WIRELESS MULTIPURPOSE ROBOT

A PROJECT REPORT

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BONAFIDE CERTIFICATE

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ABSTRACT

Wireless Multipurpose Robot involves a robot pair made of the parent robot and the autonomous robot. The parent robot is manually controlled from a computer. The commands from the computer to the robot are communicated wirelessly through a radio frequency transmitter and receiver module. This robot is equipped with a camera for surveillance purposes. The parent robot will also act as a carrier for the smaller autonomous robot.

The autonomous robot is equipped with a simple fire extinguishing mechanism. The autonomous robot traces a path adjacent to the wall and in case of fire, stops and puts off the flame automatically. The autonomous robot operates according to the response from the various sensor modules placed on it. Fire fighting is one of the several applications of the autonomous robot. It can be easily reprogrammed to perform various other operations.

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1. INTRODUCTION

1.1 Introduction to the field of Robotics

Robotics is the engineering science and technology of robots, and their design, manufacture, application, and structural disposition. Robotics is related to electronics, mechanics and software. A robot may be defined as a device that automatically performs complicated often repetitive tasks", or a "mechanism guided by automatic controls". The components of a basic typical robot include a power source, the driver circuitry, motors (for the purpose of actuation) and the sensor modules.

Much of the research in robotics focuses not on specific industrial tasks, but on investigations into new types of robots, alternative ways to think about or design robots, and new ways to manufacture them.

Few of the emerging robotics technologies are

1. Swarm Robotics which focuses on complexity in behavior with simplicity in design
2. Nano robotics which focuses on desktop devices and small parts production
3. Powered exoskeleton which focuses on heavy lifting, electric wheelchairs etc
4. Humanoid robotics which focuses on making human-like robots for the purpose of household applications.

The field of robotics is an emerging field in this modern day world. Right from a simple toy to a complex defense purpose device, robotics plays an important role.

1.2 Overview of the Project

The main objective of the project is to come up with a robot pair. One of the robots in the pair, the parent robot is used for surveillance purposes, while the other is an autonomous robot used to carry out a specific operation. The parent robot is controlled from a computer through a radio frequency channel.

The word *surveillance* may be applied to observation from a distance by means of electronic equipment or interception of electronically transmitted information. Here, an attempt has been made to implement a surveillance robot which performs basic-level surveillance in an alien environment (e.g. a laboratory, an industry chamber, etc). A surveillance robot can be used for various applications such as defense purposes, mining, fire extinguishing, rescue operations during earthquakes, etc.

The application chosen is fire extinguishing. This means that these robots can be used in buildings or industries in case of hazardous fires. The surveillance robot will also act as a carrier for the smaller autonomous robot.

Hence, these robots can be navigated to travel in an alien environment from the base station (computer) and in case a fire is viewed via surveillance cameras, then the fire extinguishing mechanism can be triggered to put out the fire, using the autonomous robot.

1.3 Need for the project

There are several surveillance robots commercially available in the market. But providing surveillance capability along with a specific application is not very common. It is also possible to take snapshots at anytime during surveillance. Further, the idea of two robots working together is really new and unique. Swamp robotic technique is used to carry the autonomous robot within the parent robot. The deployment feature is very advantageous and can be further exploited in case more number of autonomous robots is used.

2. MANUAL MODE

2.1 Manual Mode Operation

In this mode, the parent robot is manually navigated through computer commands. A simple Visual Basic (VB.NET) program is used to generate a code respective to the user command. As shown in the Fig 2.1, this code is sent from the computer to the encoder via parallel port. This code is then encoded and sent serially through the data output pin of the encoder to the RF transmitter. The RF signal is then transmitted through the antenna at a frequency of 433 MHz. The received signal is sent from the RF receiver to the decoder after amplification and carrier demodulation. The decoder then sends the parallel data to the microcontroller.

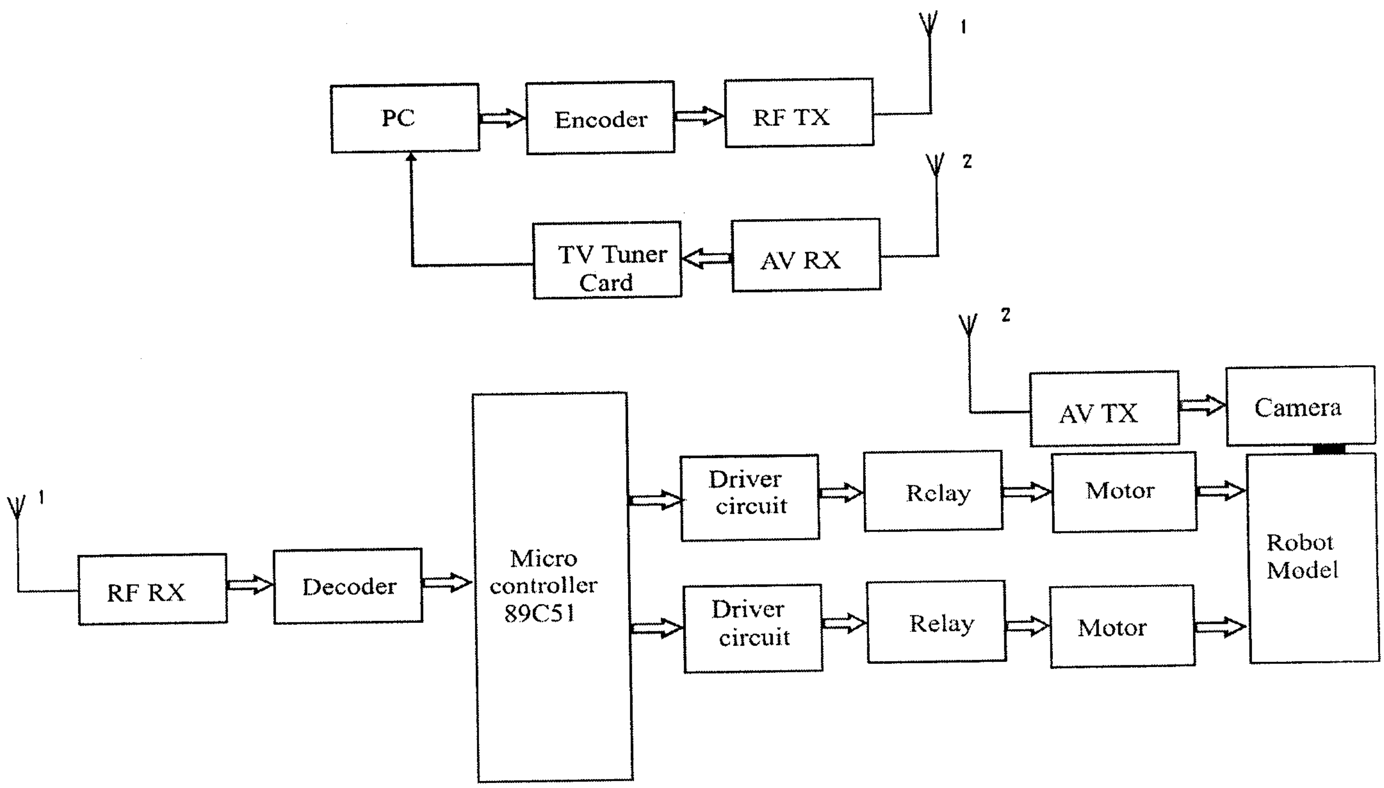


Fig 2.1 Block Description of Manual Mode

The microcontroller plays an important role in navigating the parent robot. The signal from the decoder is fed to the microcontroller input ports. The motor relay is connected to the output ports of the microcontroller. Depending on the encoded data, the respective relays are activated. This controls the movements of the robot.

The main feature of the parent robot is surveillance. A wireless camera is placed on the top of the robot. The AV receiver is connected to the PC via a TV tuner card. This constant video feed obtained through the camera is helpful in navigating the robot.

2.2 PC Interface

The parent robot is operated through the commands from the PC. A Visual Basic (VB.net) program is used to send specific data through the computer parallel port. Commands such as 'Forward', 'Reverse', 'Stop', 'Left' and 'Right' are used to control the robot accordingly. This VB tool is shown in Fig 2.2.

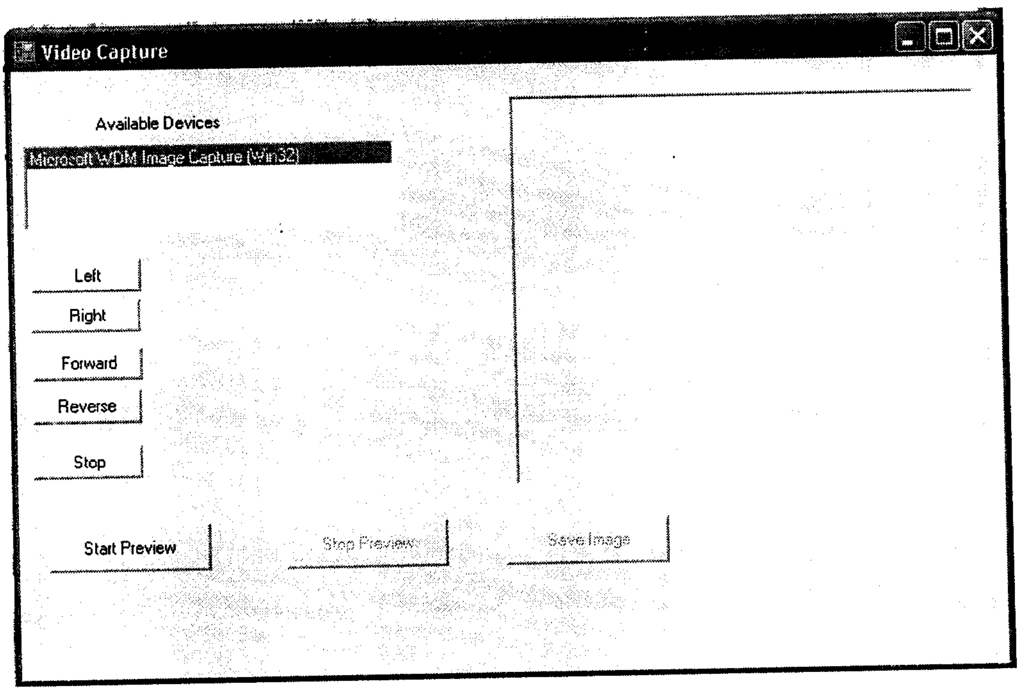


Fig 2.2 Visual Basic Tool for Controlling Robot

2.3 Encoder and RF Transmitter

2.3.1 General Description of Encoder

HT 640 IC is used as the encoder in this project. The 3^{18} encoders are a series of CMOS LSIs for remote control system application. They are capable of encoding 18 bits of information which consists of N address bits and 18-N data bits. Various packages of the 3^{18} encoders offer flexible combination of programmable address/data, which is transmitted together with the header bits via an RF or an infrared transmission medium upon receipt of a trigger signal. The capability to select a Transmission Enable (TE) trigger type further enhances the application flexibility of the 3^{18} series of encoders. The pin configuration of the encoder is given below in Fig 2.3.

