“WEATHER MONITORING SYSTEM”

Project Report submitted in partial fulfillment of the requirement for the degree of Bachelor of Technology.

in

Electronics And Communication

under the Supervision of

Mr.Munish Sood

Submitted By:

Abhinav Seth-111049

Shikhar Tandon-111046

Pankit Kumar-111116

to

Jaypee University of Information and Technology

Waknaghat, Solan – 173234, Himachal Pradesh

CERTIFICATE

This is to certify that project report entitled "**Weather monitoring System**" is submitted by **Abhinav Seth , Shikhar Tandon and Pankit Kumar** in partial fulfillment for the award of degree of Bachelor of Technology in Electronics and Communication Engineering to Jaypee University of Information Technology, Waknaghat, Solan has been carried out under my supervision.

This work has not been submitted partially or fully to any other University or Institute for the award of this or any other degree or diploma.

Supervisor's Name………………..

Designation……………………….

Signature………………………….

Date:………………………………

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DATE…………………..

Name of Students

Abhinav Seth

Shikhar Tandon

Pankit Kumar

ABSTRACT

This project aims at understanding and developing the circuitry and mathematical models associated with Infrared , temperature ,pressure ,gas and humidity sensors and GSM modem. In this project we study the characterstics of the above mentioned sensors and its interfacing with microcontroller .we constructed a robot which uses the GSM technology to transmit the data which is obtained from the temperature , pressure , humidity and gas sensor on a cell phone.

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CHAPTER 1
INTRODUCTION

The project aims at getting thorough understanding of weather monitoring sensors and GSM technique. Study the characterstics ,specifically on temperature ,humidity , pressure and gas sensors and its application with GSM module.

1.1 Background

Our Project is to build a complete weather monitoring system that measures the weather parameters that is temperature , pressure , humidity and concentration of gas and transmits these details through a GSM module to a cell phone .This cell phone receives data and displays it .

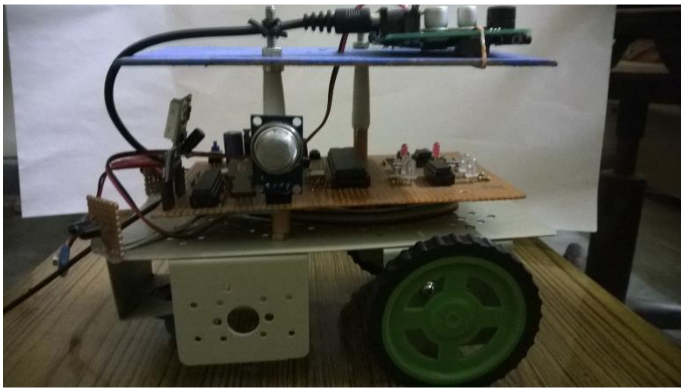


Fig 1.1 Working bot

1.2 DC Motors

A **DC motor** is a class of electrical machines that converts direct current electrical power into mechanical power. Most types produce rotary motion; a linear motor directly produces force and motion in a straight line. The universal motor can operate on direct current but is a lightweight motor used for portable power tools and appliances. Larger DC motors are used in propulsion of electric vehicles, elevator and hoists, or in drives for steel rolling mills. The advent of power electronics has made replacement of DC motors with AC motors possible in many applications. . A DC motor's speed can be controlled over a wide range, using either a variable supply voltage or by changing the strength of current in its field windings. Small DC motors are used in tools, toys, and appliances.

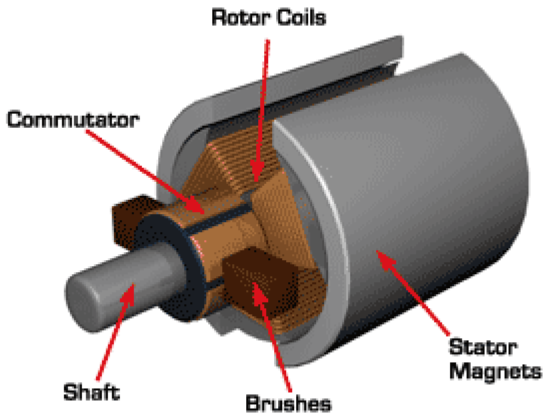


Fig 1.2 DC Motor

- Two slow speed dc gear motors are incorporated which are responsible for forward, reverse, left and right movements
- When both the motors rotate in clockwise direction, the robot moves in forward direction while the reverse motion corresponds to backward movement
- Working voltage of these motors is 9 volt to 12 volt dc

1.2.1 Optocoupler

An optocoupler is a component that transfers electrical signals between two isolated circuits by using light. Opto-couplers prevent high voltages from affecting the system receiving the signal. Commercially available opto-couplers withstand input-to-output voltages up to 10 kV

A common type of opto-coupler consists of an LED and a phototransistor in the same opaque package. Other types of source-sensor combinations include LED-photodiode, LED-LASCR(light activated SCR), and lamp-photoresistor pairs. Usually opto-couplers transfer digital (on-off) signals.

Operations

An opto-coupler contains a source (emitter) of light, almost always a near infrared light-emitting diode (LED), that converts electrical input signal into light, a closed optical channel (also called dielectrical channel), and a photosensor, which detects incoming light and either generates electric energy directly, or modulates electric current flowing from an external power supply.

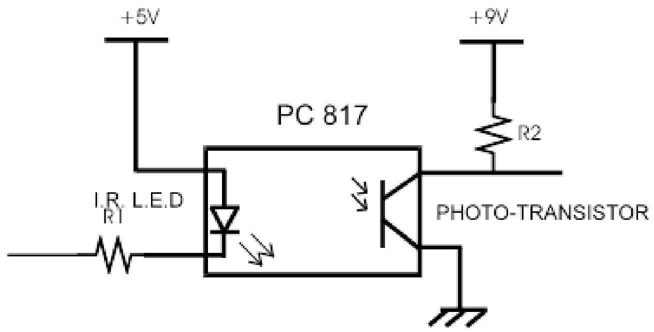


Fig 1.3 OPTO-COUPLER

1.3 Sensors Used

1.3.1 IR Sensors

Infra-red sensors are devices which emit infrared, and in some cases, the infrared reflects off objects and bounces back in the direction of the detector. The eyes of the robot are the infrared detectors. The infrared detectors send signals to the microcontroller indicating whether or not, they detect infrared reflected off an object

