AUTOPILOT VEHICLE

A Project Report

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ABSTRACT

In this project, design of a low cost autonomous vehicle capable of changing destination on run time used for navigation in unknown environments is presented. The vehicle is equipped with four ultrasonic sensors for hurdle distance measurement, a wheel encoder for measuring distance traveled, a compass for heading information, a GPS receiver and direction sensor for goal position information, a GSM modem for changing destination place on run time and a non-volatile RAM for storing waypoint data; all interfaced to a low cost PIC microcontroller **(PIC 16F877)**. The microcontroller processes the information acquired from the sensors and generates robot motion commands accordingly. The vehicle is tested with varying destination places in outdoor environments containing stationary as well as moving obstacles and is found to reach these targets successfully. Autonomous robots with mobile capability are finding their place in numerous application fields. Thus the main issues that need to be addressed in mobile robot navigation ae reactive obstacle avoidance and target acquisition.

Some typical examples of these application fields are factory automation service application, hazardous environments such as dangerous zones in nuclear power stations, material handling in hospital and security guarding.The key requirement for performing these tasks is navigation. Navigation is the ability of a mobile robot to reach the target safely without human assistance.

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ABBREVIATIONS:

1. GPS-GLOBAL POSTIONING SYSTEM
2. GSM-GLOBAL SYSTEM FOR MOBILE COMMUNICATION
3. PIC-PERIPHERAL INTERFACE CONTROLLER
4. LDR-LIGHT DEPENDENT RESISTOR
5. SCU-SIGNAL CONDITIONING UNIT
6. SMS-SHORT MESSAGING SERVICE
7. IVU-INVEHICLE UNIT
8. VTS-VEHICLE TRACKING SYSTEM
9. GPRS-GENERAL PACKET RADIO SERVICE
10. TTL-TRANSISTOR-TRANSISTOR LOGIC
11. CMOS-COMPLEMENTARY MOSFET
12. RISC-REDUCED INSTRUCTION SET COMPUTER
13. DTE-DATA TERMINAL EQUIPMENT
14. DCE-DATA CIRCUIT TERMINATING EQUIPMENT
15. EIA-ELECTRONIC INDUSTRIES ALLIANCE

1.INTRODUCTION

Chapter 1

INTRODUCTION

The design of a low cost autonomous vehicle capable of changing destination on run time used for navigation in various environments is presented. The vehicle is equipped with four ultrasonic sensors for hurdle distance measurement, a wheel encoder for measuring distance travelled, a compass for heading information, a GPS receiver and direction sensor for goal position information, a GSM modem for changing destination place on run time and a non-volatile RAM for storing waypoint data; all interfaced to a low cost PIC microcontroller. The microcontroller processes the information acquired from the sensors and generates robot motion commands accordingly. The vehicle is tested with varying destination places in outdoor environments containing stationary as well as moving obstacles and is found to reach these targets successfully.

2. EXPERIMENTAL PROTOTYPE

The experimentation is carried out on a four wheeled mobile robot which is a modified form of a readily available RC car. Steering information is obtained by connecting a potentiometer to the steering rod. Operational amplifiers , are then used as comparators to classify this information as being left, centre and right. The rear wheels information is classified as either forward or backward. In order to create a perceptual link with the environment, four ultrasonic sensors, are mounted on the robot. Three sensors are mounted in front while one sensor is mounted on the rear side of the robot. Once trained, the microcontroller is disconnected from PC.A total of 18 LDR's are mounted in circle fashion around the periphery of compass needle. These LDR's are illuminated with 6 LED's mounted in a square fashion. The information from these LDR's is converted into 0-5V range with the help of operational amplifiers employed as comparators. When pointing in some direction, needle blocks light from shining on a pair of LDR's or one LDR. In former case, average value of blocked LDR's is taken which gives 10 degree orientation information while in later case a 20 degree orientation is obtained. A GPS receiver is used to get the location information of starting and destination places. The compass data, pulses from the encoder module and location data from GPS receiver is processed by PIC microcontroller.

The waypoints are stored in a non-volatile RAM for helping the robot in successful navigation. Each waypoint is described by latitude and longitude coordinates and its direction with respect to the north. The distance between consecutive waypoints is also stored in RAM to aid in correcting the error from odometer system. A GSM modem is also interfaced to the controller it provides the operator an option for changing the destination place on run time.

3. OBSTACLE AVOIDANCE:

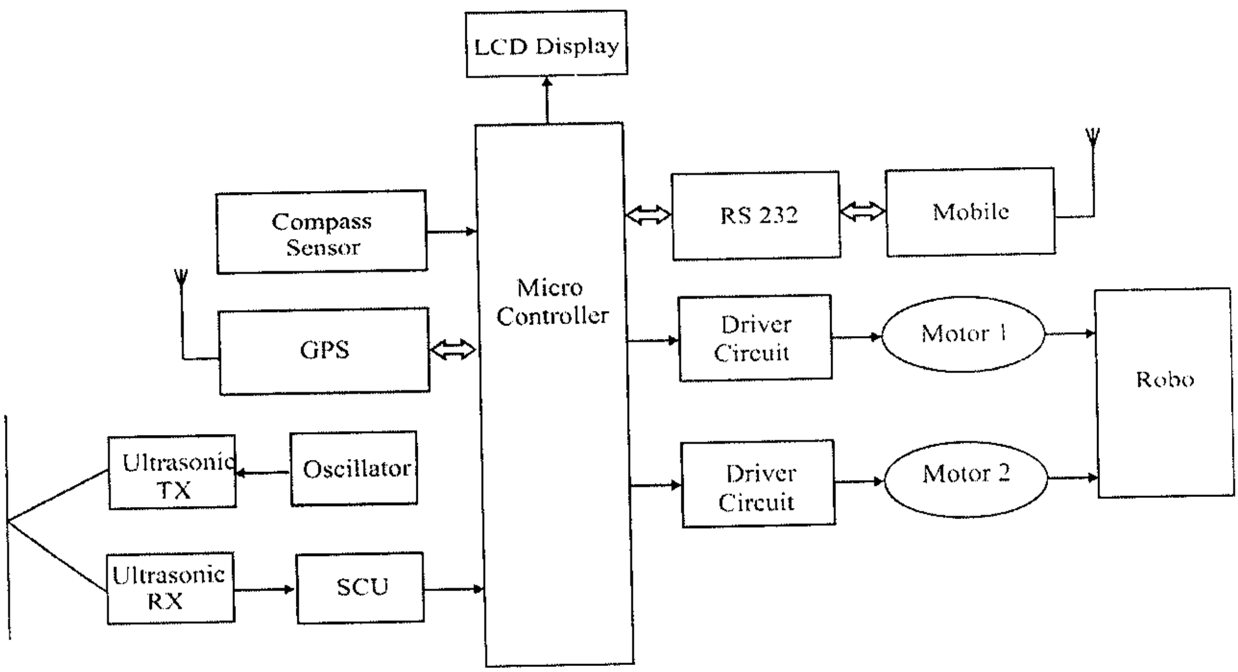


Fig: 1

When a mobile robot is travelling towards its final target, it might face a variety of obstacles in its way.

4. GATHERING EXPERIMENTAL DATA AND PRE-PROCESSING:

A number of experiments are conducted to gather training and validation data with the help of ultrasonic sensors mounted on the robot. Ultrasonic sensors work on the principle of time of flight and can be used to calculate any distance to the obstacle within its limit. However in order to reduce the complexity, distance information from left and right ultrasonic sensor is divided into four regions: very near, near, far, very far and is represented by two bits for each sensor. Also, the distance information from centre and back ultrasonic sensor divided into two regions: near and far and is represented by one bit for each sensor. The sensor placement with regions is shown in Fig. Because the training data set also contains output commands, the control commands for motors are encoded in 4 bits with 2 bits representing the status of each motor.