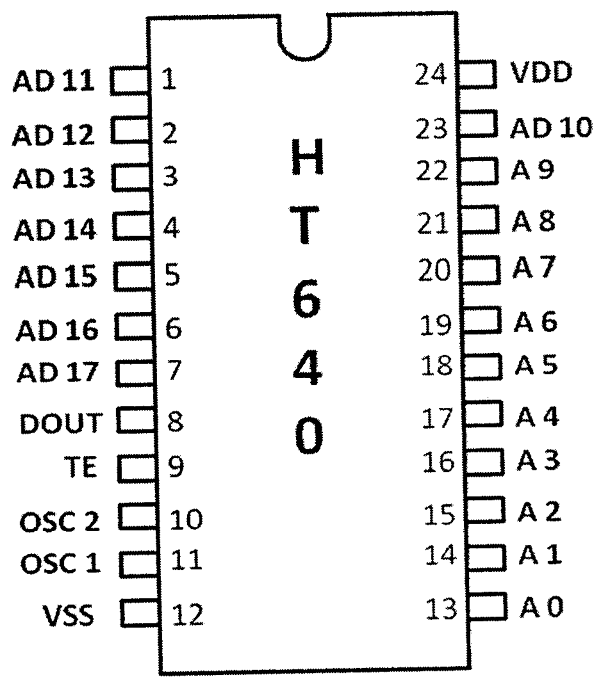
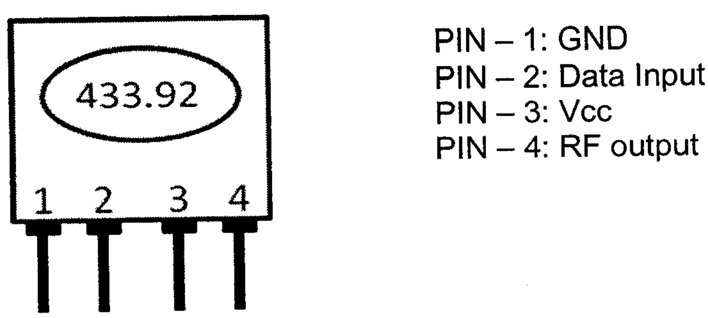


Fig 2.3 Pin Diagram of HT 640 Encoder

As shown in the Fig 3, the pins A0-A11 are used as input pins for address setting. They can be externally set to VDD, VSS or left open. AD10 ~ AD17 can be used as input pins for address/data setting. Similarly D12-D17 acts as input pins for data setting. They can be externally set to VDD or left open. DOUT is the encoder data serial transmission output. TE pin is Transmission Enable (active high). OSC1 is the oscillator input pin. OSC2 is the oscillator output pin. VSS acts as the ground pin and VCC acts as the positive power supply pin.

2.3.2 General Description of RF Transmitter

The RF transmitter module as shown in Fig 2.4 is situated at the PC site which transmits the encoded data after processing to the receiver. The TWS-434 transmitter module and RWS-434 receiver module are extremely small, and are excellent for applications requiring short-range RF remote controls. The transmitter module is only 1/3 the size of a standard postage stamp, and can easily be placed inside a small plastic enclosure. The TWS-434 transmitter output is up to 8mW at 433.92MHz with a range of approximately 200 foot, and will go through most walls.



Frequency: 433.92 MHz
Modulation: AM
Operating Voltage: 2 – 12 V

Fig 2.4 Transmitter Module

2.3.3 Functional Description

The 3^{18} series of encoders begins a three-word transmission cycle upon receipt of a transmission enable (active high). This cycle will repeat itself as long as the transmission enable (TE or D12~D17) is held high. Once the transmission enable falls low, the encoder output completes its final cycle and then stops as shown in Fig 2.5.

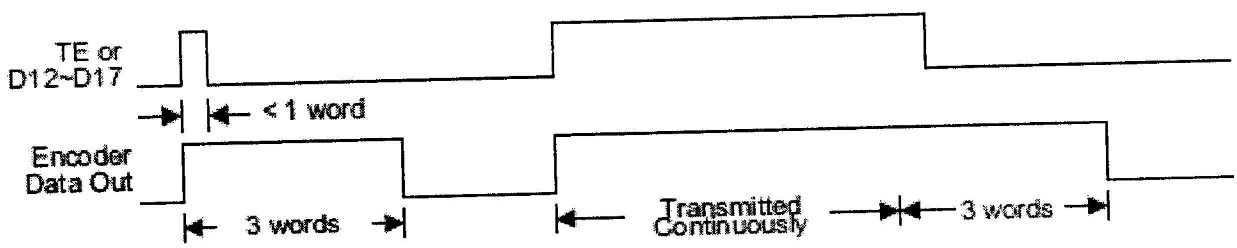


Fig 2.5 Timing Diagram of Encoder

The input signal to be encoded is given to AD7-AD0 input pins of encoder as shown in Fig 2.6. The input signal may be from key board, parallel port, microcontroller or any interfacing device. The encoder output address pins are shorted so the output encoded signal is the combination of (A0-A9) address signal and (D0-D7) data signal. The output encoded signal is taken from 8th pin which is connected to the RF transmitter section.

Whenever the high output pulse is given to base of the transistor BF 494, the transistor is conducting so tank circuit is oscillated. The tank circuit is consists of L2 and C4 generating 433 MHz carrier signal. Then the modulated signal is given LC filter section. After the filtration the RF modulated signal is transmitted through antenna.

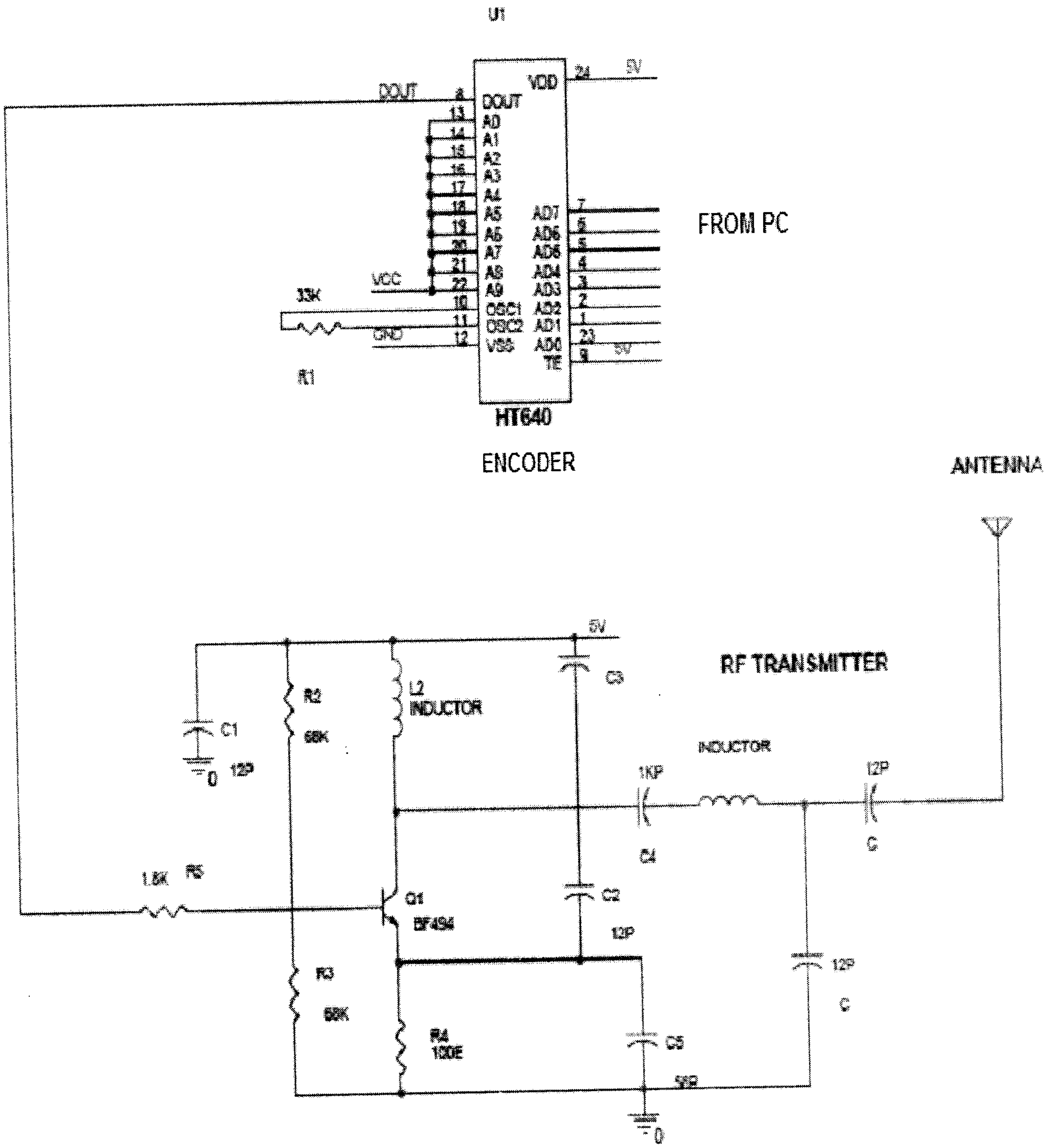


Fig 2.6 Circuit Diagram of Encoder and RF Transmitter

2.4 Decoder and RF Receiver

2.4.1 General Description of RF Receiver

The RF receiver module as shown in Fig 2.7 is situated on top of the parent robot. It is then connected to the HT 648L decoder IC which decodes the received data from the PC. The RWS – 434 receiver module operates at a frequency of 433.92MHz and has a sensitivity of 3 micro volts. The RWS-434 receiver operates from 4.5 to 5.5 volts DC, and has both linear and digital outputs. The working range is approximately 200 feet.