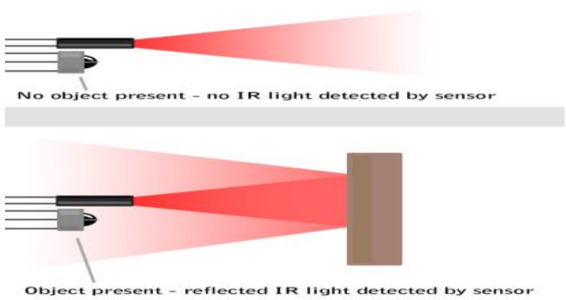


Fig 1.4 IR Sensor

1.3.2 Temperature Sensor

It is a device that measures temperature more accurately than using a thermometer.
it measures temperature in the range of -55C to +150C and has a accuracy of +1.5C

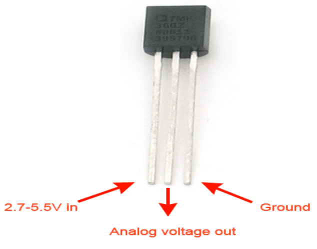


Fig 1.5 Temperature Sensor

1.3.3 Pressure Sensor

A pressure sensor measures pressure, typically of gases or liquids. Pressure is an expression of the force required to stop a fluid from expanding, and is usually stated in terms of force per unit area. A pressure sensor usually acts as a transducer; it generates a signal as a function of the pressure imposed. For the purposes of this article, such a signal is electrical.

Pressure sensors are used for control and monitoring in thousands of everyday applications. Pressure sensors can also be used to indirectly measure other variables such as fluid/gas flow, speed, water level, and altitude.

Fig 1.6 BMP 180 PRESSURE SENSOR

1.3.4 Humidity Sensor

The HH10D relative humidity sensor module is comprised of a capacitive type humidity sensor, a CMOS capacitor to frequency converter and an EEPROM used to hold the calibration factors.

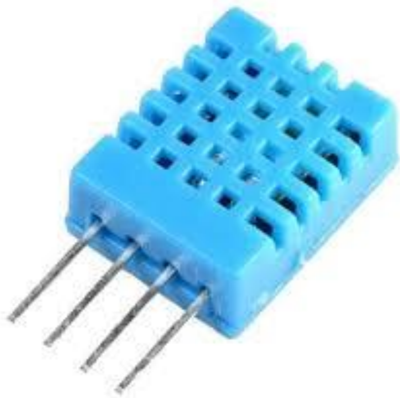


Fig 1.7 HH10D HUMIDITY SENSOR

1.3.5 Gas Sensor

When a gas interacts with this sensor, it is first ionized into its constituents and is then adsorbed by the sensing element. This adsorption creates a potential difference on the element which is conveyed to the processor unit through output pins in form of current.

The gas sensor module consists of a steel exoskeleton under which a sensing element is housed. This sensing element is subjected to current through connecting leads. This changes the resistance of the sensing element which alters the value of the current going out of it.

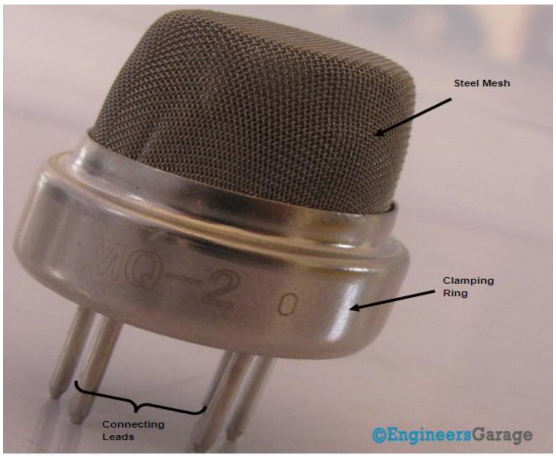


Fig 1.8 FC 22 GAS SENSOR

1.4 GSM Modem

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

When a GSM modem is connected to a computer, this allows the computer to use the GSM modem to communicate over the mobile network.

Fig 1.9 SIM 9000A GSM MODEM

1.5 DTMF

One of the few production telephone DTMF keypads with all 16 keys. The column of red keys produces the A, B, C, and D DTMF events.Dual-tone multi-frequency signaling (DTMF) is an in-band telecommunication signaling system using the voice-frequency band over telephone lines between telephone equipment and other communications devices and switching centers.

The DTMF system uses a set of eight audio frequencies transmitted in pairs to represent 16 signals, represented by digits, letters, and symbols. As the signals are audible tones in the standard telephony voice frequency range, they could be transmitted across long distances through electrical repeaters and amplifiers, and over radio and microwave links, thus eliminating the need for intermediate operators.

CHAPTER 2

DC MOTOR, DTMF AND MICROCONTROLLER

2.1 DC MOTORS

In this project, two slow speed dc gear motors are incorporated which are responsible for forward, reverse, left and right movements. When both the motors rotate in clockwise direction, the robot moves in forward direction while the reverse motion corresponds to backward movement. If one motor is in clockwise motion while the other in anti-clockwise one, then the robot moves from left to right and vice versa. Working voltage of these motors is 9 volt to 12 volt dc. We use two power source in this project. One for the motors and second for the controller circuit.

2.1.1 Design

For controlling a dc motor, a H-bridge circuit is used. Four transistors are used to control the movement of dc motor for forward and reverse directions.