(1) Hurdle Data Set (H) = {(Ls, Rs, Cos) for 0< Ls, Rs, Cos < 3}

(2) Motor Command Set (M) = {(Sm, Rm) for 0< Sm, Rm <3}

(3)Training Data Set (T) = {(H, M)}

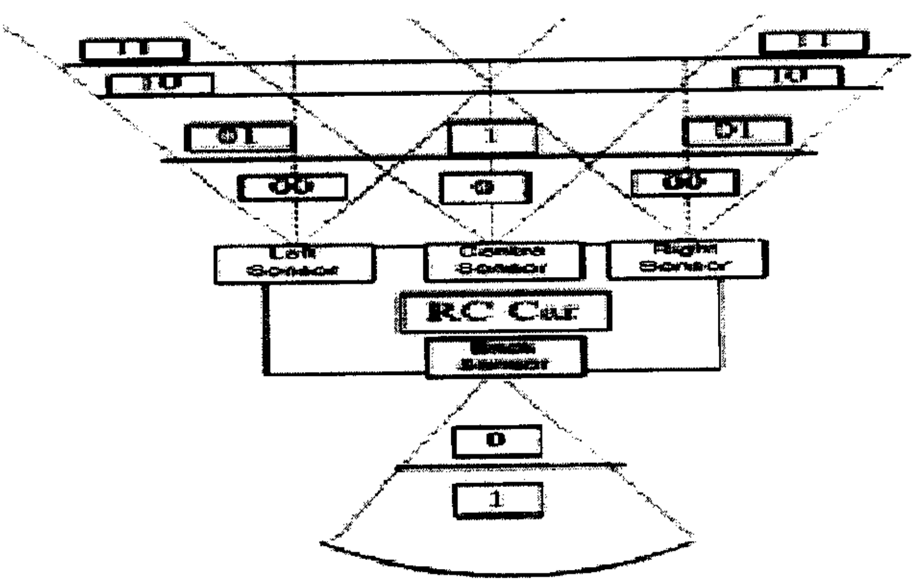
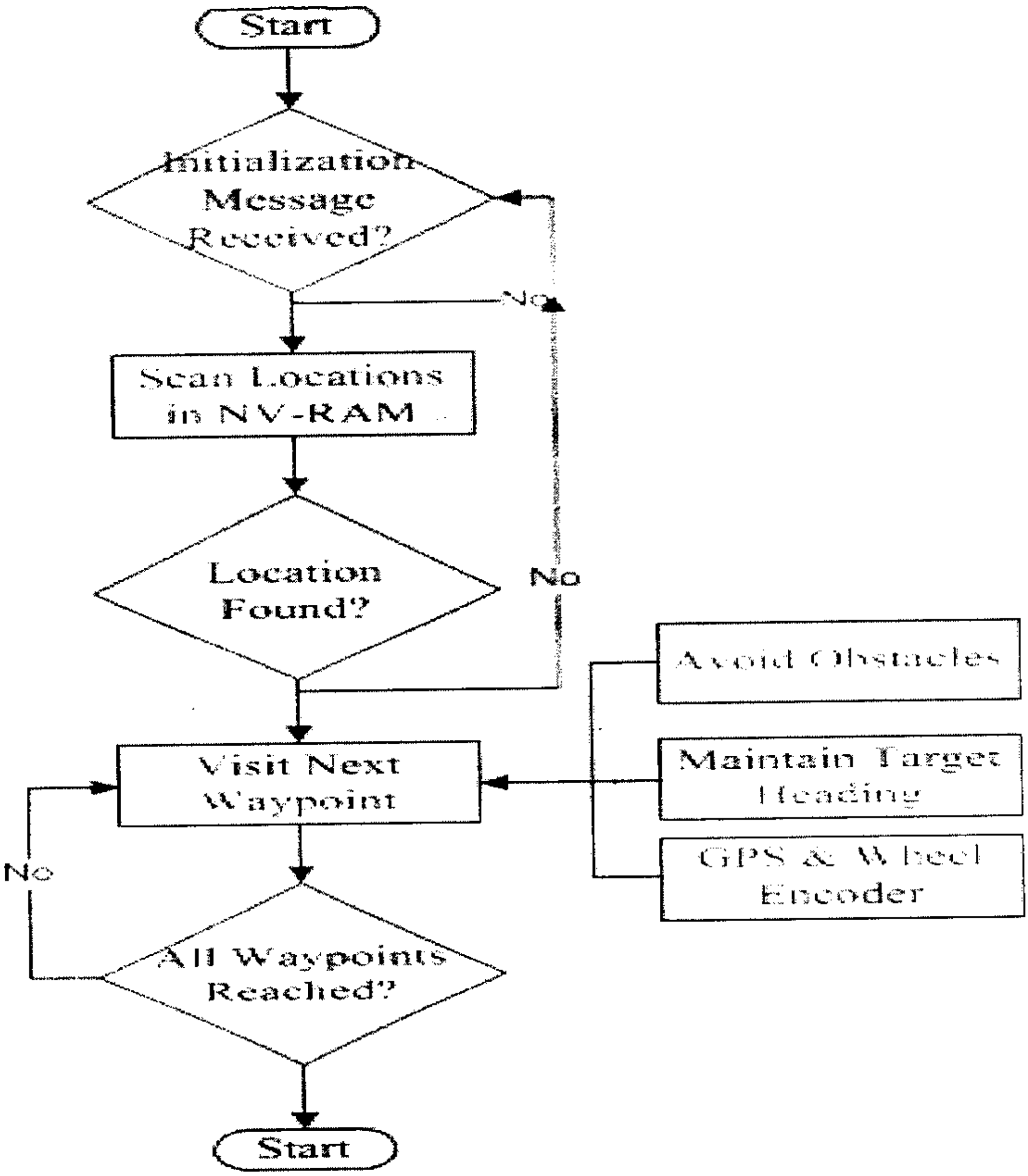


Fig:2

During an experiment, car is run with the help of remote control and different sample values are collected corresponding to different environment conditions with each sample value being a packet consisting of 10 bits.

5.GOAL REACHING

Goal reaching task combines information from compass, GPS receiver and GSM modem. The vehicle is initialized with the start and goal locations by using SMS service of GSM network.



In order to reach the desired destination, vehicle visits a sequence of static, predetermined GPS waypoints stored in NV-RAM. The specific waypoint that robot is approaching is the active waypoint. When this waypoint is reached, the next waypoint in the sequence becomes new active waypoint. The process continues until all the waypoints in between start and goal locations have been reached. While navigating towards active waypoint, the current vehicle orientation is compared with the destination orientation stored in NV-RAM. The difference in orientation is translated to vehicle movement to minimize the difference.

2.HARDWARE

CHAPTER 2

HARDWARE

2.1 DC MOTORS:

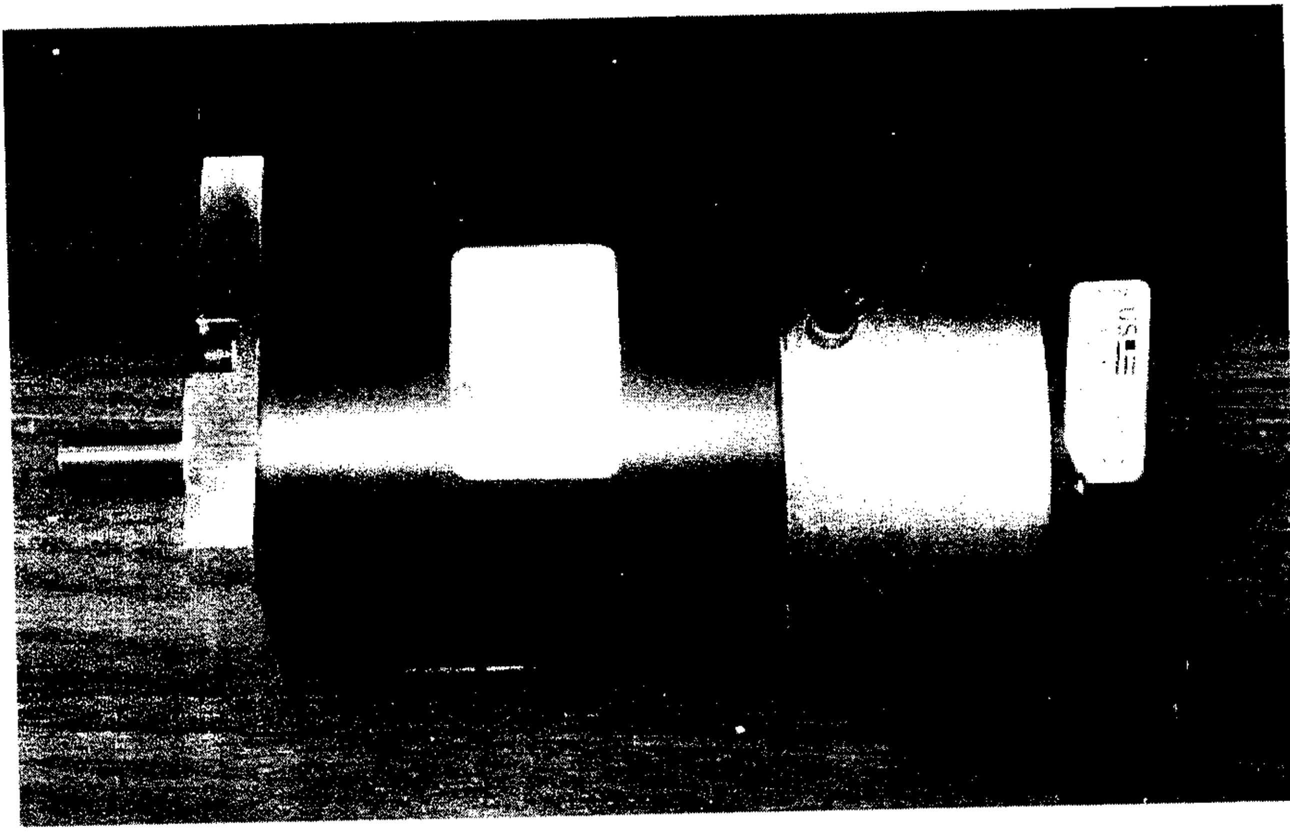


Fig: 4

2.1.1 Principles of operation:

In any electric motor, operation is based on simple electromagnetism. A current-carrying conductor generates a magnetic field; when this is then placed in an external magnetic field, it will experience a force proportional to the current in the conductor, and to the strength of the external magnetic field. As you are well aware of from playing with magnets as a kid, opposite (North and

South) polarities attract, while like polarities (North and North, South and South) repel. The internal configuration of a DC motor is designed to harness the magnetic interaction between a current-carrying conductor and an external magnetic field to generate rotational motion.

Let's start by looking at a simple 2-pole DC electric motor (here red represents a magnet or winding with a "North" polarization, while green represents a magnet or winding with a "South" polarization).

