


Fig.4.1.c location Tracking

When the same passenger punches the card again, this allows the ESP 8266 to determine the separation between the first and second punch sites. The RFID reader is constantly prepared to scan an RFID tag or card, even when it is not in use.
The passenger can tap their card to get instructions, while the LCD display shows the project title.

In the following blow first, let's look at ESP 8266 new or second punch. If it's the second punch, ESP 8266 measures the distance from the previously recorded position using the current location. Additionally, ESP 8266 determines fee based on distance.

	A	B	C	D	E	F
1	Date	Time	Card User Name	Station	Fair	
2	9/8/2023	9:28:55 PM	Mark_Zuckerberg	CBS	20RS	
3	9/8/2023	9:29:09 PM	Sundar_Pichai	CBS	20RS	
4	9/8/2023	9:29:29 PM	Elon_Musk	CBS	20RS	
5	9/8/2023	9:33:12 PM	Sundar_Pichai	CBS	20RS	
6	9/8/2023	21:44:24	Sundar_Pichai	CBS	20RS	
7	9/8/2023	21:44:49	Sundar_Pichai	CBS	20RS	
8	9/8/2023	21:48:45	Sundar_Pichai	CBS	20RS	
9	11/6/2023	19:31:58	Elon_Musk	CBS	20RS	
10	11/6/2023	19:32:42	Elon_Musk	KRANTI_CHOWK	40RS	
11	11/6/2023	19:34:22	Elon_Musk	CBS	20RS	
12	12/5/2023	8:59:14	Mark_Zuckerberg	KRANTI_CHOWK	40RS	
13						

Fig.4.1.c Enrollment of the data to the system

4.2 Performance Analysis

Algorithm analysis is the process of evaluating the performance of an algorithm, usually in terms of its time and space complexity. There are several ways to analyze the performance of an algorithm, including asymptotic analysis, which analyzes the behavior of an algorithm as the size of the input grows indefinitely.

The performance of cashless transport system is analyzed depending upon time parameter. Which will make the system faster than the regular transport system. By comparing the data entered into the system we can see the decreasing minimum time for ticketing.

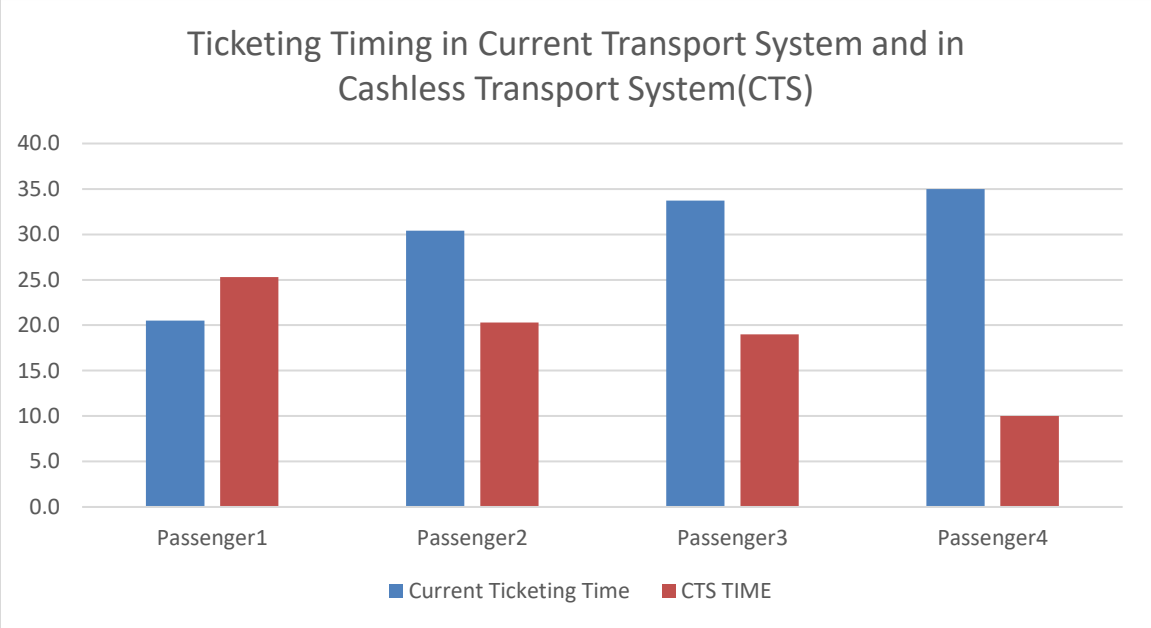


Chart 4.2: Time parameter comparison in both systems.

4.3 Result

Discussing the process of this project step by step. RFID reader in idle condition, ready to scan a card or tag. The project title is displayed on the LCD display along with a tap-your-card instruction.

Chapter V
CONCLUSION

5.1 Conclusion

A number of issues with the manual fare collection method are resolved by the solution we propose. Using GPS to automate fare collecting for transportation is a creative solution that saves effort. Our suggested method solves many of the problems with the manual fare collection mechanism.

Automated fare collecting for public transport is a creative concept that saves time. It is anticipated that by putting these systems in place, issues like the number of buses being used less frequently may arise. Because real-time information is supplied, the technology will benefit both bus station management and passengers.