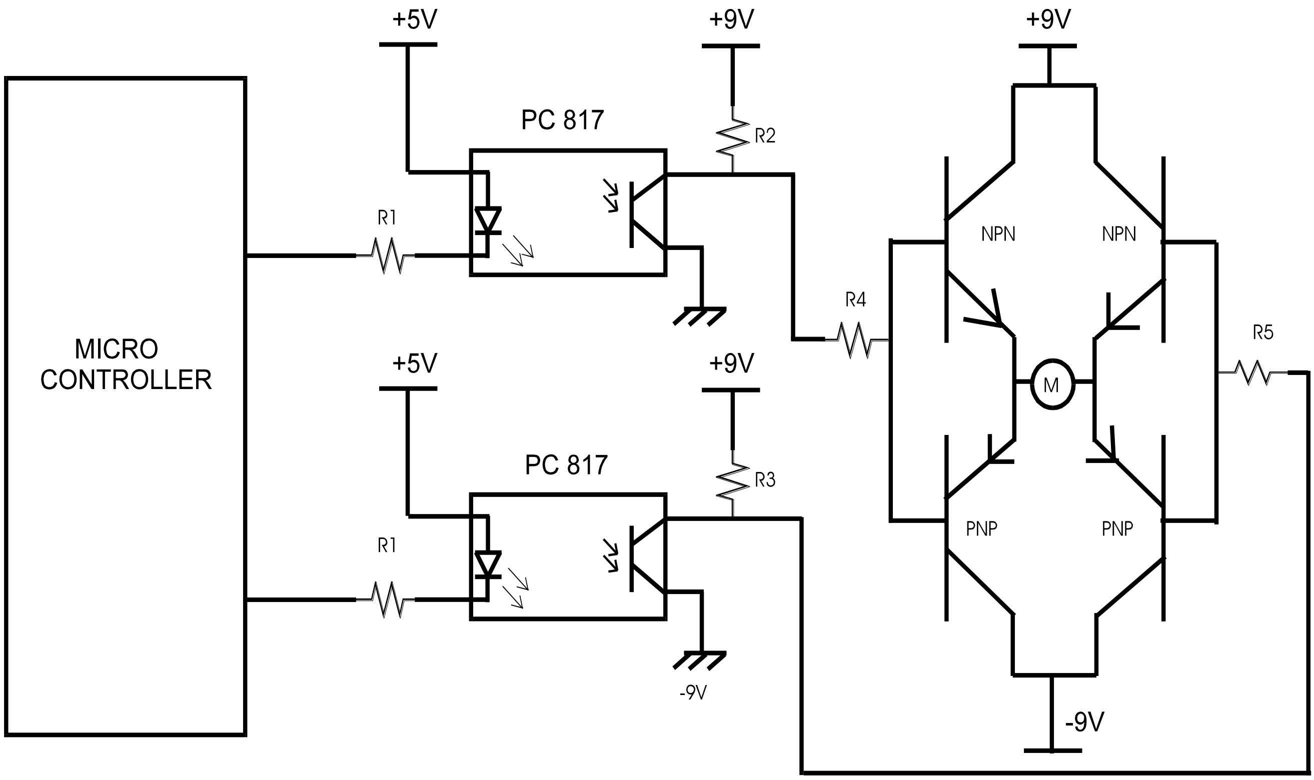


Fig 2.1 DC MOTORS' CONNECTIONS

2.1.2 Functional description

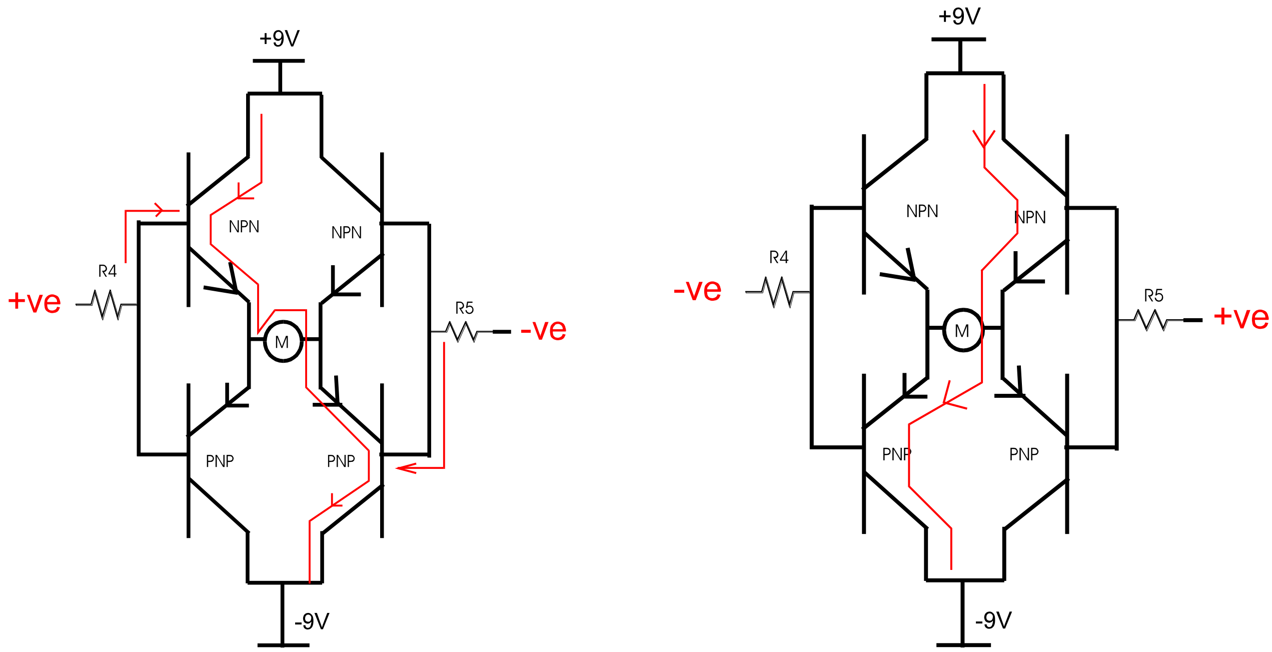


Fig 2.2 CLOCKWISE AND ANTI-CLOCKWISE MOTIONS OF DC MOTOR

Collector of both the transistor is connected to the positive supply 9 volt. This 9 volt supply is for the DC motor. If a 12 volt motor is used then a 12 volt dc supply is required. Emitter of both the transistor is connected to the DC motor. Emitter of the PNP transistor is connected to the emitter of NPN transistor. Collector of both the PNP transistor is connected to the ground potential. Base point of both transistors is join together. A voltage is now supplied.

If a positive voltage is applied to the base of left junction and negative voltage to the right junction then motor moves in one direction. This is because of the fact that due to positive on base, NPN is ON and due to negative on base, PNP is ON. If left side NPN is on and right side PNP is on then motor moves to the one direction (clockwise motion=forward direction). If the voltage is reverse on the base point then motor's moves to the reverse direction because base voltage is changed . Now left NPN and right PNP is ON and motor moves in the reverse direction. This H bridge is attached to the logical output of the micro-controller and the interfacing is done with the aid of opto-couplers.

2.2 OPTO-COUPLER

An Opto-Coupler is a special optically isolated device used to interface the input with output using light. Opto-Couplers provide electrical isolation between the input and output circuit, and in between the two power supplies. Microcontroller power supply is 5 volt dc and motor supply is variable from 9 volt to 12 volt dc.

2.2.1 Design

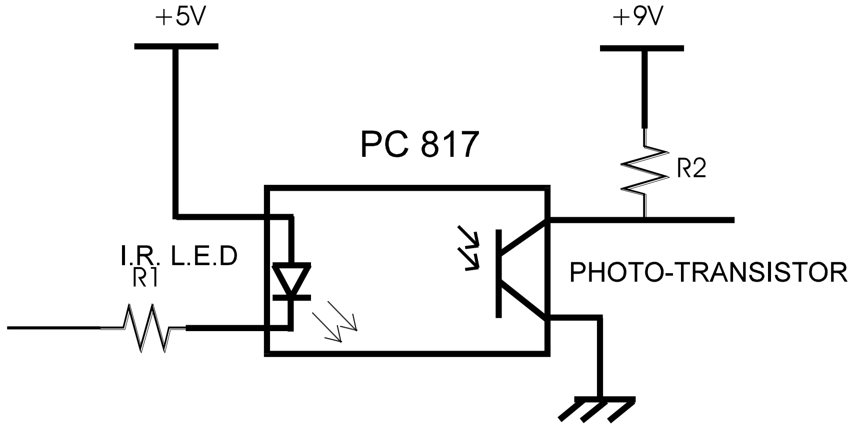


Fig 2.3 AN OPTO-COUPLER

In opto-coupler there is one input and one output and there is no connection between input and output. On input point there is one infra red LED. Cathode point of the LED is connected to the resistor R1 and further connected to the microcontroller ports. In this project, two dc motors are used, thus two H bridge circuits are used with four opto-couplers.