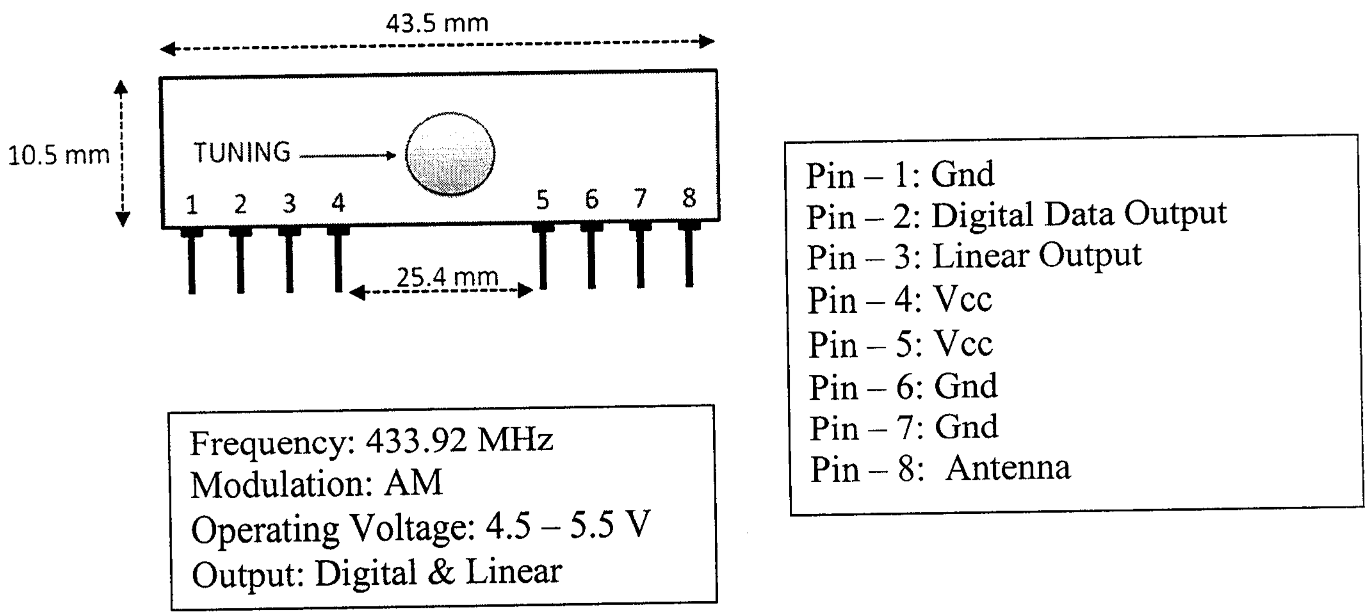


Fig 2.7 Receiver Module

2.4.2 General Description of Decoder

The 3^{18} decoders are a series of CMOS LSIs for remote control system applications. They are paired with the 3^{18} series of encoders. For proper operation a pair of encoder/decoder pair with the same number of address and data format should be selected.

The 3^{18} series of decoders receives serial address and data from that series of encoders that are transmitted by a carrier using an RF or an IR transmission medium. They are capable of decoding 18 bits of information that consists of N bits of address and 18–N bits of data. The data pins range from 0 to 8 and the address pins range from 8 to 18. In addition, the 3^{18} decoders provide various combinations of address/data number in different packages.

The pins A0-A17 are used as input pins for address setting as shown in the Fig 2.8. They can be externally set to VDD, VSS or left open. D10 ~ D17 are used as output data pins. DIN is the serial data input pin. VT pin indicates valid transmission (active high). OSC1 is the oscillator input pin. OSC2 is the oscillator output pin. VSS acts as the ground pin and VCC acts as the positive power supply pin.

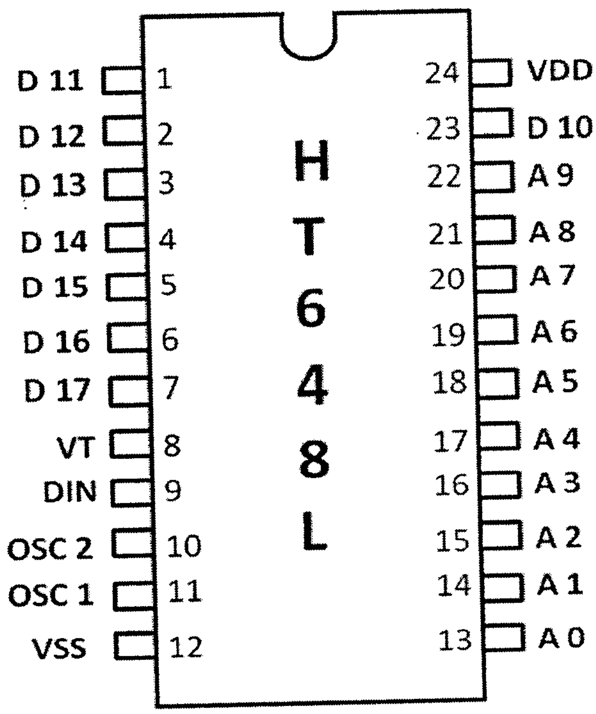


Fig 2.8 Pin Diagram of HT648L Decoder

2.4.3 Functional Description

The RF receiver as shown in the Fig 2.9 is used to receive the encoded data which is transmitted by the RF transmitter. Then the received data is given to transistor which acts as an amplifier. Then the amplified signal is given to carrier demodulator section in which transistor Q1 is turned on and turned off conducting depending on the signal. Due to this operation, the capacitor C14 is charged and discharged so that the carrier signal is removed. A saw tooth signal appears across the capacitor. Then this saw tooth signal is given to comparator. The LM558 comparator is used to convert the saw tooth signal to exact square pulse.

A signal on the DIN pin then activates the oscillator which in turns decodes the incoming address and data. The decoder separates the address (A0-A9) and data signal (D0-D7). It interprets the first N bits of the code period as address and the last 18–N bits as data (where N is the address code number). The decoders will check the received address twice continuously. If all the received address codes match the contents of the decoder's local address, the 18–N bits of data are decoded to activate the output pins, and the VT pin is set high to indicate a valid transmission. That will last until the address code is incorrect or no signal has been received. The output of the VT pin is high only when the transmission is valid. Otherwise it is low always. Then the output data signal generated is given to the ATMEL 89C51 microcontroller.

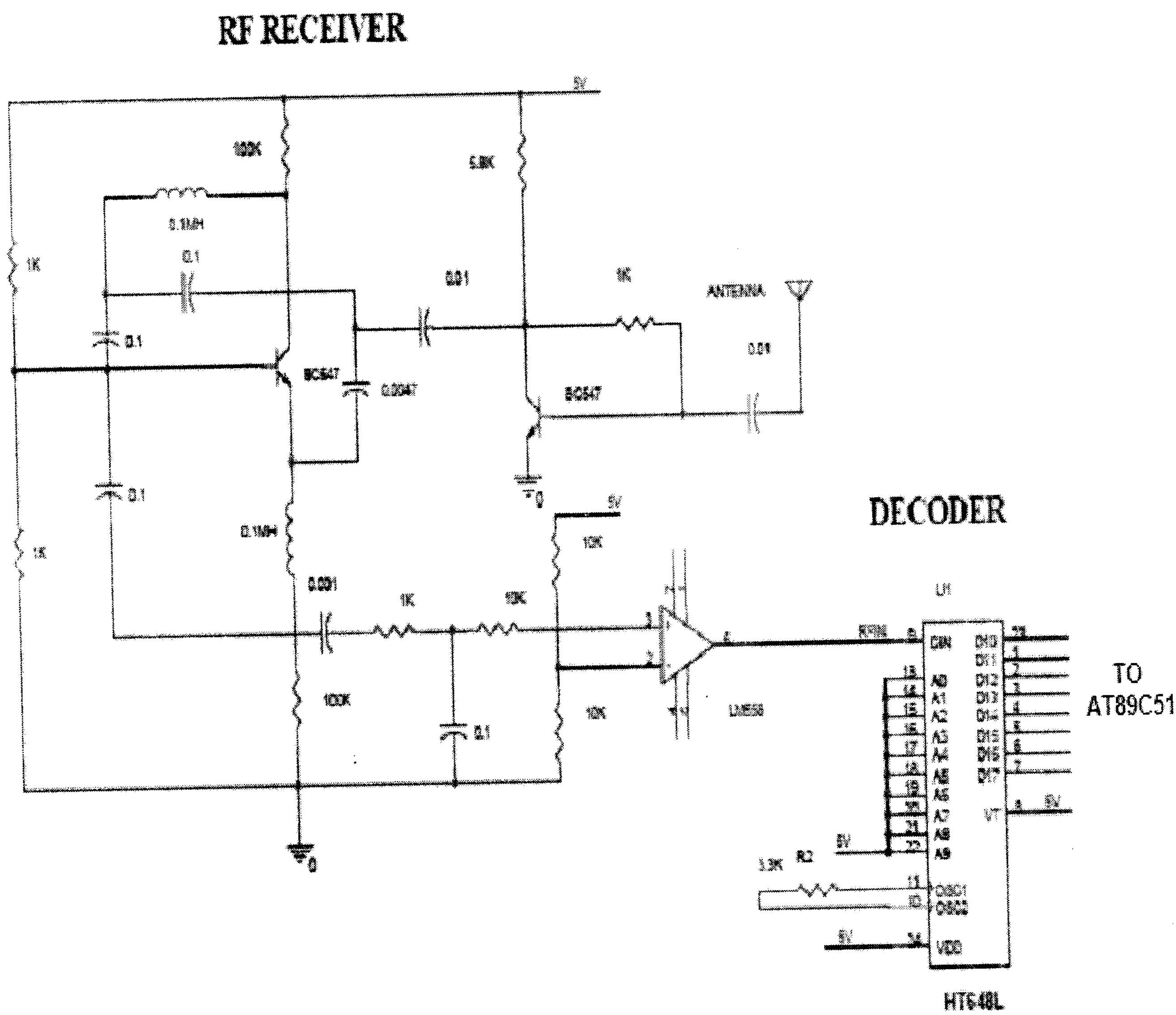


Fig 2.9 Circuit Diagram of RF Receiver and Decoder

2.5 ATMEL Microcontroller (AT89C51)

2.5.1 Description of AT89C51

The AT89C51 is a low-power, high-performance CMOS 8-bit microcomputer with 4K bytes of Flash Programmable and Erasable Read Only Memory (PEROM). The device is manufactured using Atmel's high density nonvolatile memory technology. 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 AT89C51 is a powerful microcomputer which provides a highly flexible and cost effective solution to many embedded control applications The AT89C51 provides the following standard features: 4K Bytes of Flash, 128 bytes of RAM, 32 I/O lines, two 16-bit timer/counters, a five vector two-level interrupt architecture, a full duplex serial port, on-chip oscillator and clock circuitry.