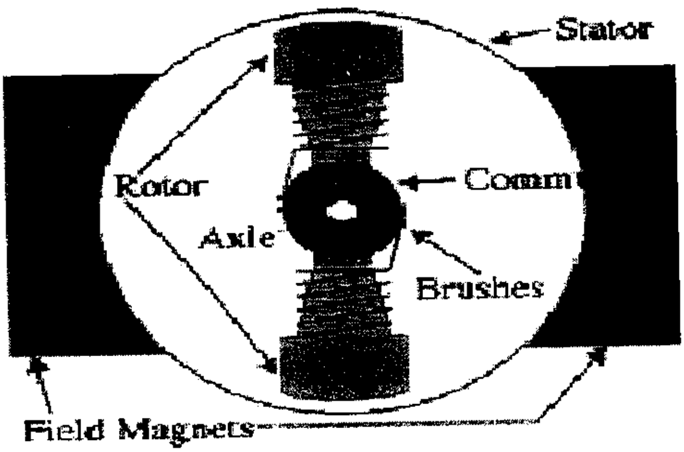


Fig: 5

Every DC motor has six basic parts -- axle, rotor (a.k.a., armature), stator, commutator , field magnet(s), and brushes. In most common DC motors (and all that beamers will see), the external magnetic field is produced by high-strength permanent magnets[1]. The stator is the stationary part of the motor -- this includes the motor casing, as well as two or more permanent magnet pole pieces. The rotor (together with the axle and attached commutator) rotate with respect to the stator. The rotor consists of windings (generally on a core), the windings being electrically connected to the commutator. The above diagram shows a common motor layout -- with the rotor inside the stator (field) magnets.

The geometry of the brushes, commutator contacts, and rotor windings are such that when power is applied, the polarities of the energized winding and the stator magnet(s) are misaligned, and the rotor will rotate until it is almost aligned with the stator's field magnets. As the rotor reaches alignment, the brushes move to the next commutator contacts, and energize the next winding. Given our example two-pole motor, the rotation reverses the direction of current through the rotor winding, leading to a "flip" of the rotor's magnetic field, driving it to continue rotating..

The use of an iron core armature (as in the Mabuchi, above) is quite common, and has a number of advantages[2]. First off, the iron core provides a strcng, rigid support for the windings -- a particularly important consideration for high-torque motors. The core also conducts heat away from the rotor windings, allowing the motor to be driven harder than might otherwise be the case. Iron core construction is also relatively inexpensive compared with other construction types.

But iron core construction also has several disadvantages. The iron armature has a relatively high inertia which limits motor acceleration. This construction also results in high winding inductances which limit brush and commutator life.

In small motors, an alternative design is often used which features a 'coreless' armature winding. This design depends upon the coil wire itself for structural integrity. As a result, the armature is hollow, and the permanent magnet can be mounted inside the rotor coil. Coreless DC motors have much lower armature inductance than iron-core motors of comparable size, extending brush and commutator life.

The coreless design also allows manufacturers to build smaller motors; meanwhile, due to the lack of iron in their rotors, coreless motors are somewhat prone to overheating. As a result, this design is generally used just in small, low-power motors. beamers will most often see coreless DC motors in the form of pager motors.

Diagram of MicroMotor

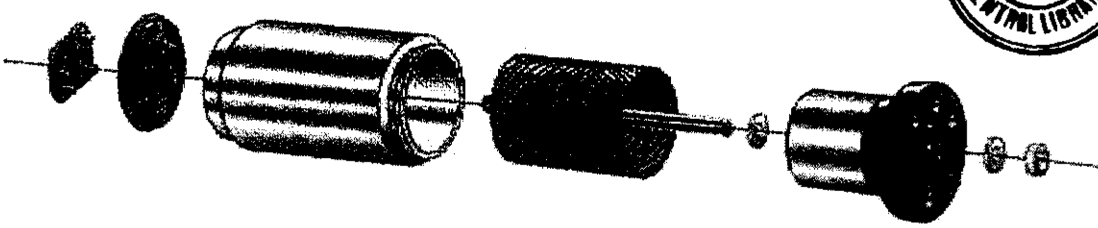


Fig: 6

Again, disassembling a coreless motor can be instructive -- in this case, my hapless victim was a cheap pager vibrator motor. The guts of this disassembled motor are available for you to see <u>here</u> (on 10 lines / cm graph paper). This is (or more accurately, was) a 3-pole coreless DC motor.

2.2 Power supply

INTRODUCTION:

The present chapter introduces the operation of power supply circuits built using filters, rectifiers, and then voltage regulators. Starting with an ac voltage, a steady dc voltage is obtained by rectifying the ac voltage, then filtering to a dc level, and finally, regulating to obtain a desired fixed dc voltage. The regulation is usually obtained from an IC voltage regulator unit, which takes a dc voltage and provides a somewhat lower dc voltage, which remains the same even if the input dc voltage varies, or the output load connected to the dc voltage changes.

Block diagram:

The ac voltage, typically 220V rms, is connected to a transformer, which steps that ac voltage down to the level of the desired dc output. A diode rectifier then provides a full-wave rectified voltage that is initially filtered by a simple capacitor filter to produce a dc voltage. This resulting dc voltage usually has some ripple or ac voltage variation.

A regulator circuit removes the ripples and also remains the same dc value even if the input dc voltage varies, or the load connected to the output dc voltage changes. This voltage regulation is usually obtained using one of the popular voltage regulator IC units.

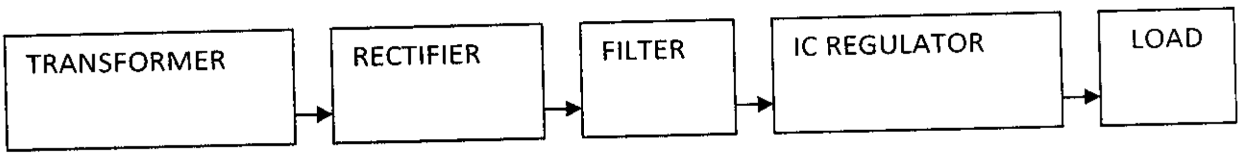


Fig: 7

Block diagram (Power supply)

Working principle

2.2.1 Transformer

The potential transformer will step down the power supply voltage (0-230V) to (0-6V) level. Then the secondary of the potential transformer will be connected to the precision rectifier, which is constructed with the help of op–amp. The advantages of using precision rectifier are it will give peak voltage output as DC, rest of the circuits will give only RMS output.

2.2.2 Bridge rectifier

When four diodes are connected as shown in figure, the circuit is called as bridge rectifier. The input to the circuit is applied to the diagonally opposite corners of the network, and the output is taken from the remaining two corners.

Let us assume that the transformer is working properly and there is a positive potential, at point A and a negative potential at point B. the positive potential at point A will forward bias D3 and reverse bias D4.

The negative potential at point B will forward bias D1 and reverse D2. At this time D3 and D1 are forward biased and will allow current flow to pass through them; D4 and D2 are reverse biased and will block current flow.

The path for current flow is from point B through D1, up through RL, through D3, through the secondary of the transformer back to point B. this path is indicated by the solid arrows. Waveforms (1) and (2) can be observed across D1 and D3.

One-half cycle later the polarity across the secondary of the transformer reverse, forward biasing D2 and D4 and reverse biasing D1 and D3. Current flow will now be from point A through D4, up through RL, through D2, through the secondary of T1, and back to point A. This path is indicated by the broken arrows. Waveforms (3) and (4) can be observed across D2 and D4. The current flow through RL is always in the same direction. In flowing through RL this current develops a voltage corresponding to that shown waveform (5). Since current flows through the load (RL) during both half cycles of the applied voltage, this bridge rectifier is a full-wave rectifier.

One advantage of a bridge rectifier over a conventional full-wave rectifier is that with a given transformer the bridge rectifier produces a voltage output that is nearly twice that of the conventional full-wave circuit.

This may be shown by assigning values to some of the components shown in views A and B. assume that the same transformer is used in both circuits. The peak voltage developed between points X and y is 1000 volts in both circuits. In the conventional full-wave circuit shown—in view A, the peak voltage from the center tap to either X or Y is 500 volts. Since only one diode can conduct at any instant, the maximum voltage that can be rectified at any instant is 500 volts.

2.2.3 IC voltage regulator:

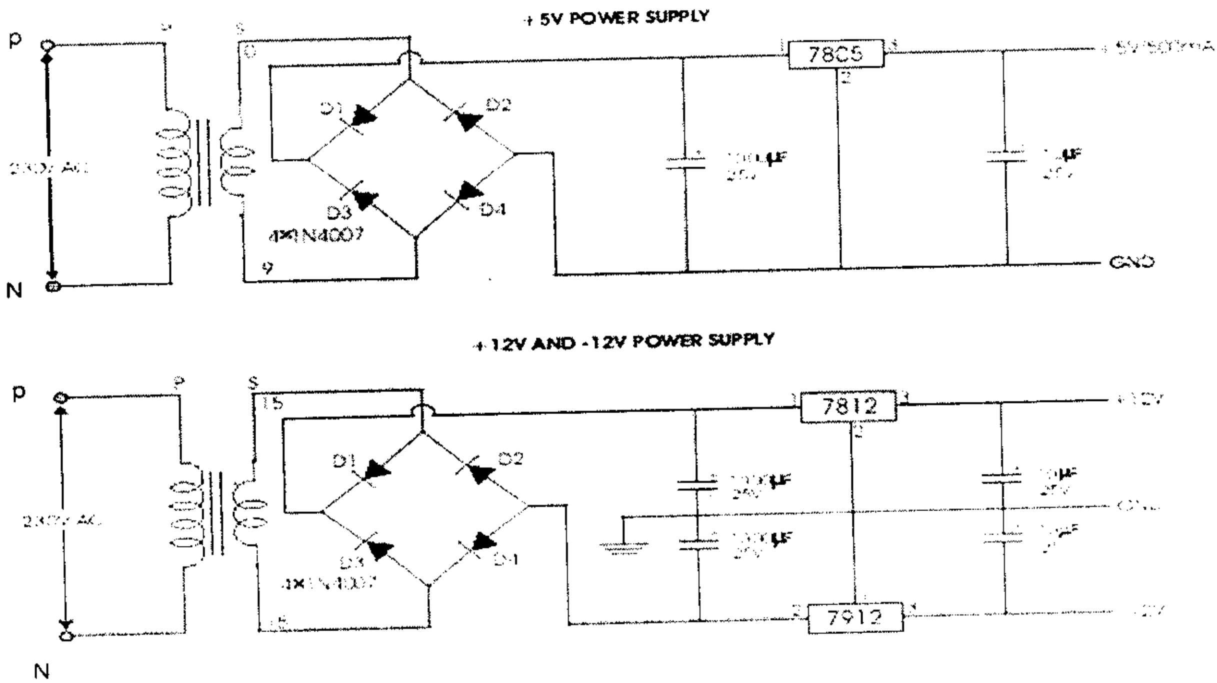


Fig: 8 and 9

Voltage regulators comprise a class of widely used ICs. Regulator IC units contain the circuitry for reference source, comparator amplifier, control either a fixed positive voltage, a fixed negative voltage, or an adjustably set voltage. The regulators can be selected for operation with load currents from hundreds of milli amperes to tens of amperes, corresponding to power ratings from milli watts to tens of watts.