2.2.2 Functional Description

PC 817 is a 4 pin IC. Two pins act as input and the other two pins act as output. One of the input is a line from voltage regulator and the other one is accepted from the output of microcontroller. Whenever a voltage is applied at the input of the opto-coupler provided by microcontroller, no potential difference is created between both the inputs, i.e. both the inputs bear 5V. Thus no light is generated from the photodiode and hence the transistor is not in action. This output is further used to drive the motor.

However, if no voltage is applied at the input, a potential difference is created which causes the photodiode to emit light and thereby, cause the transistor current to flow. This causes the driving of motors.

2.3 MECHANICAL ASPECT

This section is about the mechanical aspect of the project. The robot needed a body of some shape in order to be useful especially as a technology demonstrator.Due to the scope of the work and the time allocated, it was found necessary to focus more on the implementation of the GSM functions to be demonstrated, so on the mechanical side, the idea was to build a basic frame on which the various electronics circuits and other equipments could be supported and carried. This frame can serve for experimental purposes as the first prototype, and later be improved for future versions of the robot. The actual body for GCAAR comprises of the PCB and the chassis.

2.3.1 Chassis Design

The chassis is the base that carries the main frame. It is a square/triangular structure with two wheels on the rear-left and rear-right sides and a small wheel at the bottom-front. The big wheels on the sides are 200mm diameter, and the small wheels at the bottom are 30mm diameter.

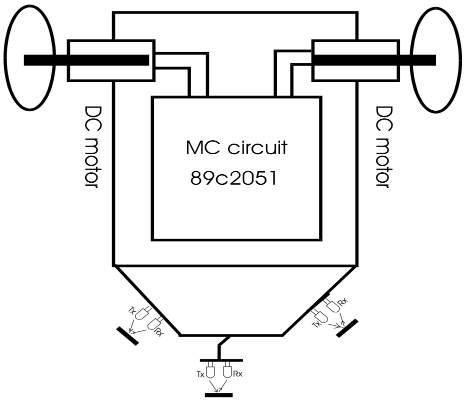


Fig 2.4 CHASSIS BLOCK DESIGN

SOFTWARE DESIGN

The implementation of most of the functionalities of GCAAR required some software development.

Embedded software

This section discusses the codes written for the microcontroller in the electronics boards developed in this project. The microcontroller used is AVR microcontroller from Atmel, all the codes are written in assembly language.

2.4 IC 8870: DTMF DECODER

First circuit involves IC 8870, which is a DTMF decoder. Hence the first part of the entire system functioning is decoding of DTMF tones received by the receiver phone. It is indispensible conversion since without it, its impossible to interact with the mobile phone (GSM control) and receive any command.

2.4.1 Design

Whenever a switch is pressed on the transmitter phone, a signal corresponding to particular frequencies is transmitted. Such signals are known as DTMF (Dual Tone Multi Frequency) tones or DTMF signals.

Frequencies ⇩⇨	1209	1336	1477	1633
697	**1**	**2**	**3**	**A**
770	**4**	**5**	**6**	**B**
852	**7**	**8**	**9**	**C**
941	*****	**0**	**#**	**D**

TABLE 2.1 DUAL TONE MULTI FREQUENCY TABLE

DTMF is available in the form of sound signal. Each digit corresponds to two frequencies: one being a low tone and other being a high tone. Whenever a digit is pressed, the two frequencies corresponding to it, modulate with a carrier to form third frequency, which is then transmitted. At the receiver end with the help of mobile phone and handsfree kit the sound signal is decoded by cutting the speaker of handsfree and connecting the speaker wires to the DTMF decoder circuit. Note that, only digits from 1-9 are considered and 0 is not included for this purpose.

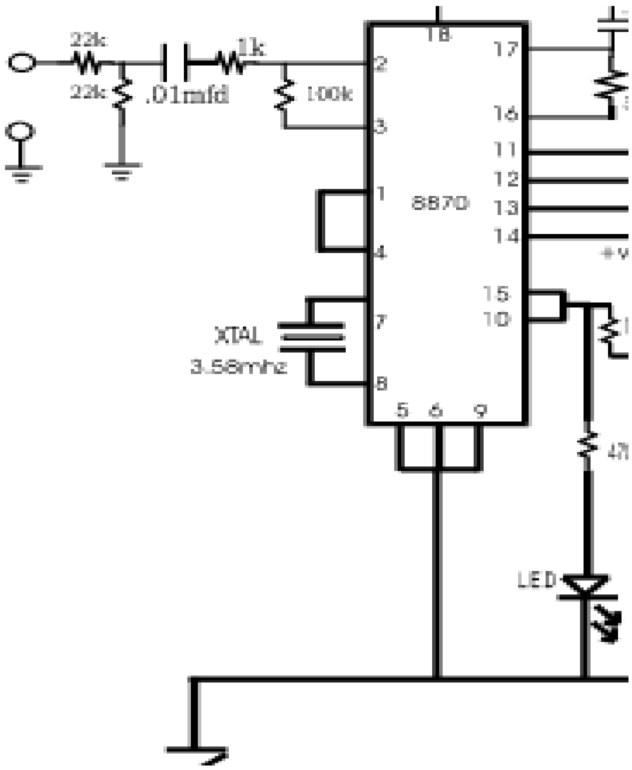


Fig 2.5 IC 8870: DTMF DECODER

2.4.2 Functional Description

IC 8870 is a 18 pin IC. DTMF decoder circuit receives the signal on pin no 2 and 3 via resistor and capacitor circuit. One of the resistor and capacitor together form a high pass filter (rejects lower frequencies), while rest of the two resistors are used for voltage drop. A crystal oscillator is connected across pin no. 7 and 8 for demodulating the signal. The frequency of this crystal is decided by the IEEE standards and is equal to 3.5749. Apart from IC 8870, IC 3170/9170 are also capable of decoding the signal. Pin no. 18 is connected to the positive supply. Pin nos. 5, 6, 9 are connected to the ground pin. Output signal which is a BCD signal is available on the pin nos. 11, 12, 13, 14 as the binary output. One pulse is also available on the pin no 15 for visual indication. This high pulse further drives the next IC by short circuiting the transistor and making the output at pin nos 18 and 19 of IC 74154 equal to 0 thereby enabling it. Output of DTMF decoder is further connected to the IC 74154 which is described in further sections.