In addition, the AT89C51 is designed with static logic for operation down to zero frequency and supports two software selectable power saving modes. The Idle Mode stops the CPU while allowing the RAM, timer/counters, serial port and interrupt system to continue functioning.

2.5.2 Pin Description

The pin details of AT89C51 are shown in Fig 2.10.

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

Port 1: Port 1 is an 8-bit bidirectional I/O port .When 1s are written to Port 1 pins they are pulled high by the internal pull-ups and can be used as inputs.

As inputs, Port 1 pins that are externally being pulled low will source current because of the internal pull-ups. Port 1 also receives the low-order address bytes during Flash programming and verification.

Port 2: Port 2 is an 8-bit bidirectional I/O port. The Port 2 output buffers can sink/source four TTL inputs. When 1s are written to Port 2 pins they are pulled high by the internal pull-ups and can be used as inputs. Port 2 also receives code data during Flash programming and verification.

Port 3: Port 3 is an 8-bit bidirectional I/O port with internal pull-ups. The Port 3 output buffers can sink/source four TTL inputs. When 1s are written to Port 3 pins they are pulled high by the internal pull-ups and can be used as inputs. It receives some control signals for Flash programming and verification too. Port 3 also serves the functions of various special features of the AT89C51 as listed in the Table 2.1.

Port pins	Alternate functions
P3.0	RXD (serial input port)
P3.1	TXD (serial output port)
P3.2	INT0 (external interrupt 0)
P3.3	INT1 (external interrupt 1)
P3.4	T0 (timer 0 external input)
P3.5	T1 (timer 1 external input)
P3.6	WR (external data memory write strobe)
P3.7	RD (external data memory read strobe)

Table 2.1 Port 3 Pin Details

The External Access Enable (EA) must be strapped to GND in order to enable the device to fetch code from external program memory locations starting at 0000H up to FFFFH. This pin also receives the 12-volt programming enable voltage (VPP) during Flash programming. Address Latch Enable (ALE) output pulse is for latching the low byte of the address during accesses to external memory. This pin is also the program pulse input (PROG) during Flash programming. Program Store Enable (PSEN) is the read strobe to external program memory. XTAL1 is the input to the inverting oscillator amplifier and the input to the internal clock operating circuit. XTAL2 is the output from the inverting oscillator amplifier. Further, a high on the Reset pin for two machine cycles with the oscillator running resets the device. The VCC pin serves as the pin for the supply voltage and the GND pin is for the ground connection.

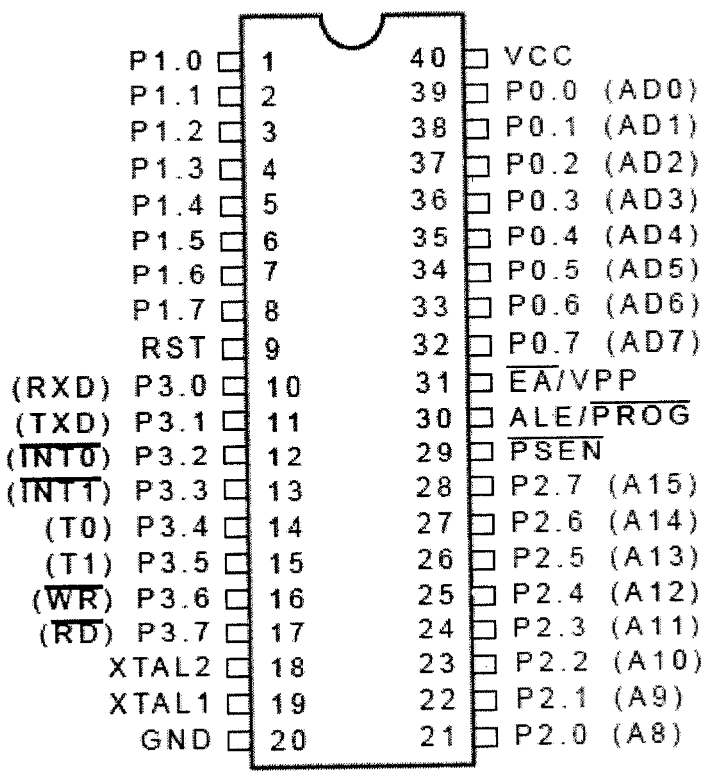


Fig 2.10 Pin Diagram of AT89C51 Microcontroller

2.5.3 Functional Description

The microcontroller is interfaced with the RF receiver section for controlling the motor relay operation. The decoded data is given to the microcontroller ports P1.0 to P1.4 respectively. Corresponding outputs are taken from ports P1.5, P1.6, P1.7 and P3.0 of the microcontroller. These output pins are connected to the motor relay circuit.

The microcontroller functions so as to control the relay switches depending on the decoder output. If 'forward' command is given in the PC, the data received at the RF receiver is decoded and the output generated at the microcontroller is 0110. The respective relay switches are switched ON. The robot will hence move forward till some other command is given at the transmitter side. Similarly, to drive the robot in the reverse direction, the code is 1001. To drive the robot in the left and right directions, the codes 1011 and 1101 are generated respectively. To stop the robot, the code 1111 is generated. Hence, these codes enable simple navigation of the parent robot which results in efficient surveillance.

2.6 DC Motor Relay Description

A Relay is nothing but electromagnetic switching device which consists of three pins. They are common, normally close (NC) and normally open (NO). The motor relay circuit as shown in Fig 2.11 is designed to control the motor in the forward and reverse direction. It consists of two relays named as relay1, relay2. The common pin of two relays is connected to positive and negative terminal of motor through a snubber circuit respectively. The series combination of resistor and capacitor is called as snubber circuit. When the relay is turn ON and turn OFF continuously, the back EMF generated may create a fault in the relays. So the back EMF is grounded through the snubber circuit.

2.6.1 Working Principle

The 'relay ON' and 'relay OFF' is controlled by the pair of switching transistors. The relays are connected to the collector terminal of the transistors Q2 and Q4.

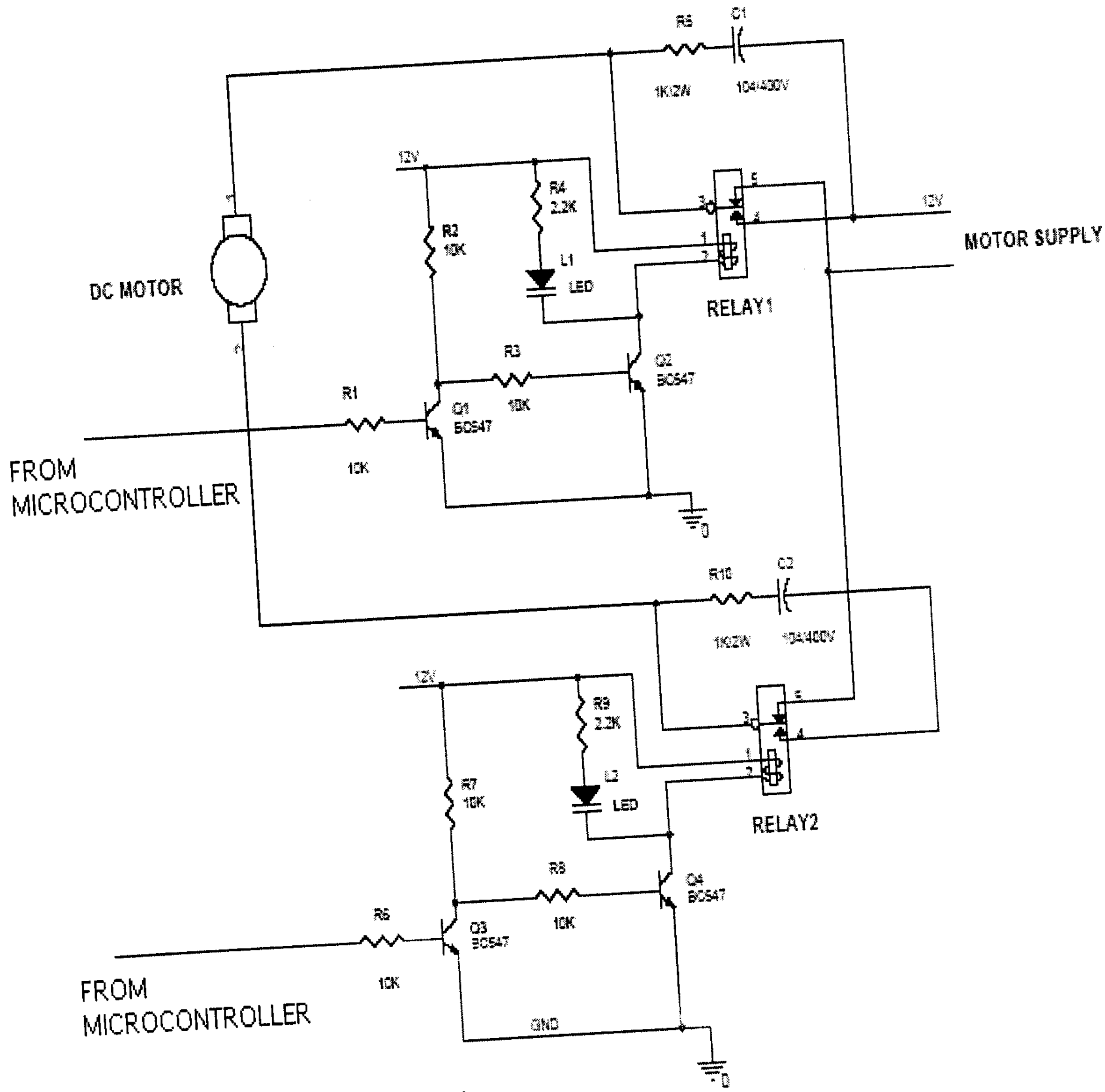


Fig 2.11 Motor Relay Circuit Diagram

When high pulse signal is given to either base of the Q1 or Q3 transistors, the transistor conducts. This leads to a zero signal given to base of the Q2 or Q4 transistor. So the relay is in turned OFF state. On the other hand, when low pulse signal is given to either base of the transistor Q1 or Q3 transistor, the transistor remains open. Now 12V is given to base of Q2 or Q4 transistors; so that the transistor is conducting and relay is turned ON. The NO and NC pins of two relays are interconnected so only one relay can be operated at a time. Hence, when relay 1 is in the ON state and relay 2 is in the OFF state, the motor is running in the forward direction. And when relay 2 is in the ON state and relay 1 is in the OFF state, the motor is running in the reverse direction. The motor relay circuit diagram is given in Fig 2.11.