A fixed three-terminal voltage regulator has an unregulated dc input voltage, Vi, applied to one input terminal, a regulated dc output voltage, Vo, from a second terminal, with the third terminal connected to ground.

The series 78 regulators provide fixed positive regulated voltages from 5 to 24 volts. Similarly, the series 79 regulators provide fixed negative regulated voltages from 5 to 24 volts.

- For ICs, microcontroller, LCD --------- 5 volts
- For alarm circuit, op-amp, relay circuits ---------- 12 volts

2.2.4.Three-Terminal Voltage Regulators:

The basic connection of a three-terminal voltage regulator IC to a load. The fixed voltage regulator has an unregulated dc input voltage, Vi, applied to one input terminal, a regulated output dc voltage, Vo, from a second terminal, with the third terminal connected to ground. For a selected regulator, IC device specifications list a voltage range over which the input voltage can vary to maintain a regulated output voltage over a range of load current. The specifications also list the amount of output voltage change resulting from a change in load current (load regulation) or in input voltage (line regulation).

The series 78 regulators provide fixed regulated voltages from 5 to 24 V. Figure 19.26 shows how one such IC, a 7812, is connected to provide voltage regulation with output from this unit of +12V dc. An unregulated input voltage Vi is filtered by capacitor C1 and connected to the IC's IN terminal. The IC's OUT terminal provides a regulated + 12V which is filtered by capacitor C2 (mostly for any high-frequency noise). The third IC terminal is connected to ground (GND).

TABLE : Positive Voltage Regulators in 7800 series

IC Part	Output Voltage (V)	Minimum Vi (V)
7805	+5	7.3
7806	+6	8.3
7808	+8	10.5
7810	+10	12.5
7812	+12	14.6
7815	+15	17.7
7818	+18	21.0
7824	+24	27.1

2.3 ULTRASONIC DISTANCE METER

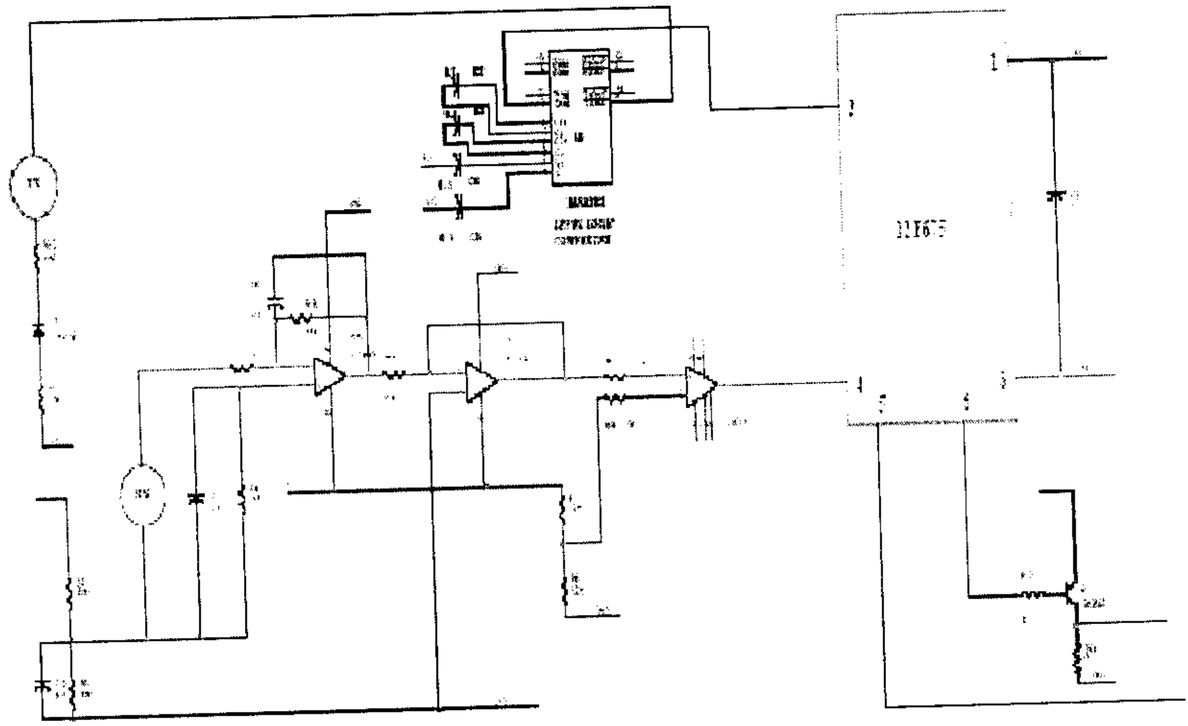


Fig: 10

2.3.1 Circuit Description:

This circuit is designed to measure the distance of the object with the help of ultrasonic waves. The 12F675 microcontroller is used to generate the 40 KHz frequency signal. This signal is given to level logic converter (MAX232) in order to convert to TTL output pulse to +12v and -12v pulse. Then this pulse is transmitted through ultrasonic transmitter.

The ultrasonic wave is spread in the air and hit the nearest object and reflected from the object which is received by the ultrasonic receiver. The received wave is given to amplifier in order to amplify the received weak signal. After the amplification the amplified wave is given to zero adjustment amplifier because the amplified wave is in the range of above 6v level. Then the output is given to comparator in which the wave signal is converted into corresponding square wave signal. Then the square wave signal is given to input of the microcontroller. Now the microcontroller compares the time between the transmitted signal and received signal and generates the corresponding pulse output which is equal to distance of the object. Then the pulse signal is given to input of BC547 transistor.

2.4. Digital Direction Sensor

This sensor provides eight directions of heading information by measuring the earth's magnetic field using hall-effect technology. The 1490 sensor is internally designed to respond to directional change similar to a liquid filled compass. It will return to the indicated direction from a 90 degree displacement in approximately 2.5 seconds with no over swing. The 1490 can operate tilted up to 12 degrees with acceptable error. It is easily interfaced to digital circuitry and microprocessors using only pull-up resistors.

Specifications:

Power	5-18 volts DC @ 30 ma
Outputs	Open collector NPN, sink 25 ma per direction
Weight	2.25 grams
Size	12.7 mm diameter, 16 mm tall
Pins	3 pins on 4 sides on .050 centers
Temp	-20 to +85 degrees C

3. GPS BASED VEHICLE TRACKING SYSTEM

CHAPTER 3

GPS BASED VEHICLE TRACKING SYSTEM

3.1 DESCRIPTION:

GPS is used in vehicles for both tracking and navigation. Tracking systems enable a base station to keep track of the vehicles without the intervention of the driver where, as navigation system helps the driver to reach the destination. Whether navigation system or tracking system, the architecture is more or less similar. The navigation system will have convenient, usually a graphic, display for the driver which is not needed for a tracking system. Vehicle Tracking Systems combine a number of well-developed technologies. Irrespective of the technology being used, VTS consist of three subsystems: a) In-vehicle unit (IVU), b) Base station and c) Communication link. The IVU includes a suitable position sensor and an intelligent controller together with an appropriate interface to the communication link. Thanks to the US Government announcement of 911E regulation, radio based position technology has witnessed a spurt of great developmental activities which is a positive sign.

The controller interacts with the GPS receiver, collects co-ordinates at predefined intervals, processes it and sends out to the communication link. Optionally in certain cases a man-machine- interface like a display with key board can be added for message communication between the driver and the base station.

The base station consists of a high-speed system running VTIS application software that will receive the position data from the vehicles and display on a digital map. It too will have the interface to the communication link. Enhanced features include video features, trace mode, history track, vehicle database, network support etc. Fig.3 gives the block diagram of a Base station.

The most costly part of a VTIS is the data link. The data link, together with a suitable communication protocol, has to be selected after a thorough study of various parameters such as the bandwidth requirement, number of vehicles to be tracked, expandability, terrain, area of coverage etc. Sophisticated VTIS are linked to data bases that can support information about the vehicles such as the cargo, the temperature of storage of perishable goods, fuel consumption rate etc. Naturally, such systems demand data link with higher bandwidth. UHF links are suitable for short range without shadow region, as they require line of sight. Cell phone based systems demand minimum infrastructure investment, but is limited in coverage. On the contrary, LEO based systems are expensive and offer largest coverage. The recently introduced WAP and GPRS technologies hold great promises for VTIS.