ELECTRONICS

The robot being an electromechanical system, there are a number of electronics circuits design and used in this project, and this section will be a close look at each of those circuits. The electronics section takes into consideration all the electronic circuits necessary for a proper operation of the robot.

IC 7805: VOLTAGE REGULATOR

A 9V battery is used to drive the entire system. However, all the components of the system operate at lower voltage i.e. 5V only. Hence, voltage regulation is necessary for safe and accurate functioning of the robot. This task is performed by IC 7805. This IC belongs to XX series while the input belongs to XX+2 series. This is because the batteries available for the use are available as the multiple of 1.5V.

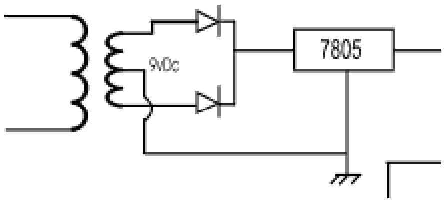


Fig 2.6 IC 7805: VOLTAGE REGULATOR

IC 74154: BCD TO DECIMAL CONVERTER (1:16 DEMULTIPLEXER)

IC 74154 acts as a BCD to Decimal Decoder Circuit. It converts the BCD signal available as the output from IC 8870 into decimal signal.

Design

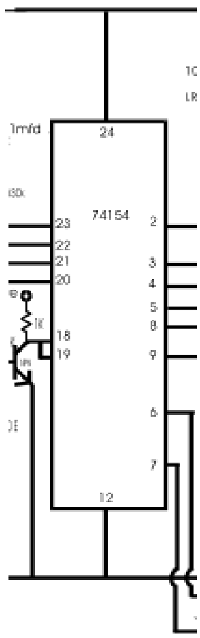


Fig 2.7 IC 74154: BCD TO DECIMAL DECODER

(1:16 DEMULTIPLEXER)

Functional Description

IC 74154 is 24 pin IC. Its main function is de-multiplexing. A total 16 outputs are available from this IC. On pin no. 18 and 19 a transistor circuit is connected. Collector of the transistor is connected to the pin no 18 and 19 and base point of the transistor is connected to the pin no 15 of the DTMF decoder IC. A high pulse from IC 8870 is used to enable this IC. It is active on low signal. Output of the 74154 is connected to the IC 89c2051 micro-controller.

2.5 IC 89C2051: MICROCONTROLLER

In this project we use IC 89C2051 as a main processor to control all the sensors and motors' output. This IC is a derivative of 8051 family. The features of the 8051 are-

- 4K Bytes of Flash Memory
- 128 x 8-Bit Internal RAM
- Fully Static Operation: 1 MHz to 24 MHz
- 32 Programmable I/O Lines
- Two 16-Bit Timer/Counters
- Six Interrupt Sources (5 Vectored)
- Programmable Serial Channel
- Low Power Idle and Power Down Modes

The 8051 has a 8-Bit CPU that means it is able to process 8 bit of data at a time. 8051 has 235 instructions. The AT89C2051 is a low-voltage, high-performance, CMOS 8-bit microcomputer with 2 Kbytes of Flash Programmable and Erasable Read Only Memory (PEROM). The device is manufactured using Atmel's high density nonvolatile memory technology and is compatible with the industry standard MCS-51 instruction set and pinout. By combining a versatile 8-bit CPU with Flash on a monolithic chip, the Atmel AT89C2051 is a powerful microcomputer which provides a highly flexible and cost effective solution to many embedded control applications.

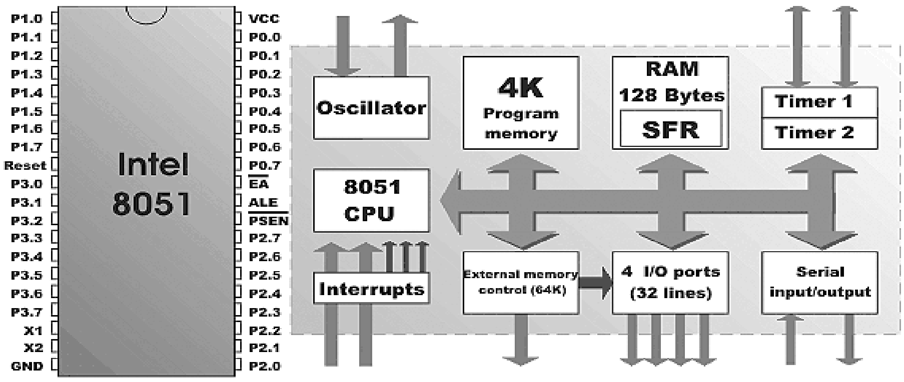


Fig 2.8 ARCHITECTURE OF 8051 MICROCONTROLLER

Design

The AT89C2051 provides the following standard features:

- Kbytes of Flash
- 128 bytes of RAM
- 15 I/O lines
- two 16-bit timer/counters
- a five vector two-level interrupt architecture
- a full duplex serial port
- a precision analog comparator
- on-chip oscillator
- clock circuitry

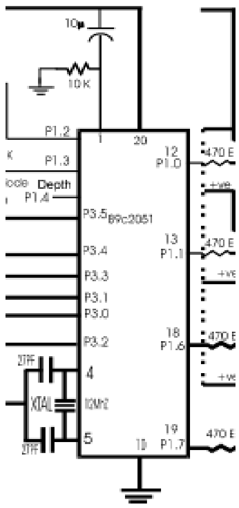


Fig 2.9 IC 89C2051: MICROCONTROLLER

In addition, the AT89C2051 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. The Power Down Mode saves the RAM contents but freezes the oscillator disabling all other chip functions until the next hardware reset.