2.6.2 Construction and Working of DC Motor

DC Motor Principle

A machine that converts direct current power into mechanical power is known as D.C Motor. Its gyrations are based on the principle that when a current carrying conductor is placed in a magnetic field, the conductor experiences a mechanical force. The direction of this force is given Fleming's left hand rule.

Components

All D.C. machines have five principle components (i) Field system (ii) armature core (iii) armature winding (iv) commutator (v) brushes.

The function of the field system is to produce uniform field within which the armature rotates. It consists of an even number of salient poles bolted to the inside of circular frame called the yoke. The armature core is keyed to the machine shaft and rotates between the field poles.

It consists of slotted soft-iron laminations (about 0.4 to 0.6mm thick) that are stacked to form a cylindrical core. The slots of the armature core hold conductors that are connected in a suitable manner. This is known as armature winding. This is the winding in which "working" EMF is induced. The armature conductors are connected in series-parallel combinations. The conductors connected in series increase the voltage and the conductors in parallel paths increase the current. A commutator is a mechanical rectifier which converts the alternating voltage in the armature winding into direct voltage across the brushes. The stator is the stationary part of an electric generator or electric motor. The non-stationary part on an electric motor is the rotor. The external diagram of the DC motor used in this project is given in Fig 2.12.

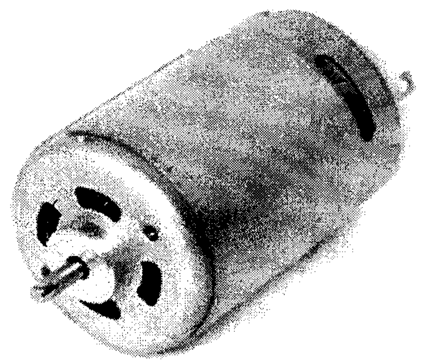


Fig 2.12 DC Motor

Working of a DC Motor

Consider a part of a multi polar DC motor, when the terminals of the motor are connected to an external source of DC supply (battery) as shown in Fig 2.13. Here, the field magnets are excited developing alternate N and S poles. The armature conductor carries currents.

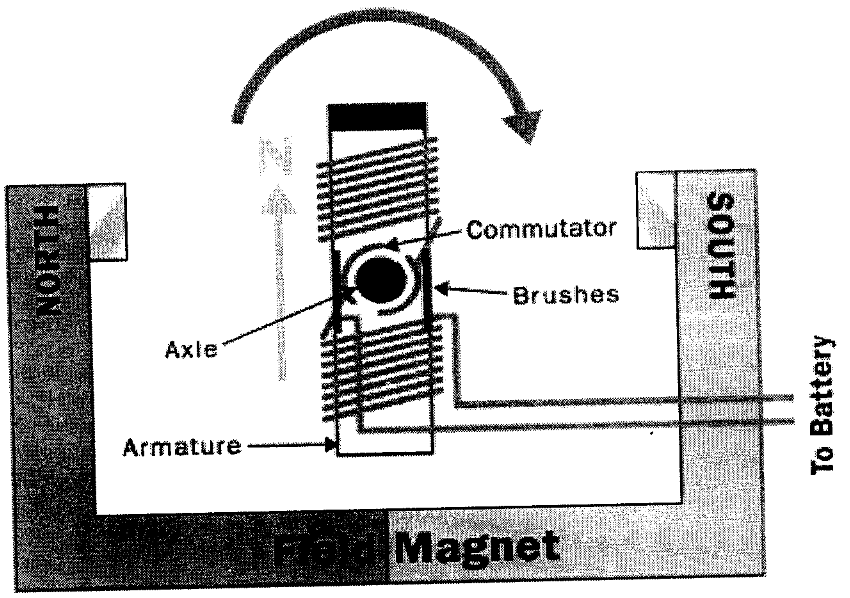


Fig 2.13 Working of a DC Motor

All conductors under N-pole carry currents in one direction while all the conductors under S-pole carry currents in the opposite direction. The rotor (alternator), which is the non-stationary part of a rotary electric motor, rotates because the wires and magnetic field of the motor are arranged so that a torque is developed about the axis of the rotor.

2.7 Wireless Camera

Wireless camera systems come with a wireless receiver, which can detect and receive signals from multiple cameras at once. The receiver can be plugged into a monitor to view the feeds or be connected to a storage device. Wireless video transition is made possible with use of video transmitters and receivers. Most wireless cameras come within built video transmitter and a separate video receiver. Once installed the video signal is sent wirelessly through a specific frequency to the receiver which is connected directly to security monitor systems.

A wireless security camera is not completely wireless. Even though no video cable is needed for the wireless camera, it still requires power, which means another cable from the camera to the closest outlet. And if there is no power outlets located nearby than a power cable will have to be installed all the way back to the nearest outlet.

2.7.1 Implementation of the Wireless Camera

In the Manual Mode of the project, the wireless camera is fit at the top of the parent robot. The camera used is an INTEC wireless camera. This camera sends the video signal from the parent robot to the wireless antenna and receiver module. This receiver module is in turn connected to the PC through a TV Tuner card, which is basically an A/D Converter. The video can be continuously monitored and the parent robot can hence be navigated in the desired direction. The video transmission is in Phase Alternate Line (PAL) standard at a frequency of 2.4 GHz. The color video feed received is viewed in the VB tool created as shown in Fig 2.2. The video is viewable by clicking the 'Start Preview' button. There will be no display if the 'Stop Preview' button is clicked. The video may also be stored for future references. A sensitivity tuning knob is present at the receiver for fine tuning of the video signal. Thus the presence of a wireless camera on top of the parent robot makes it a surveillance-purpose robot.

The notable features of this wireless camera are wireless transmission and reception, small size, light weight, low power consumption, high sensitivity, easy installation and operation. Some of the applications involve wireless video transmission from a surveillance camera to TV, Monitor, Computer and recorder. Also, it can be implemented as a surveillance camera to send video feed from the main gate back to the house. There are many such applications for a wireless camera.

2.8 TV Tuner Card

A TV tuner card is a computer component that allows television signals to be received by a computer. Most TV tuners also function as video capture cards, allowing them to record television programs onto a Hard disk. TV tuners are available in a number of different interfaces: As PCI bus expansion card, PCI Express (PCI) bus or USB devices. In addition, some video cards double as TV tuners as well. The card contains a tuner and an analog-to-digital converter (collectively known as the analog front end) along with demodulation and interface logic. Some very cheap cards, like a Win Modem lack an onboard processor and, rely on the CPU of the system for demodulation.

Types of TV Tuner Cards

There are currently four kinds of tuner cards:

Analog TV Tuners: Cheaper models output a raw video stream, suitable for real-time viewing but ideally requiring some sort of compression if it is to be recorded. More expensive models encode the signal to Motion JPEG or MPEG, relieving the main CPU of this load.

Digital TV tuners: Digital TV is broadcast as an MPEG-2 stream, so no encoder is necessary. Instead, the digital cards either provide the whole MPEG transport stream or extract the individual (audio and video) elementary streams.

Hybrid tuners: A Hybrid tuner has one tuner that can be configured to act as an analog tuner or a digital tuner. Switching in between the systems is fairly easy, but cannot be done immediately. The card operates as a digital tuner or an analog tuner until reconfigured.

Combo tuners: This is similar to a hybrid tuner, except there are two separate tuners on the card. One can watch analog while recording digital, or vice versa. The card operates as an analog tuner and a digital tuner simultaneously.

2.8.1 Functional Description

The TV tuner card as shown in the Fig 2.14 has a number of pins. A cable is connected between the AV input (AV IN) pin of the tuner card and the wireless camera receiver. The video signal received by the receiver module is hence demodulated by the tuner card. This enables the user to view the constant color video feed obtained from the wireless camera placed on top of the parent robot. The tuner card is slotted into the PCI slot which is at the back of the CPU.

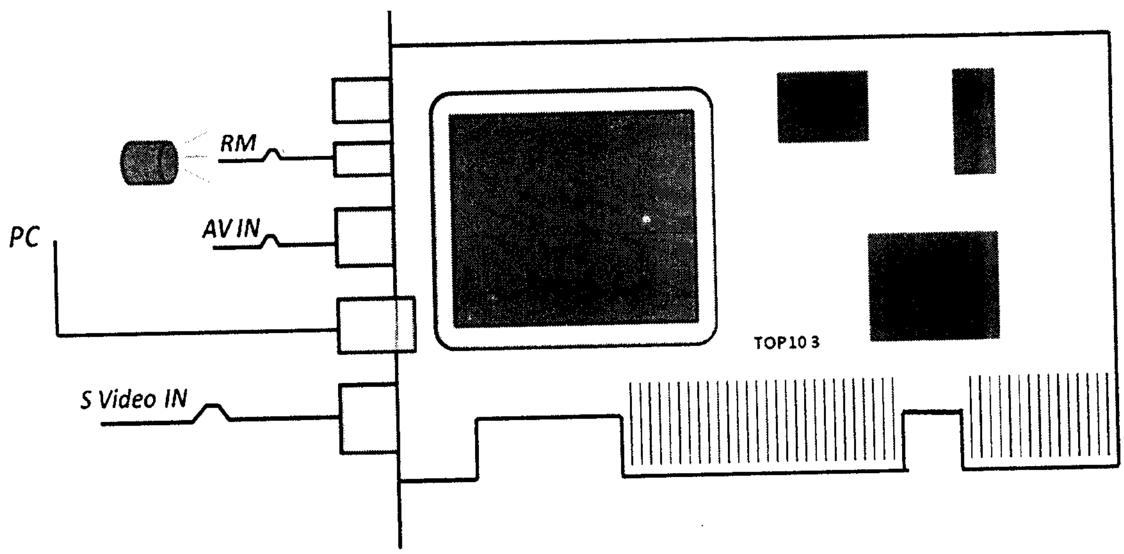


Fig 2.14 TV Tuner Card

2.9 Power Supply

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 keeps 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.