The previously mentioned problems can be resolved by combining the RFID ticketing systems. In fact, this idea proposes the use of RFID-based tickets in an automated ticketing system that is far more user- friendly.

The transport system can incorporate this intelligent embedded technology to handle automated fare collecting. Megacities like Chennai and Bangalore, where a sizable number of people use transportation options every day, are good choices for this system.

5.2 Future Scope

Smooth, simple and secure payment processes will help to bring about behavioral changes and faster adoption of digital payments and banking among un-banked segments.

When new technologies enter the market, it will make a best transportation system.

A larger pie with more cashless transportation system is definitely good for the changing dynamics of the country.

We can add coin system into the transportation system for passenger's coin change issues, will help to lose the coin and securing from frauds.

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PLAGIARISM SCAN REPORT

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Abstract - In the modern world, the public transportation system is just as smart as the metro. The country's need for an intelligent transportation system is being driven by requirements such as passenger safety, convenience, and the need to enhance the efficiency of the current public transportation system. It has been discovered that one of the main causes of significant economic loss in India is the paper-based ticket system for collecting bus fares. It is challenging to make sure that every passenger purchases a ticket. Passengers lose the use of a paper ticket when the destination is reached. In addition; conductors have trouble uploading ticket transaction data within a day. Sometimes broken extra took place. Even the number of unsold tickets on a daily basis is fairly significant. In the technological age, India has been focusing on developing an automated bus fare collection system. Therefore, this study suggests an automated card-driven system that makes use of GPS and RFID. For Indian bus travel. With the app, users can keep tabs on the location of the bus and its passenger count. The effort suggests the cashless payments and ticket without paper.

1.INTRODUCTION

Everything in the modern world is intelligent and automated. There have also been additional developments in the transportation industry. But in India, transport vehicles have always been a place where these new technologies have made their appearance. Work one

of the study areas is intelligent vehicles for transportation. The global positioning system plays a major role in this situation for location identification. A visual milometer is an alternate method of position determination, as there may be mistakes in some metropolitan areas. Where it has been demonstrated that vision-based algorithms can use a series of photos to monitor a vehicle's position over a large distance without the need for prior environmental knowledge. However, under different weather circumstances, the findings have significant drawbacks, thus GPS works best in comparison with others. Expert rules and fuzzy logic-based control techniques are employed to regulate the time of departure, space between two cars, and trafficrelated delays. Particle crowd efficiency was used to fine-tune the settings of fuzzy controllers. Using a PTN operator with positioning sensors to provide on-the-go personalized navigation information is an additional alternative method to GPS. Here, positioning sensors may be used to find the unknown destination location for regular users. This indicates that the public's preference for it over other forms of transportation is motivated by this. Pre-paid or postpaid registered RFID TAG subscriptions are the basis of the mobile ticketing business. The traveler's identification is verified by scanning the RFID TAG at the vehicle's entrance or exit. The amount taken from the RFID tag balance in the mobile device is based on the passenger's distance travelled. The usage of smart phones has an impact on this system. Users of regular phones are unable to use this technology.

3. Body of Paper

Conductors keep an eye on the buses while they issue paper or token tickets and collect fares from the passengers. Still, there are problems with this approach. Conductors are responsible for making sure that every passenger has a ticket; printing tickets takes extra time and paper.

Additionally, tickets must be retained by passengers until they arrive at their destination. These days, people employ portable gadgets to get around these problems. However, there is still a chance that this technique may squander time and effort. For example, in order to board a bus, a traveler has to present payment. The conductor will then issue a ticket once the money has been collected. The Automatic Fare Collection (AFC) system offers an alternative. It consists of an automated vehicle finding system that tracks each passenger as they board a bus and logs transaction information such the route, bus number, trip card used, and the time and place of the trip. This device may be used for onboard ticket inspection and does away with the requirement for paper tickets. To further increase its use, it can include fresh spatial validation components.

4. PROPOSED METHOD

In addition to introducing innovative features, the suggested technique raises India's public transport bus system to the level of the rest of the world by introducing an Automated Fare Collection System (AFCS) and Contactless Fare Media Technology (CFMT). There were numerous malfunctions, nasty arguments among the public, and corruption in the current ticketing system. Additionally, it seeks to lessen income loss and fraud associated to fees by using open, standard, secure transaction technologies. According to the paper "GPS based automatic bus fare collecting system using electronic Ticket," if the user has previously specified the locations he plans to visit, a system that utilizes the same RFID-based location information will provide navigational indications based on his current location. Bus moment timing may be predicted using collected data to deliver improved service.

Instead of utilizing RFID and GPS, we may locate the entry and exit points for passengers by employing smart cards. We can determine the amount and distance travelled by using

the location. The smart card may be used to withdraw the money. This system may be programmed using a microcontroller that interfaces with a smart card and GPS. This approach may be used to establish effective ticketing and decrease the use of loose currency. This paper's goal is to count passengers using an infrared sensor, calculate each passenger's automated trip distance using a motor and a u-slot sensor, and debit the appropriate amount from the passenger's RFID card. The signals that a passenger receives will stop as they cross, and fare collection will happen automatically. This RFID tag is rechargeable; however, it can be charged at the closest retail store or bus terminal.

5. CONCLUSIONS

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