Functional description

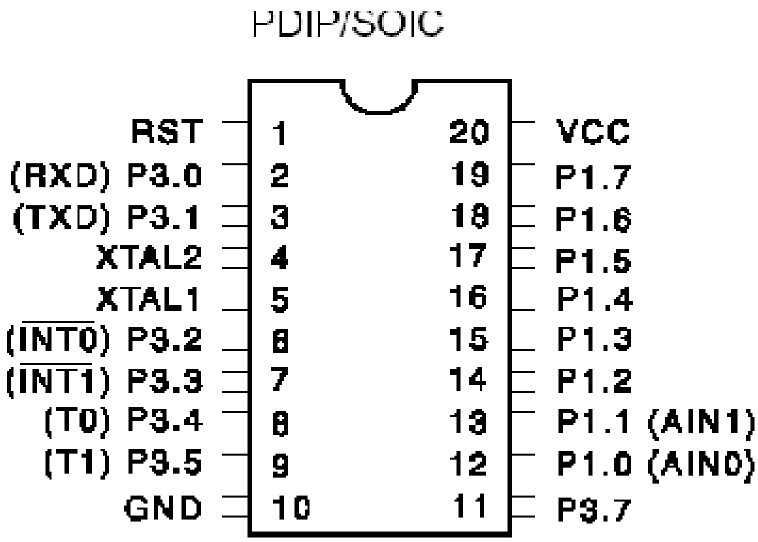


Fig 2.10 PIN DESCRIPTION OF IC 89C2051

Port 1 is an 8-bit bidirectional I/O port. Port pins P1.2 to P1.7 provide internal pullups. P1.0 and P1.1 require external pullups. P1.0 and P1.1 also serve as the positive input (AIN0) and the negative input (AIN1), respectively, of the on-chip precision analog comparator. The Port 1 output buffers can sink 20 mA and can drive LED displays directly. When 1s are written to Port 1 pins, they can be used as inputs. When pins P1.2 to P1.7 are used as inputs and are externally pulled low, they will source current (IIL) because of the internal pullups. Port 1 also receives code data during Flash programming and program verification. Port 3 pins P3.0 to P3.5, P3.7 are seven bidirectional I/O pins with internal pullups. P3.6 is hard-wired as an input to the output of the on-chip comparator and is not accessibleas a general purpose I/O pin. The Port 3 output buffers can sink 20 mA. When 1s are written to Port 3 pins they are pulled high by the internal pullups and can be used as inputs. As inputs, Port 3 pins that are externally being pulled low will source current (IIL) because of the pullups.

Port 3 also serves the functions of various special features of the AT89C2051 as listed below:

- 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)
- Port 3 also receives some control signals for Flash programming and programming verification.

RST : Reset input

All I/O pins are reset to 1s as soon as RST goes high. Holding the RST pin high for two machine cycles while the oscillator is running resets the device. Each machine cycle takes 12 oscillator or clock cycles.

XTAL1

Input to the inverting oscillator amplifier and input to the internal clock operating circuit.

XTAL2

Output from the inverting oscillator amplifier.

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, as shown in Figure 1. 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 as shown in Figure 2. 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.

Note: C1, C2 = 30 pF ± 10 pF for Crystal oscillators and

C1, C2 = 40 Pf ± 10 pF for Ceramic Resonators

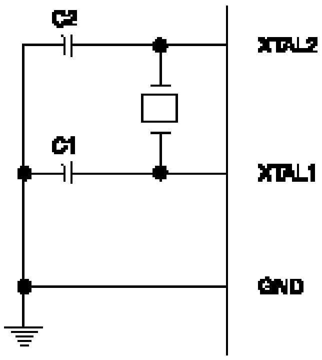


Fig 2.11 OSCILLATOR CONNECTIONS

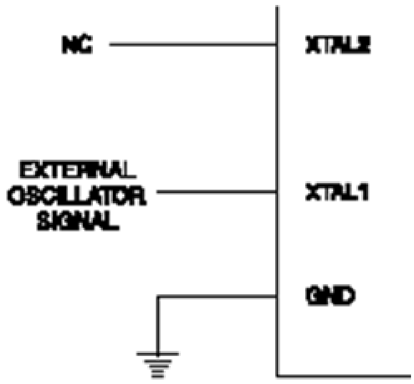


Fig 2.12 EXTERNAL CLOCK DRIVE CONFIGURATION

Restrictions on Certain Instructions

The AT89C2051 and is an economical and cost-effective member of Atmel's growing family of microcontrollers. It contains 2 Kbytes of flash program memory. It is fully compatible with the MCS-51 architecture, and can be programmed using the MCS-51 instruction set. However, there are a few considerations that one must keep in mind when utilizing certain instructions to program this device. All the instructions related to jumping or branching should be restricted such that the destination address falls within the physical program memory space of the device, which is 2K for the AT89C2051. This should be the responsibility of the software programmer. For example, LJMP 7E0H would be a valid instruction for the AT89C2051 (with 2K of memory), whereas LJMP 900H would not.

Branching instructions: LCALL, LJMP, ACALL, AJMP, SJMP, JMP @A+DPTR These unconditional branching instructions will execute correctly as long as the programmer keeps in mind that the destination branching address must fall within the physical boundaries of the program memory size (locations 00H to 7FFH for the 89C2051). Violating the physical space limits may cause unknown program behavior. CJNE [...], DJNZ [...], JB, JNB, JC, JNC, JBC, JZ, JNZ With these conditional branching instructions the same rule above applies. Again, violating the memory boundaries may cause erratic execution.

For applications involving interrupts the normal interrupt service routine address locations of the 80C51 family architecture have been preserved.

MOVX-related instructions, Data Memory: The AT89C2051 contains 128 bytes of internal data memory. Thus, in the AT89C2051 the stack depth is limited to 128 bytes, the amount of available RAM. External DATA memory access is not supported in this device, nor is external PROGRAM memory execution. Therefore, no MOVX [...] instructions should be included in the program. A typical 80C51 assembler will still assemble instructions, even if they are written in violation of the restrictions mentioned above. It is the responsibility of the controller user to know the physical features and limitations of the device being used and adjust the instructions used correspondingly.

CHAPTER 3

SENSORS

3.1 INFRA RED SENSOR

Infra-red sensors are devices which emit infrared, and in some cases, the infrared reflects off objects and bounces back in the direction of the detector. The eyes of the robot are the infrared detectors. The infrared detectors send signals to the microcontroller indicating whether or not, they detect infrared reflected off an object. The brain of the robot, the microcontroller makes decisions and operates the motors based on this sensor input

The IR detectors have built-in optical filters that allow very little light except the 980 nm infrared that we want to detect onto its internal photodiode sensor. The infrared detector also has an electronic filter that only allows signals around 38.5 kHz to pass through. In other words, the detector is only looking for infrared that's flashing on and off 38,500 times per second.

This prevents common IR interference sources such as sunlight and indoor lighting. Sunlight is DC interference (0 Hz), and indoor lighting tends to flash on and off at either 100 or 120 Hz, depending on the main power source in the region where you reside. Since 120 Hz is way outside the electronic filter's 38.5 kHz band pass frequency, it is, for all practical purposes, completely ignored by the IR detectors.

As the receivers detects only modulated signals we need to have our IR LEDs modulated in 36 KHz to 40 KHz. We can use 555 timer to make this 40 KHz pulse.