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 advantage of using a precision rectifier is that it will give peak voltage output as DC while rest of the circuits will give only RMS output. The power supply block diagram is shown in Fig 2.15.

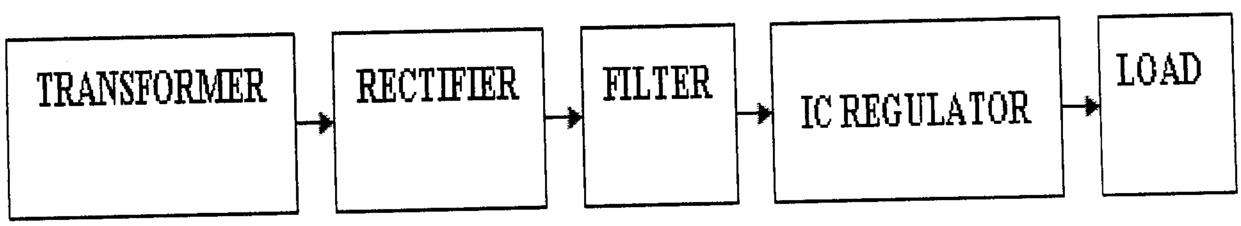


Fig 2.15 Power Supply Block Diagram

Bridge rectifier

When four diodes are connected, 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. With both circuits using the same transformer, the bridge rectifier circuit produces a higher output voltage than the conventional full-wave rectifier circuit.

IC voltage regulators

Voltage regulators comprise a class of widely used ICs. Regulator IC units contain the circuitry for reference source, comparator amplifier, control device, and overload protection all in a single IC. IC units provide regulation of 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 applied to one input terminal; a regulated dc output voltage 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. The power supply voltage needed for ICs, microcontrollers, LCD is 5 volts while for other circuits like alarm circuit, op-amp, relay circuits, it is 12 volts.

3. AUTOMATIC MODE

3.1 Automatic Mode Operation

The robot is completely autonomous in nature. Once triggered it is programmed to deploy itself from the parent robot and proceed to trace a wall. The robot is equipped with proximity sensor modules, a fire sensor module and a fire extinguishing system as shown in Fig 3.1. Proximity sensors are used to make sure the robot does not deviate from the path adjacent to the wall. A proximity sensor is placed in the left side and so the robot traces the wall in the clockwise direction only.

In case of obstacles in the path of the robot, another proximity sensor placed in the front of the robot will detect it and ensures that the robot follows a path around the obstacle.

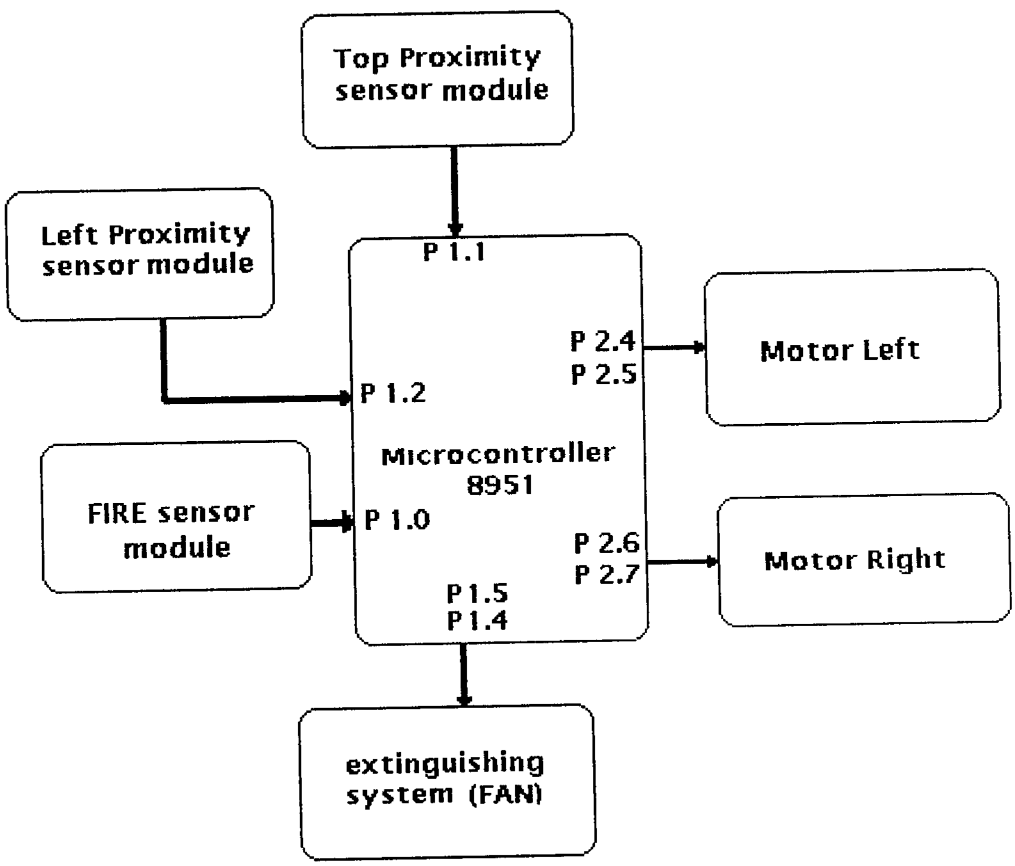


Fig 3.1 Block Diagram of Automatic Mode

Along the path, in case the fire sensor is triggered then the robot stops and the extinguishing system is activated. The fire sensor and the extinguisher are placed to precisely detect and put off the flame. Once the flame is put off, the extinguisher is switched off and the robot resumes traveling along its path. The mechanism occurs every time a flame is encountered.

3.2 Controller Board

The Controller Board as shown in Fig 3.2 is based around the popular Philips 89V51RD2 microcontroller. This microcontroller has ample program memory space (64Kb). It has 8 channels of motor control, capable of driving 4 DC motors. Further, there are 8 digital input channels for sensor interfacing and 4 general purpose LEDs and Switches.

The power ON switch is a basic 'push to on - push to off' type switch. The IC 7805 is a three terminal linear 5 volt regulator used to supply the microcontroller and other peripherals. The motor enable switch is used to enable/disable the motor driver chips, hence in turn enabling/disabling the motors. The reset switch is used to reset the microcontroller. IC 555, a general purpose timer is used in the mono-stable mode to automatically reset the microcontroller during programming. The L293D is a 4 channel motor driver with 600mA of current per channel and has inbuilt clamp diodes. The potentiometer is used to vary the contrast of the LCD (if used). At a time, 8 individual sensor modules can be connected to the sensor port. The port also provides a 5V supply needed drive the sensors. A DB 9 connector is used to connect to the COM port of the PC during programming.

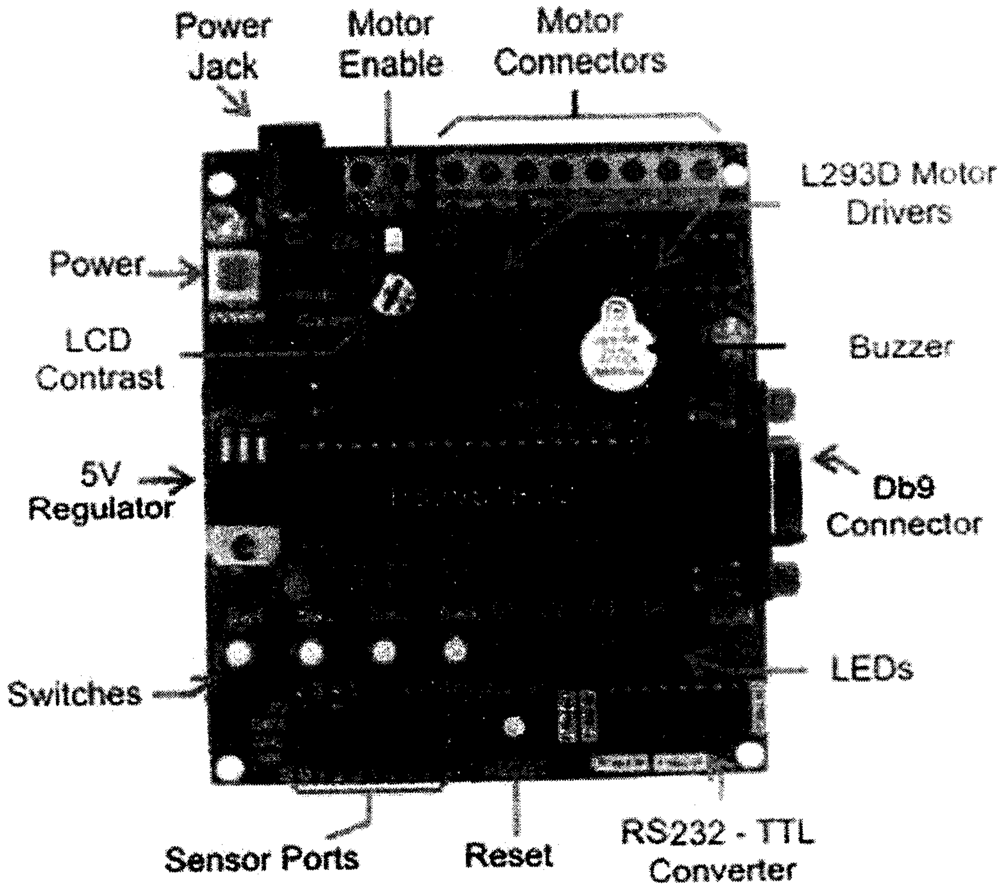


Fig 3.2 Controller Board

3.2.1 Port Configuration

With the help of the block diagram in Fig 3.1, the automatic mode port configuration is explained. The motors are connected using the motor connector ports and the various sensor modules are connected using the sensor ports. The right DC motor is connected to the microcontroller port P2.6 and P2.7. The left DC motor is connected to the port P2.4 and P2.5. The fan DC motor is connected to the port P1.4 and P1.5 respectively. These ports operate as the output ports of the microcontroller. The fire sensor module is connected to the port P1.0. The top proximity sensor module and the left proximity sensor module is connected the ports P1.1 and P1.2 respectively.