When multiple vehicles are being tracked, a suitable communication protocol need to be established to avoid collision of radio signal. The simple technique is TDMA, where each IVU communicates during predefined time slots. This synchronization is easy in a GPS based IVU as the GPS receiver provides very precise time reference signal. However, TDMA based systems have limited expandability, flexibility and are known for under-utilization of bandwidth.

The alternative is polling technique. Here each vehicle is addressed by the control station and in response the IVU sends the information. This arrangement enables variable polling rate for different vehicles, non-polling of specific vehicles and expansion of polling list as new vehicles are added

The relatively large investment needed for the communication link, makes VTIS an opportunity area for service providers. Fig. 4 shows the global market for GPS based VTIS in the next three years. In US and Europe many vehicle tracking service providers are already in operation. In a large country like India with a very long network of roads and long coastline, this opportunity area is yet to be exploited.

3.2 GPS ANTENNA

The designing, building, and testing a GPS antenna that would be implemented on the body or inside of a vehicle. This antenna would be different than others on the market in that it would not only utilize the L1 frequency (1575.42 MHz), but also the L5 frequency (1176.45 MHz) to be introduced in the future. Our goal is to also make it interoperable with the European counterpart to GPS, Galileo which uses 1164–1214 MHz and 1563–1591 MHz bands. In addition, we intend to gather the specifications for the LNA that would be needed for our specific antenna based on its gain, impedance, and other characteristics. If time allows, we intend to design and simulate the LNA using Agilent's Advanced Design System software package at the end as well.

3.2.1 **Benefits**:

- Antenna could be used presently because it would be utilizing the presently available L1 frequency
- L5 frequency will allow compatibility with the modernized GPS system in the future
- Be interoperable with the Galileo system so receiver would be capable of working with that system once it's fully online and functional
- Receiver would need only one antenna for both L1 and L5 frequencies

3.2.2 **Features:**

- Ability to receive both the presently available L1 frequency and the L5 frequency to be introduced in the future
- Interoperability with the Galileo system would allow receiver manufacturer to utilize this antenna
- Vehicle mounting of antenna would allow navigational tracking capability for any vehicle

3.3 GSM MODEM **OR MOBILE**

SMS on Nokia 5110/6110 via microcontroller

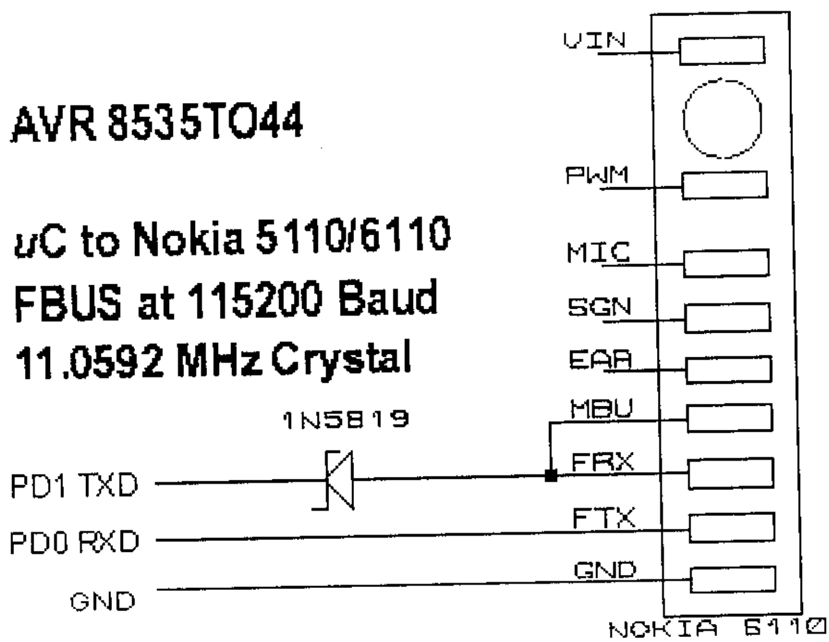


Fig: 11

The signal conditioning unit is constructed with operational amplifier which acts as comparator. It received the signal from all above mentioned transducer and generates the square pulse. Then this square pulse is given to microcontroller. Here the microcontroller may be Atmel or PIC both are flash type reprogrammable microcontroller in which we have already programmed with desired phone number.

The mobile phone is interfaced with microcontroller through data cable and RS 232. Data cable is the special type of cable available with mobile phone. RS 232 converts TTL logic to RS 232 logic. If any one transducer is activated due to that corresponding reason microcontroller send the related information to the mobile phone. The mobile phone sends this information as SMS to desired phone as per the phone number stored in the microcontroller.

4.MICROCONTROLLER

CHAPTER 4

MICROCONTROLLER

The robot of our project has been programmed to take a particular path and measure the wind speed and direction. For this purpose we are using microcontroller which inturn is interfaced with the personal computer. For our application, we are using PIC16F877.

4.1 PIC (16F877) :

The microcontroller that has been used for this project is from PIC series. PIC microcontroller is the first RISC based microcontroller fabricated in CMOS (complimentary metal oxide semiconductor) that uses separate bus for instruction and data allowing simultaneous access of program and data memory.

The main advantage of CMOS and RISC combination is low power consumption resulting in a very small chip size with a small pin count. The main advantage of CMOS is that it has immunity to noise than other fabrication techniques.

Various microcontrollers offer different kinds of memories. EEPROM, EPROM, FLASH etc. are some of the memories of which FLASH is the most recently developed. Technology that is used in pic16F877 is flash technology, so that data is retained even when the power is switched off. Easy Programming and Erasing are other features of PIC 16F877.

4.2 PIC START PLUS PROGRAMMER :

The PIC start plus development system from microchip technology provides the product development engineer with a highly flexible low cost microcontroller design tool set for all microchip PIC micro devices. The picstart plus development system includes PIC start plus development programmer and mplab ide.The PIC start plus programmer gives the product developer ability to program user software in to any of the supported microcontrollers. The PIC start plus software running under mplab provides for full interactive control over the programmer.

4.3 SPECIAL FEATURES OF PIC MICROCONTROLLER :

CORE FEATURES :

- High-performance RISC CPU
- Only 35 single word instructions to learn
- All single cycle instructions except for program branches which are two cycle
- Operating speed: DC - 20 MHz clock input

  DC - 200 ns instruction cycle
- Up to 8K x 14 words of Flash Program Memory,

  Up to 368 x 8 bytes of Data Memory (RAM)

  Up to 256 x 8 bytes of EEPROM data memory
- Pin out compatible to the PIC16C73/74/76/77
- Interrupt capability (up to 14 internal/external

- Eight level deep hardware stack
- Direct, indirect, and relative addressing modes
- Power-on Reset (POR)
- Power-up Timer (PWRT) and Oscillator Start-up Timer (OST)
- Watchdog Timer (WDT) with its own on-chip RC Oscillator for reliable operation
- Programmable code-protection
- Power saving SLEEP mode
- Selectable oscillator options
- Low-power, high-speed CMOS EPROM/EEPROM technology
- Fully static design
- In-Circuit Serial Programming (ICSP) via two pins
- Only single 5V source needed for programming capability
- In-Circuit Debugging via two pins
- Processor read/write access to program memory
- Wide operating voltage range: 2.5V to 5.5V
- High Sink/Source Current: 25 mA
- Commercial and Industrial temperature ranges
- Low-power consumption

4.4 PERIPHERAL FEATURES :

- Timer0: 8-bit timer/counter with 8-bit prescaler.
- Timer1: 16-bit timer/counter with prescaler, can be incremented during sleep via external crystal/clock
- Timer2: 8-bit timer/counter with 8-bit period register, prescaler and postscaler
- Two Capture, Compare, PWM modules
    - Capture is 16-bit, max resolution is 12.5 ns,
    - Compare is 16-bit, max resolution is 200 ns,
    - PWM max. resolution is 10-bit
- 10-bit multi-channel Analog-to-Digital converter
- Synchronous Serial Port (SSP) with SPI. (Master Mode) and I2C. (Master/Slave)
- Universal Synchronous Asynchronous Receiver Transmitter (USART/SCI) with 9- bit address detection.
- Brown-out detection circuitry **for Brown-out Reset (BOR)**