Functional Description

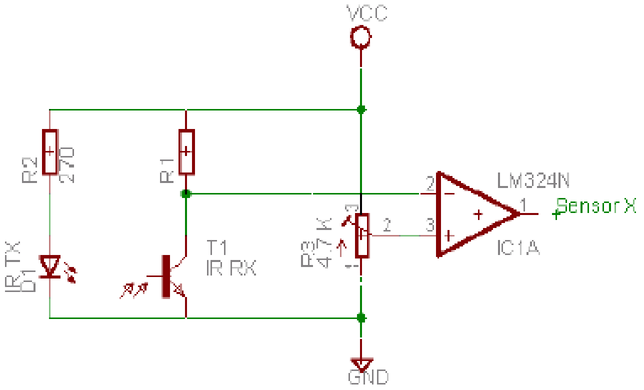


Fig 3.1 IR SENSOR SCHEMATIC DIAGRAM

To get a good voltage swing , the value of R1 must be carefully chosen. If R_{sensor} = a when no light falls on it and R_{sensor} = b when light falls on it. The difference in the two potentials is:

Vcc * { a/(a+R1) - b/(b+R1) }

Relative voltage swing = Actual Voltage Swing / Vcc

= Vcc * { a/(a+R1) - b/(b+R1) } / Vcc

= a/(a+R1) - b/(b+R1)

The resistance of the sensor decreases when IR light falls on it. A good sensor will have near zero resistance in presence of light and a very large resistance in absence of light. This property of the sensor is used to form a potential divider. The potential at point '2' is R_{sensor} / (R_{sensor} + R1). Again, a good sensor circuit should give maximum change in potential at point '2' for no-light and bright-light conditions. This is especially important if an ADC is to be used in place of the comparator.

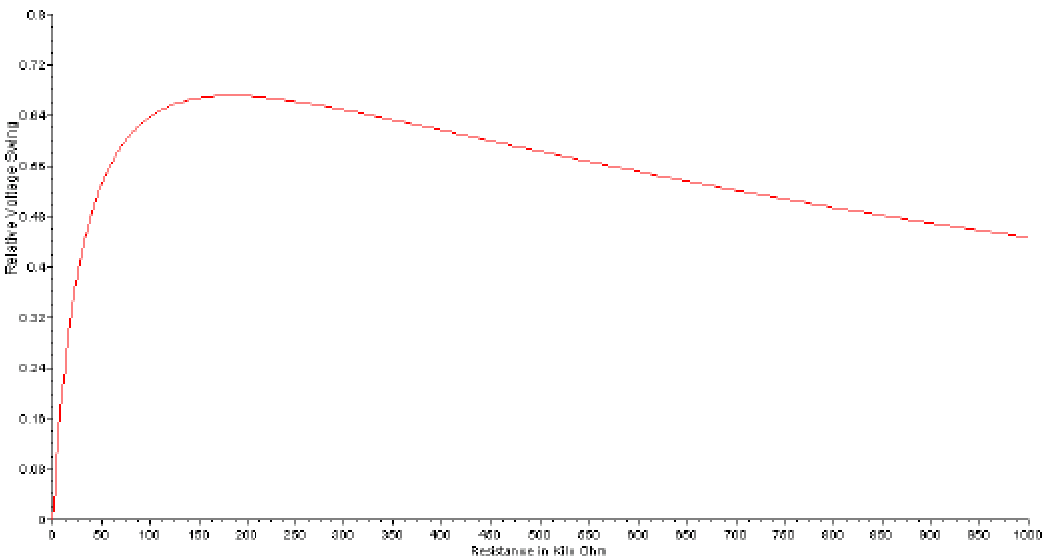


Fig 3.2 VOLTAGE SWING OF SENSOR

The front sensors continuously emit light. Whenever any obstacle is encountered in the way, these infra red rays are reflected back by the obstacle and received by the detector. The depth sensor and detector, continuously receives the infra red rays. However, on determination of depth or pit in the path, no rays are received and thus, appropriate action is taken.

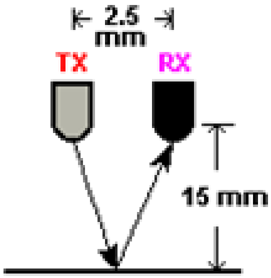


Fig 3.3 IR SENSOR

3.1.1 Applications:-

Night Vision Devices:-Infrared technology is implemented in night vision equipment if there is not enough visible light available to see unaided.

Infrared Astronomy:-Infrared astronomy is a field of astronomy which studies astronomical objects which are visible in infrared radiation.

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

3.2 TEMPERATURE SENSOR

LM 35 temperature sensor. By using this sensor we give an input to an ADC and then convert this analog data into digital to be processed by the microcontroller using a transducer.

1. Temperature measurement included
2. I2C interface
3. Fully calibrated
4. Pb-free, halogen-free

Transducers are used to convert physical data such as temperature into voltage,current etc. which is again converted into an output voltage and is fed into the input of AtoD converter. This conversion is called signal conditioning.

Temperature sensed by BC548 is converted to output voltage using a transducer called thermistor.

A thermistor responds to temperature change by changing resistance.

Temperature (C)	Tf (K ohms)
0	29.490
25	10.000
50	3.893
75	1.700
100	0.817

TABLE 3.1

BC548 can have an input voltage varying from 2.7v to 5.5v.

Then in ADC we apply a formula to convert the analog voltage value to digital value between 0 to 1023.

This formula converts the digital values from 0 to 1023 into the range of 0-5000mv.

Voltage at pin in miliVolt = (reading from ADC) * (5000/1024)

Now to convert mV to celsius we divide analog voltage in mV by 10 as BC548 is calibrated such that output voltage varies by 10mV/ oC

3.2.1 Applications

1. Enhancement of GPS navigation (dead-reckoning, slope detection, etc.)
2. In- and out-door navigation
3. Leisure and sports
4. Weather forecast
5. Vertical velocity indication (rise/sink speed)

Fig 3.4 Temperature sensor

3.3 PRESSURE SENSOR

The BMP180 series is designed to sense absolute air pressure in an altimeter or barometer applications

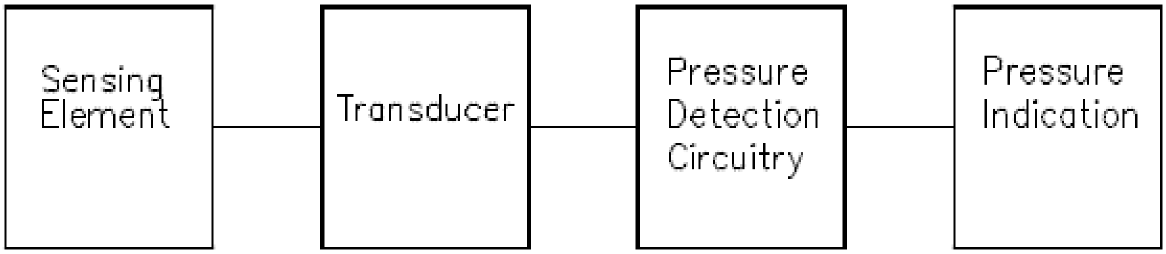


Fig 3.5 Block Diagram of Pressure Sensor

BMP180 general description

The BMP180 is the function compatible successor of the BMP085, a new generation of high precision digital pressure sensors for consumer applications.