3.3 Programming Method

The programming is done through the TRIC software. The logic is first implemented using embedded C. After compiling the program, the software converts the C program into a Hex code file. This Hex code file is dumped into to the microcontroller using the Flash magic software at a baud rate of 9600 KHz via the computer COM port. A DB 9 connector is present in the controller board to connect to the COM port of the PC during programming.

3.4 Program Explanation

The autonomous robot is programmed to operate on its own after it is deployed from the parent robot. The program basically operates according to the inputs from the various sensor modules as shown in flowchart in Fig 3.3. The highest priority is given to the fire sensor module. If the fire is detected then the robot stops and the extinguishing system is made to switch on. In case the fire sensor is inactive then the priority is passed on to the TOP proximity sensor.

The TOP proximity sensor switches ON whenever there is an obstacle in the path of the robot. This forces the robot to turn in the 'right' direction in order to use a path around the obstacle. In case the TOP proximity sensor is inactive then the priority is passed on to the LEFT proximity sensor.

The LEFT proximity sensor is used to make sure that the robot traces a path adjacent to the wall. This is the default condition of the robot. When it is ON, the robot is made to run in the forward direction. In case the sensor is OFF then the robot is made to turn in the 'left' direction.

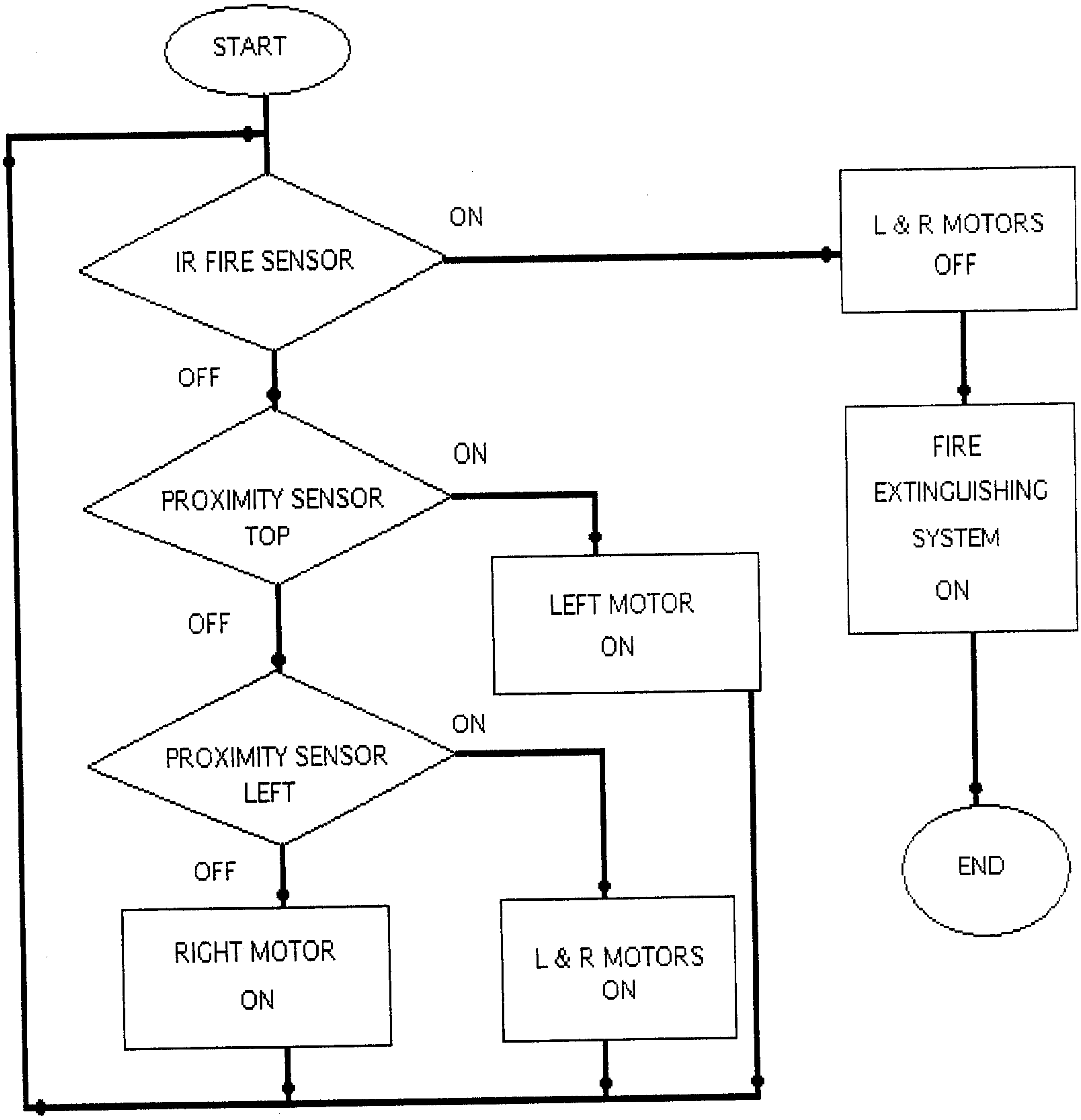


Fig 3.3 Flowchart for the Fire Fighter Logic

3.5 Fire Sensor Module

The fire sensing module is designed to detect any Infra-Red source of light from an ideal distance of 10cm. In this case, the fire will act as the strong source of IR light. The red indicator led lights up whenever in encounters a fire. The potentiometer in the module is used to alter the sensitivity of the sensor

3.5.1 Working Principle

An IR LED as shown in Fig 3.4 is used to sense the fire. It is connected in the reverse biased configuration so that it functions as a photo-diode. So depending on the IR light intensity, a specific voltage is sent to the comparator. This voltage is compared with the reference voltage, using LM358N an operational amplifier. The reference voltage is set using the potentiometer. If the voltage is higher than the reference voltage then an output is generated. This output signal is fed to the microcontroller.

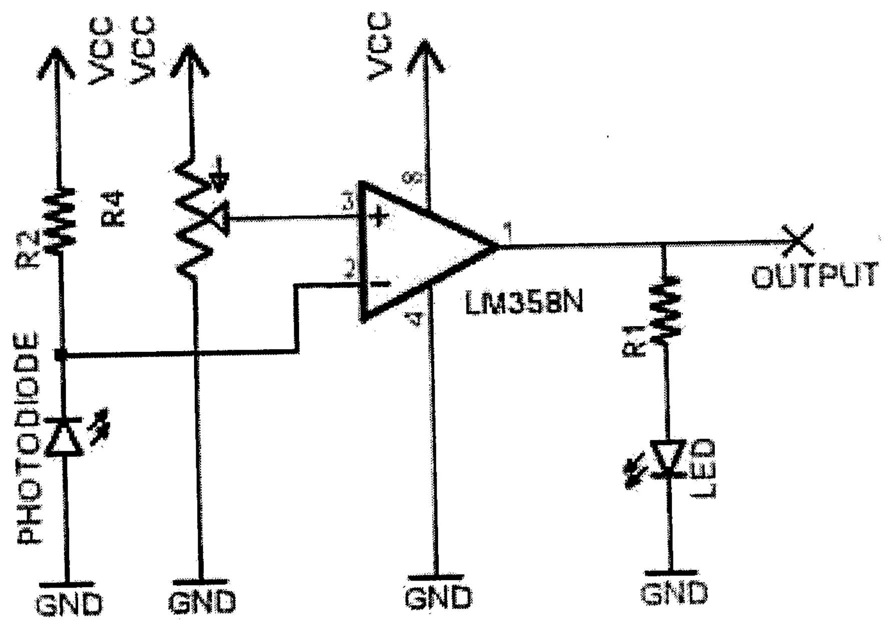


Fig 3.4 Fire Sensor Circuit Diagram

3.6 Proximity Sensor Module

The IR proximity sensor module is based around the TSOP sensor, commonly used in TV remote receivers. This module is able to detect objects at a distance of 5cm to 15cm. The maximum detectable distance varies in accordance with the color and texture of the object. For example, a white object can be easily detected from a distance of 15cm while a black object would be detectable from a maximum distance of 5cm.

3.6.1 Working Principle

The TSOP 1738 module as shown in the Fig 3.5 receives data that are modulated at a frequency of 38 KHz and ignores all other IR signals. So a constant wave of square wave signals from the IC555 is used to drive the IR LED. Whenever this signal bounces off the obstacles, the receiver would detect it and generate an output. A potentiometer is used to alter the intensity of the LED, thus varying the distance at which the sensor detects the obstacle.