4.5 ARCHITECTURE OF PIC 16F877

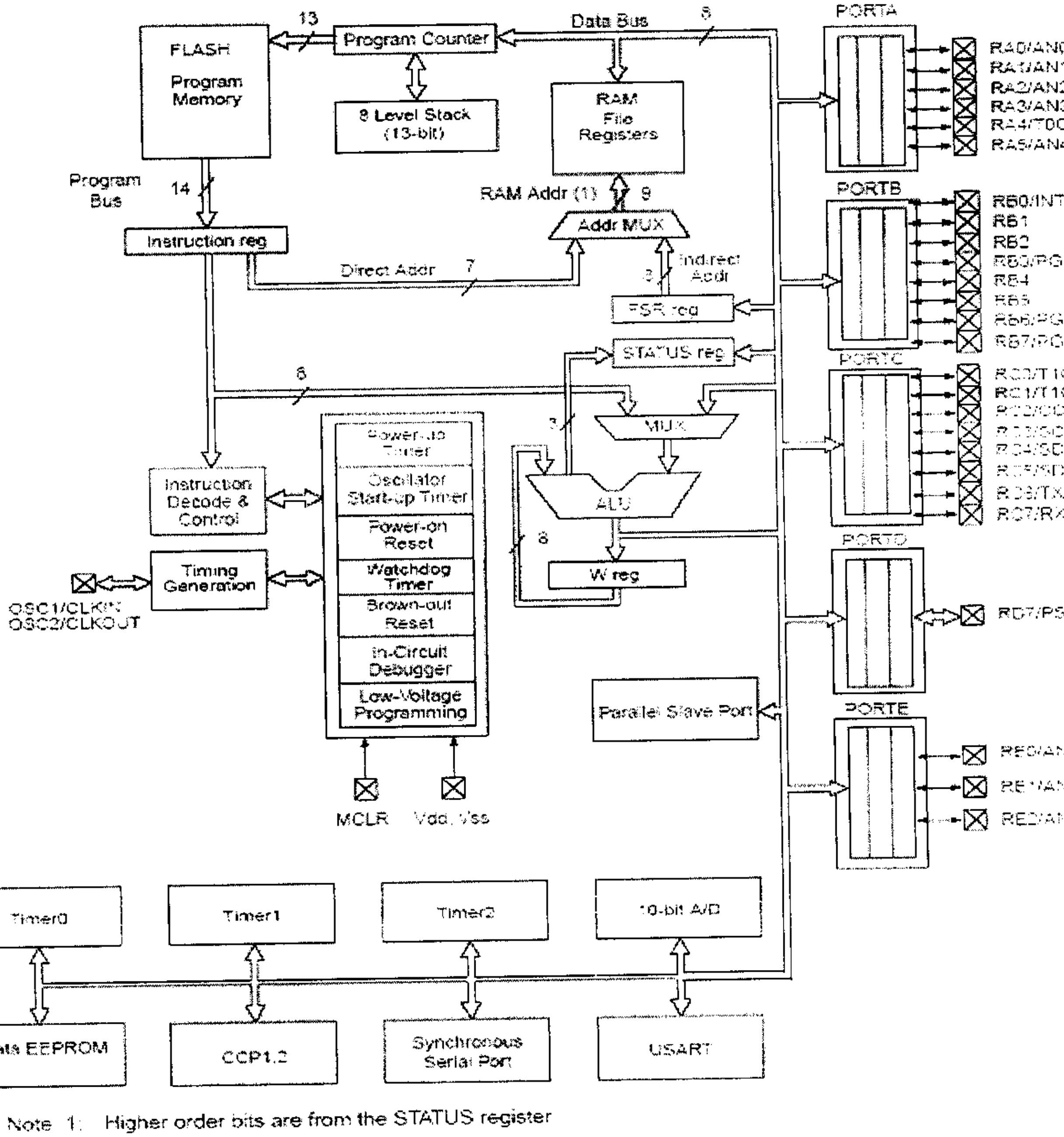
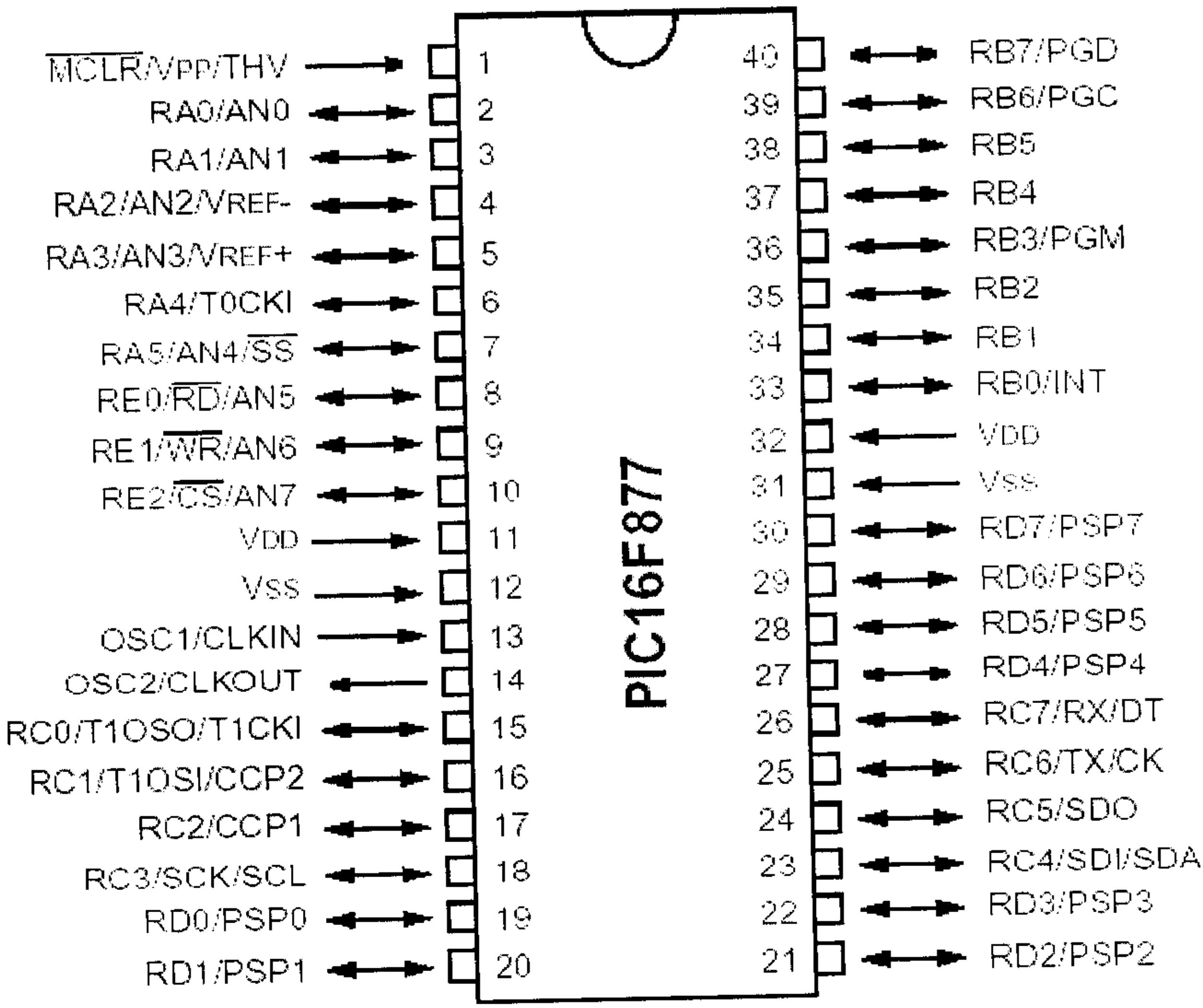


Fig: 12

4.6 SPECIFICATIONS

DEVICE	PROGRAM FLASH	DATA MEMORY	DATA EEPROM
PIC 16F877	8K	368 Bytes	256 Bytes

4.7 PIN DIAGRAM OF PIC 16F877



4.8 PIN OUT DESCRIPTION

Pin Name	DIP Pin#	PLCC Pin#	QFP Pin#	I/O/P Type	Buffer Type	Description
OSC1/CLKIN	13	14	30	I	ST/CMOS[4]	Oscillator crystal input/external clock source input.
OSC2/CLKOUT	14	15	31	O	—	Oscillator crystal output. Connects to crystal or resonator in crystal oscillator mode. In RC mode, OSC2 pin outputs CLKOUT which has 1/4 the frequency of OSC1, and denotes the instruction cycle rate.
$\overline{\text{MCLR}}$/V_{PP}/THV	1	2	18	I/P	ST	Master clear (reset) input or programming voltage input or high voltage test mode control. This pin is an active low reset to the device.
						PORTA is a bi-directional I/O port.
RA0/AN0	2	3	19	I/O	TTL	RA0 can also be analog input0
RA1/AN1	3	4	20	I/O	TTL	RA1 can also be analog input1
RA2/AN2/V_{REF-}	4	5	21	I/O	TTL	RA2 can also be analog input2 or negative analog reference voltage
RA3/AN3/V_{REF+}	5	6	22	I/O	TTL	RA3 can also be analog input3 or positive analog reference voltage
RA4/T0CKI	6	7	23	I/O	ST	RA4 can also be the clock input to the Timer0 timer/counter. Output is open drain type.
RA5/$\overline{\text{SS}}$/AN4	7	8	24	I/O	TTL	RA5 can also be analog input4 or the slave select for the synchronous serial port.
						PORTB is a bi-directional I/O port. PORTB can be software programmed for internal weak pull-up on all inputs.
RB0/INT	33	36	8	I/O	TTL/ST[1]	RB0 can also be the external interrupt pin.
RB1	34	37	9	I/O	TTL	
RB2	35	38	10	I/O	TTL	
RB3/PGM	36	39	11	I/O	TTL	RB3 can also be the low voltage programming input
RB4	37	41	14	I/O	TTL	Interrupt on change pin.
RB5	38	42	15	I/O	TTL	Interrupt on change pin.
RB6/PGC	39	43	16	I/O	TTL/ST[2]	Interrupt on change pin or In-Circuit Debugger pin. Serial programming clock.
RB7/PGD	40	44	17	I/O	TTL/ST[2]	Interrupt on change pin or In-Circuit Debugger pin. Serial programming data.

Legend: I = input O = output I/O = input/output P = power — = Not used TTL = TTL input ST = Schmitt Trigger input

5. RS232 COMMUNICATION

CHAPTER 5

RS232 COMMUNICATION

5.1 INTRODUCTION:

In telecommunications, **RS-232** is a standard for serial binary data interconnection between a *DTE* (Data terminal equipment) and a *DCE* (Data Circuit-terminating Equipment). It is commonly used in computer serial ports.