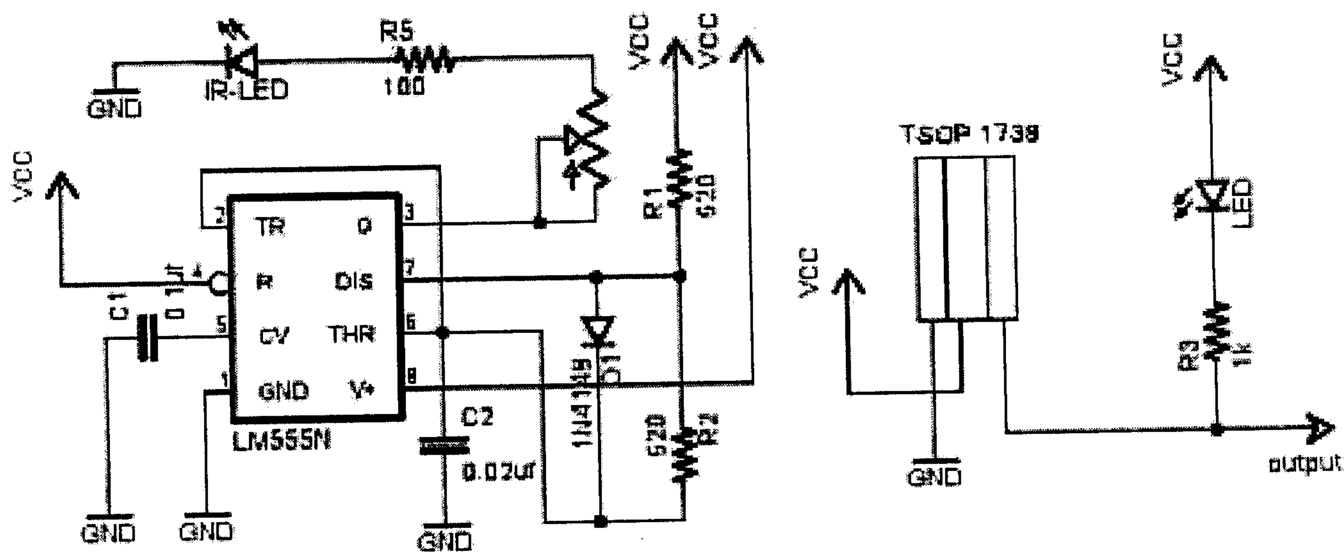


Fig 3.5 Proximity Sensor Circuit Diagram

3.7 Extinguishing System

In the present robot a prototype extinguishing system is used. A simple DC motor – Fan system is used. The Fan is placed at a specific elevation to optimally blow off the flame of the candle and to ensure that the wings do not disturb the working of the sensors. In real time, in order to fight the fire, a much more effective system can be used. For example, a chemical based fire deterrent can be sprayed over the fire.

4. CONCLUSION AND FUTURE SCOPE

Thus the wireless multipurpose robot is implemented with the robot pair. The parent robot is used for surveillance activities and also acts as the carrier of the autonomous robot. Such robotic swamp techniques can be used to tackle problem during situation, which are deemed dangerous from human. These robots have innumerous application in almost every field. The scope of this project can be expanded tremendously by increasing the number of autonomous robots used. These robots are mere prototypes. There is a wide scope for various improvements.

The future enhancements would include

- A high range camera, capable of 360` view.
- A dexterous chassis and body so that the robot can withstand various environmental hazards.
- Tank wheels for the robot, so that the robot can function in rough terrain.
- A chemical based lightweight fire extinguishing system.

The most interesting enhancement can be made by increasing the number of autonomous robots used. Swamp technique can hence be further used to make the operations more effective and faster by using more number of robots. For example, if there were two or three autonomous fire fighting robots, then the room can be scanned at a faster pace enabling the fire to be detected and extinguished faster. Thus, the Wireless Multipurpose Robot (WMR) belongs to the league of robots capable of creating a revolution in the technology of tomorrow.

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6. APPENDIX

ATMEL 89C51 MICROCONTROLLER

Microcontroller is a general purpose device, which integrates a number of the components of a microprocessor system on to single chip. It has inbuilt CPU, memory and peripherals to make it as a mini computer. A microcontroller combines on to the same microchip:

- The CPU core
- Memory(both ROM and RAM)
- Some parallel digital i/o

CPU registers

The 8051 contain 34 general-purpose, or working, registers. Two of these, registers A and B hold results of many instructions, particularly for arithmetical and logical operations. The other 32 are arranged as part of internal RAM in four banks, Bank0-Bank3, of eight registers each.

Program Counter (PC)

The 8051 contain two 16-bit registers: the program counter (PC) and the data pointer (DPTR). Each is used to hold the address of a word in memory. Program instruction bytes are fetched from locations in memory that are addressed by the PC. Program ROM may be on the chip at addresses 000h to FFFh, external to the chip for address that exceed FFFh, or totally external for all address from 0000h to FFFFh. The PC is automatically incremented after every instruction byte is fetched and may also be altered by certain instructions. The PC is the only register that does not have an internal address.

The Program Counter (PC) is a 2-byte address that tells the 8051 where the next instruction to execute is found in memory. When the 8051 is initialized PC always starts at 0000h and is incremented each time an instruction is executed. It is important to note that PC isn't always incremented by one. Since some instructions require 2 or 3 bytes the PC will be incremented by 2 or 3 in these cases.

Data Pointer (DPTR)

The DPTR register is made up of two 8-bit registers, named DPH and DPL, which are used to furnish memory addresses for internal and external code access and external data access. The DPTR is under the control of program instructions name, DPH and DPL. DPTR does not have a single internal address; DPH and DPL are each assigned an address.

The Data Pointer (DPTR) is the 8051's only user-accessible 16-bit (2-byte) register. DPTR, as the name suggests, is used to point to address something like HL register pair in 8085 microprocessor. While DPTR is most often used to point to data in external memory, many programmers often take advantage of the fact that it's the only true 16-bit register available. It is often used to store 2-byte values that have nothing to do with memory locations.

Program Status Word (PSW)

Flags are 1-bit registers provided to store the results of certain program instructions. Other instructions can test the condition of the flags and make decisions based on the flag states. In order that the flags may be conveniently addressed, they are grouped inside the program status word (PSW) and the power control (PCON) registers.

The 8051 have four math flags that respond automatically to the outcomes of math operations and three general-purpose user flags that can be set to 1 or cleared to 0 by the programmer as desired. The math flags include Carry (CY), Auxiliary Carry (AC), Overflow (OV), and Parity (P). User flag is named F0; this general-purpose flags that may be used by the programmer to record some event in the program. The math flags, however, are also affected by math operations.

CY	AC	F0	RS1	RS0	OV	--	P

The program status word is shown above. The PSW contains the math flags, user program flag F0, and the register select bits RS0, RS1 that identify which of the four general-purpose register banks is currently in use by the program.

The Stack and the Stack Pointer

The stack refers to an area of internal RAM that is used in conjunction with certain opcodes to store and retrieve data quickly. The 8-bit Stack Pointer (SP) register is used by the 8051 to hold an internal RAM addresses that is called the top of the stack. The address held in the SP register is the location in internal RAM where the last byte of data was stored by a stack operation.

When data is to be placed on the stack, the SP increments before storing data on the stack so that the stack grows up as data is stored. As data is retrieved from the stack, the byte is read from the stack, and then the SP decrements to point to the next available byte of stored data.

Absolute Maximum Ratings

Operating Temperature	-55°C to +125°C
Storage Temperature	-65°C to +150°C
Voltage on Any Pin with Respect to Ground	-1.0V to +7.0V
Maximum Operating Voltage	6.6V
DC Output Current	15.0 mA

Oscillator Characteristics

XTAL1 and XTAL2 are the input and output, respectively, of an inverting amplifier which can be configured for use as an on-chip oscillator. Either a quartz crystal or ceramic resonator may be used. To drive the device from an external clock source, XTAL2 should be left unconnected while XTAL1 is driven. There are no requirements on the duty cycle of the external clock signal, since the input to the internal clocking circuitry is through a divide-by-two flip-flop, but minimum and maximum voltage high and low time specifications must be observed.

Idle Mode

In idle mode, the CPU puts itself to sleep while all the on-chip peripherals remain active. The mode is invoked by software. The content of the on-chip RAM and all the special functions registers remain unchanged during this mode. The idle mode can be terminated by any enabled interrupt or by a hardware reset. It should be noted that when idle is terminated by a hard ware reset, the device normally resumes program execution, from where it left off, up to two machine cycles before the internal reset algorithm takes control. On-chip hardware inhibits access to internal RAM in this event, but access to the port pins is not inhibited. To eliminate the possibility of an unexpected write to a port pin when Idle is terminated by reset, the instruction following the one that invokes Idle should not be one that writes to a port pin or to external memory.

Power Down Mode

In the power down mode the oscillator is stopped, and the instruction that invokes power down is the last instruction executed. The on-chip RAM and Special Function Registers retain their values until the power down mode is terminated. The only exit from power down is a hardware reset. Reset redefines the SFRs but does not change the on-chip RAM. The reset should not be activated before VCC is restored to its normal operating level and must be held active long enough to allow the oscillator to restart and stabilize.

Program Memory Lock Bits

On the chip are three lock bits which can be left unprogrammed (U) or can be programmed (P) to obtain the additional features. When lock bit 1 is programmed, the logic level at the EA pin is sampled and latched during reset. If the device is powered up without a reset, the latch initializes to a random value, and holds that value until reset is activated. It is necessary that the latched value of EA be in agreement with the current logic level at that pin in order for the device to function properly.

Programming the Flash

The AT89C51 is normally shipped with the on-chip Flash memory array in the erased state (that is, contents = FFH) and ready to be programmed. The programming interface accepts either a high-voltage (12-volt) or a low-voltage (VCC) program enable signal. The low voltage programming mode provides a convenient way to program the AT89C51 inside the user's system, while the high-voltage programming mode is compatible with conventional third party Flash or EPROM programmers. The AT89C51 is shipped with either the high-voltage or low-voltage programming mode enabled.

Programming Algorithm:

Before programming the AT89C51, the address, data and control signals should be set up according to the Flash programming mode table and. To program the AT89C51, take the following steps:

1. Input the desired memory location on the address lines.
2. Input the appropriate data byte on the data lines.

3. Activate the correct combination of control signals.

4. Raise EA/VPP to 12V for the high-voltage programming mode.

5. Pulse ALE/PROG once to program a byte in the Flash array or the lock bits. The byte-write cycle is self-timed and typically takes no more than 1.5 ms. Repeat steps 1 through 5, changing the address and data for the entire array or until the end of the object file is reached.

Ready/Busy:

The progress of byte programming can also be monitored by the RDY/BSY output signal. P3.4 is pulled low after ALE goes high during programming to indicate BUSY. P3.4 is pulled high again when programming is done to indicate READY.

Program Verify:

If lock bits LB1 and LB2 have not been programmed, the programmed code data can be read back via the address and data lines for verification. The lock bits cannot be verified directly. Verification of the lock bits is achieved by observing that their features are enabled.

Chip Erase:

The entire Flash array is erased electrically by using the proper combination of control signals and by holding ALE/PROG low for 10 ms. The code array is written with all "1"s. The chip erase operation must be executed before the code memory can be re-programmed.