5.2 CIRCUIT DIAGRAM

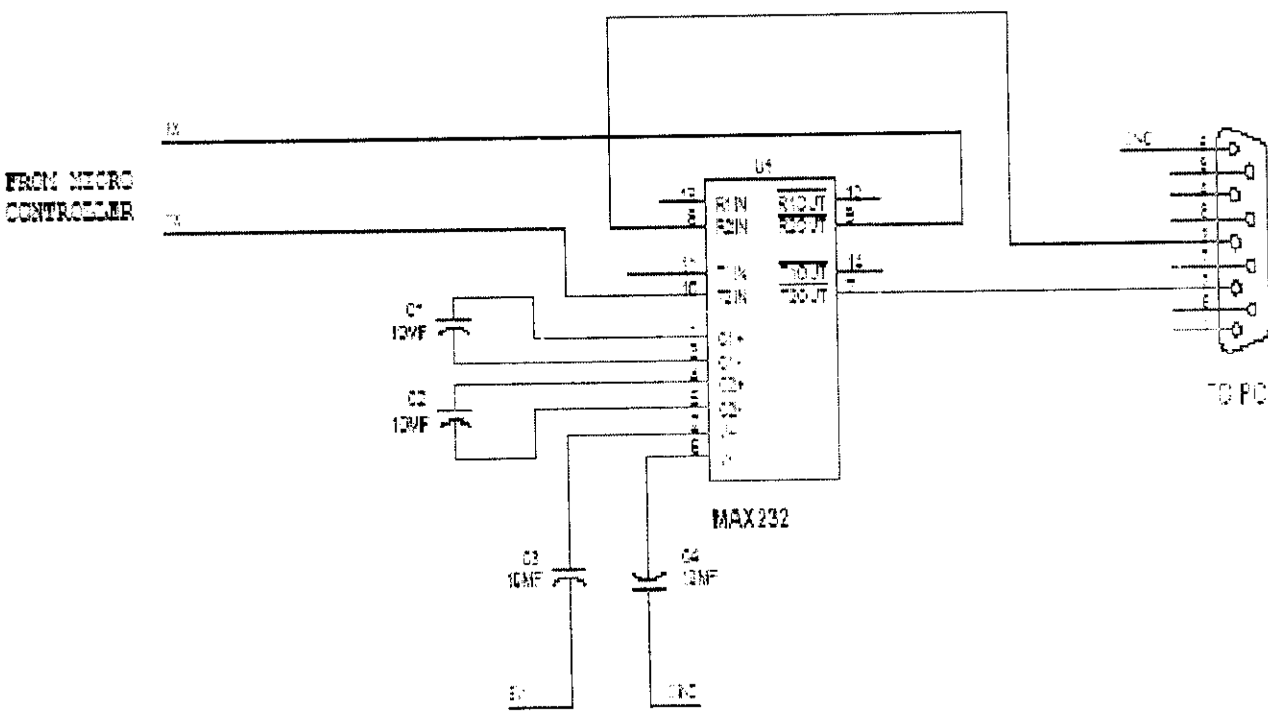


Fig: 13

5.3 Scope of the Standard:

The Electronic Industries Alliance (EIA) standard RS-232-C [3] as of 1969 defines:

- Electrical signal characteristics such as voltage levels, signaling rate, timing and slew-rate of signals, voltage withstand level, short-circuit behavior, maximum stray capacitance and cable length
- Interface mechanical characteristics, pluggable connectors and pin identification
- Functions of each circuit in the interface connector
- Standard subsets of interface circuits for selected telecom applications

The standard does not define such elements as character encoding (for example, ASCII, Baudot or EBCDIC), or the framing of characters in the data stream (bits per character, start/stop bits, parity). The standard does not define protocols for error detection or algorithms for data compression.

The standard does not define bit rates for transmission, although the standard says it is intended for bit rates lower than 20,000 bits per second. Many modern devices can exceed this speed (38,400 and 57,600 bit/s being common, and 115,200 and 230,400 bit/s making occasional appearances) while still using RS-232 compatible signal levels.

Details of character format and transmission bit rate are controlled by the serial port hardware, often a single integrated circuit called a UART that converts data from parallel to serial form. A typical serial port includes specialized driver and receiver integrated circuits to convert between internal logic levels and RS-232 compatible signal levels.

5.4 Circuit working Description:

In this circuit the MAX 232 IC used as level logic converter. The MAX232 is a dual driver/receiver that includes a capacive voltage generator to supply EIA 232 voltage levels from a single 5v supply. Each receiver converts EIA-232 to 5v TTL/CMOS levels. Each driver converts TLL/CMOS input levels into EIA-232 levels.

Function Tables

EACH DRIVER

INPUT TIN	OUTPUT TOUT
L	H
H	L

H = high level, L = low level

EACH RECEIVER

INPUT RIN	OUTPUT ROUT
L	H
H	L

H = high level, L = low level

logic diagram (positive logic)

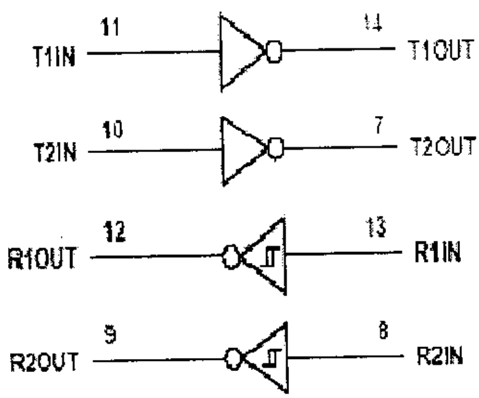


Fig: 14

In this circuit the microcontroller transmitter pin is connected in the MAX232 T2IN pin which converts input 5v TTL/CMOS level to RS232 level. Then T2OUT pin is connected to reviver pin of 9 pin D type serial connector which is directly connected to PC.

In PC the transmitting data is given to R2IN of MAX232 through transmitting pin of 9 pin D type connector which converts the RS232 level to 5v TTL/CMOS level. The R2OUT pin is connected to receiver pin of the microcontroller. Likewise the data is transmitted and received between the microcontroller and PC or other device vice versa.

Meet or Exceed TIA/EIA-232-F and ITU Recommendation V.28

Operate With Single 5-V Power Supply

Operate Up to 120 kbit/s

Two Drivers and Two Receivers

±30-V Input Levels

Low Supply Current . . . 8 mA Typical

Designed to be Interchangeable With Maxim MAX232

ESD Protection Exceeds JESD 22-2000-V Human-Body Model(A114-A)

5.5 Applications

TIA/EIA-232-F

Battery-Powered Systems

Terminals

Modems

Computers

5.6 Description/ordering information

The MAX232 is a dual driver/receiver that includes a capacitive voltage generator to supply EIA-232 voltage levels from a single 5-V supply. Each receiver converts EIA-232 inputs to 5-V TTL/CMOS levels. These receivers have a typical threshold of 1.3 V and a typical hysteresis of 0.5 V, and can accept ±30-V inputs. Each driver converts TTL/CMOS input levels into EIA-232 levels.

CONCLUSION AND FUTURE SCOPE

CONCLUSION AND FUTURE SCOPE

In this paper, design of a low cost autonomous capable of changing destination on run time is presented for transportation of light weight equipment inside the university campus. Equipped with various sensors, the vehicle has the capability of navigating in complex environments avoiding the obstacles in its way and reaching the target.

This vehicle is used for mine site clearing, factory automation, hazardous environment, planetary exploration, law enforcement, security guarding, warfields.

The complexity of the system is reduced by making it modular i.e., more modules can easily be added to system by setting their priority level in the PIC controller. This low cost solution can also be used in wheel chairs as a navigation aid for disabled persons.

REFERENCES

REFERENCES

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2.Jonathan Milton Turner, obstacle avoidance and path traversal using interactive machine learning , M.S Thesis, Brigham Young University, August 2007.

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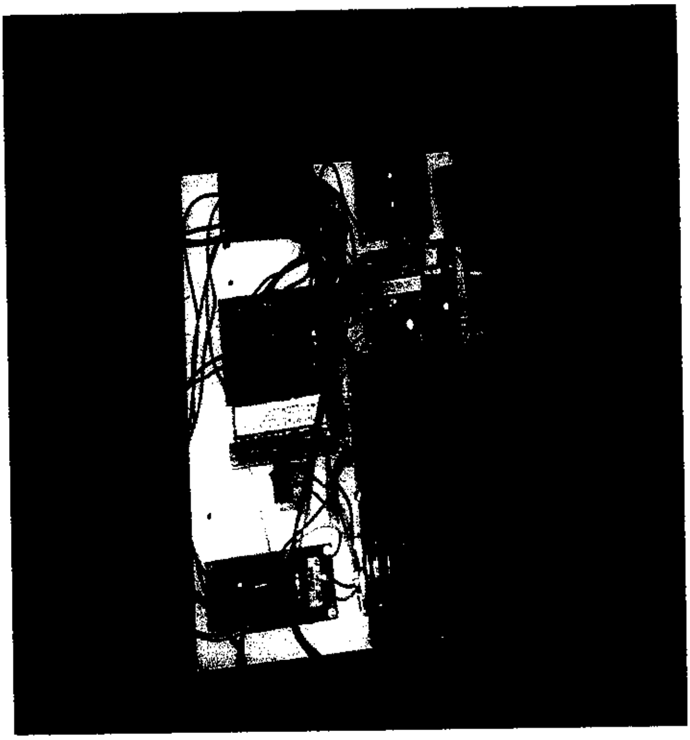
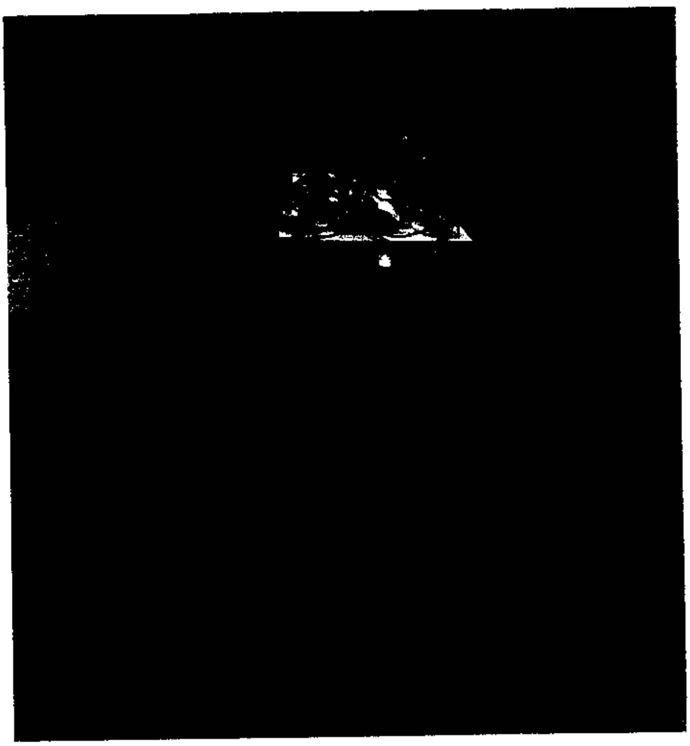
APPENDIX A





APPENDIX B

PROGRAM:

```
#include<pic.h>
#include"pic_lcd8.h"
#include"pic_serial.h"
#define c1 RB0
#define c2 RB1
#define c3 RB2
#define c4 RB3
#define r1 RB4
#define r2 RB5
#define r3 RB6
#define r4 RB7
#define relay RC2
#define tx RC0
#define rx RC1
bank2 unsigned char x,val[80],m[90],t,sec,count,sec1,j,pp,kc,cu,i,dd;
unsigned int lat[15],lon[15],i1,num[10],k,gp[10],ii;
unsigned int count1,count2,inch1,inch2,result,dis1;
unsigned int g1,g2,g11,g22;
bit g5,fd,rv,rt,lt;
unsigned char ff;


void msg_send();
void msg_read();
void Distance_Measure1();
void main()
{
```

```
TRISD=0X00;
TRISC=0XC2;
TRISB=0X0F;
Lcd8_Init();
r1=r2=r3=r4=1;
Lcd8_Display(0x80,"AUTOPILOT VEHICLE",16);
Lcd8_Display(0xc0,"                ",16);
Delay(65000);Delay(65000);
Serial_Init(4800);
Receive(1);dd=1;
GIE=1;
PEIE=1;
T0IE=1;
OPTION = 0x07;
TMR0 = 61;

g1=g2=0;fd=rt=rv=lt=g5=0;ff=0;
while(1)
{
            Lcd8_Decimal2(0xc0,sec);
            if(sec>29)
            {
                T0IE=0;
                count=0;
                sec=0;
                relay=1;
                dd=0;
                msg_read();
                Delay(65000);
```

```
        relay=0;dd=1;
        Serial_Init(4800);
        Delay(65000);
        x=0;
        Receive(1);
        Delay(65000);
        T0IE=1;TMR0=61;
}
Distance_Measure1();
if(dis1<10)
{
        r1=r2=r3=r4=1;Delay(65000);Delay(65000);
        r1=r4=0;r2=r3=1;Delay(65000);Delay(65000);
        r1=r4=1;r2=r3=0;Delay(65000);Delay(65000);
}
if(x>68)
{
        Receive(0);
        Lcd8_Display(0x80,"LON:",4);
        for(i1=32;i1<=43;i1++)
        {
                Lcd8_Write(0x84+i1-32,val[i1]);
        }
        Delay(15000);
        Lcd8_Display(0xc0,"LAT:",4);
        for(i1=20;i1<32;i1++)
        {
                Lcd8_Write(0xc4+i1-20,val[i1]);
        }
```

```
                        g11=((val[38]-48)*1000)+((val[39]-48)*100)+((val[40]-
48)*10)+(val[41]-48);
                        g22=((val[25]-48)*1000)+((val[26]-48)*100)+((val[27]-
48)*10)+(val[28]-48);
                        relay=0;dd=1;
                        Serial_Init(4800);
                        Delay(65000);
                        x=0;
                        Receive(1);
                        Delay(65000);
                  }
             if(ff==1)
             {
                  Lcd8_Command(0x01);
                  Lcd8_Decimal4(0x8c,g1);Lcd8_Decimal4(0xcc,g2);
                  Lcd8_Decimal4(0x86,g11);Lcd8_Decimal4(0xc6,g22);
                  if(g2>g22+300){fd=1;rv=0;}
                  else if(g2<g22-300){rv=1;fd=0;}
                  else {rv=fd=0;}
                  if(g1>g11+300){rt=1;lt=0;}
                  else if(g1<g11-300){lt=1;rt=0;}
                  else {rt=lt=0;}
             }
             if(fd && ff){Lcd8_Display(0x80,"FWD",3);r1=r3=0;r2=r4=1;}
             else if(rv && ff){Lcd8_Display(0x80,"REV",3);r1=r3=1;r2=r4=0;}


             if(!fd && !rv && rt &&
  ff){Lcd8_Display(0x80,"RGT",3);r1=r4=0;r2=r3=1;}
             else if(!fd && !rv && lt &&
  ff){Lcd8_Display(0x80,"LFT",3);r1=r4=1;r2=r3=0;}
```

```
		else if(!fd && !rv && !rt &&
!lt){Lcd8_Display(0x80,"STP",3);ff=0;r1=r4=1;r2=r3=1;}

	}

}
void interrupt serial()

{

	if(RCIF)

	{

	if(dd)

	{		RCIF = 0;

	val[x] = RCREG;

			if(val[0]!='$'){x=0;goto last;}

			else if(val[0]=='$'&&val[1]!='G'){x=1;goto last;}

			else if(val[0]=='$'&&val[1]=='G'&&val[2]!='P'){x=2;goto last;}

			else
if(val[0]=='$'&&val[1]=='G'&&val[2]=='P'&&val[3]!='R'){x=3;goto last;}

			else
if(val[0]=='$'&&val[1]=='G'&&val[2]=='P'&&val[3]=='R'&&val[4]!='M'){x=4;goto
last;}

			else
if(val[0]=='$'&&val[1]=='G'&&val[2]=='P'&&val[3]=='R'&&val[4]=='M'&&val[5]!='
C'){x=5;goto last;}

			if(x<80)x++;

			last: ;

	}

	if(!dd)

	{

		m[t]=RCREG;

		t++;

		RCIF=0;

	}
```

```
}
        if(TMR0IF)
                {
                count++;
                TMR0IF=0;
                if(count>=20)
                        {
                                sec++;count=0;
                        }
                TMR0 = 61;
                }
}
void msg_read()
{
        relay=1;dd=0;
        Serial_Init(9600);
        Delay(65500);Delay(65500);
        Lcd8_Display(0x80,"MSG READING.....",16);
        Lcd8_Display(0xc0,"................",16);
        Serial_Out('A');Serial_Out('T');
        Serial_Out(0x0d);Serial_Out(0x0a);
        Delay(65000);Delay(40000);
        Serial_Conout("AT+CMGF=1",9);
        Serial_Out(0x0d);Serial_Out(0x0a);
        Delay(65000);Delay(40000);
        Serial_Conout("AT+CMGR=1",9);
        Serial_Out(0x0d);Serial_Out(0x0a);
        t=0;
        Receive(1);
```

```
Delay(65000);Delay(40000);
Delay(65000);Delay(40000);
Delay(65000);Delay(40000);
Delay(65000);Delay(40000);
Delay(65000);Delay(40000);
Receive(0);
if(t>60)
        { for(k=40;k<90;k++)
                { Delay(4000);
                        if((m[k]=='*'))
                        {  g2=((m[k+1]-48)*1000)+((m[k+2]-48)*100)+((m[k+3]-
48)*10)+(m[k+4]-48);
                                g1=((m[k+6]-48)*1000)+((m[k+7]-
48)*100)+((m[k+8]-48)*10)+(m[k+9]-48);
                                ff=1;
                                Lcd8_Display(0x80,".......ON.......",16);
                                goto end;
                        }
                }
end:            Delay(60000);Lcd8_Display(0xc0,"                ",16);
                Serial_Conout("AT+CMGD=1,4",11);
                Serial_Out(0x0d);Serial_Out(0x0a);
                Delay(65000);Delay(40000);k=0;
                Lcd8_Command(Clear_Display);
        }
}
void Distance_Measure1()
{
count=count1=0;
```

```
TMR1ON=0;TMR1H=TMR1L=0x00; //Chk0=1;
for(i=0;i<5;i++)          // For taking 5 sample values
{
        tx=0;             // Make tx pin is low
        Delay(1000);
        tx=1;             // Make tx pin is high
        Delay(10);
        tx=0;              // for avoiding initial random values
        while(rx==0);
        TMR1ON=1;
        while(rx==1);
        TMR1ON=0;
        count1=TMR1H<<8;         // left shift for 8times(same as muliplying by
        count1=count1|TMR1L;       // Bitwise OR operation between THO and TLO
        TMR1H=TMR1L=0x00;
        count2=count2+count1;    // adding previous value with current value
        Delay(5000);          // delay process decrements untill zero
}
count1=count2/5;
inch1=count1%10000/1000;
inch2=count1%1000/100;
result=(inch1*10)+inch2;
dis1=result;
Lcd8_Decimal2(0X8D,dis1);Delay(65000);
}
```