The ultra-low power, low voltage electronics of the BMP180 is optimized for use in mobile phones, GPS navigation devices and outdoor equipment. With a low altitude noise of merely 0.25m at fast conversion time, the BMP180 offers superior performance. The I2C (Inter-Integrated Circuit) interface allows for easy system integration with a microcontroller.

The BMP180 is based on piezo-resistive technology for EMC robustness, high accuracy and linearity as well as long term stability.

CIRCUITRY

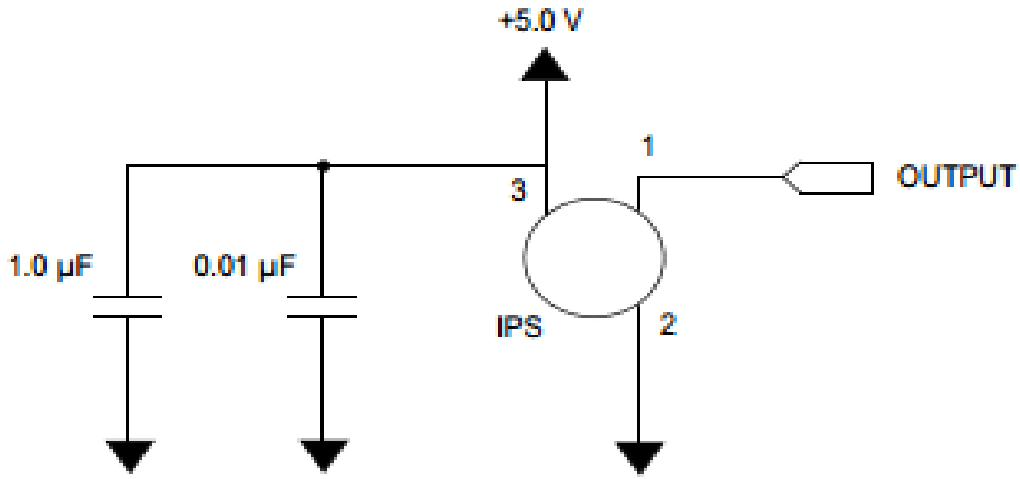


Fig 3.6 Circuit

INTERNAL CIRCUITRY

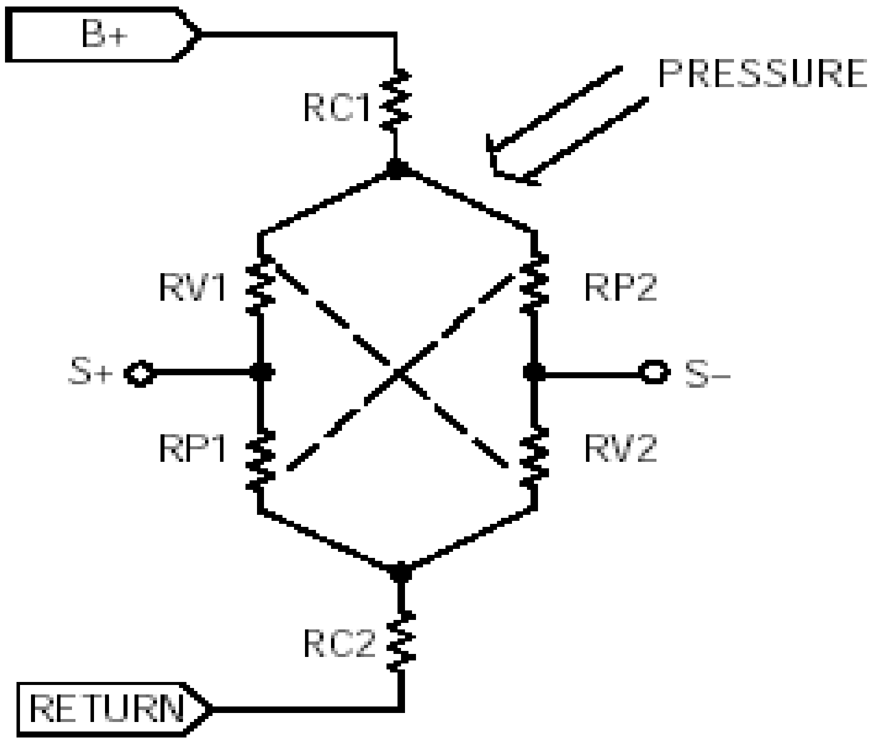
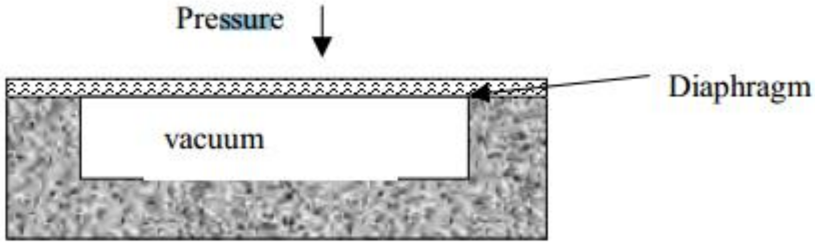


Figure 1. Sensor Equivalent Circuit

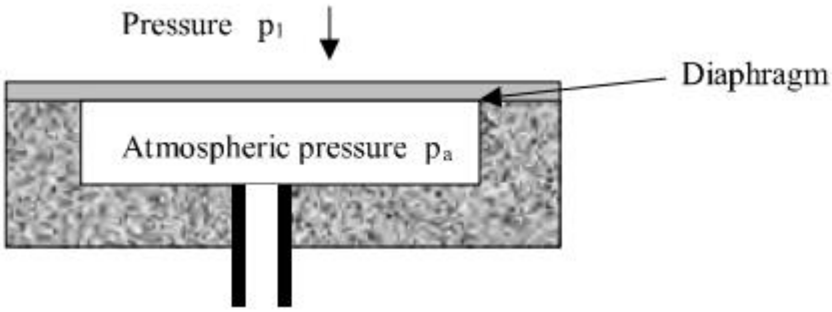
Bridge resistors RP1, RP2, RV1 and RV2 are arranged on a thin silicon diaphragm such that when pressure is applied RP1 and RP2 increase in value while RV1 and RV2 decrease a similar amount. Pressure on the diaphragm, therefore, unbalances the bridge and produces a differential output signal. One of the fundamental properties of this structure is that the differential output voltage is directly proportional to bias voltage B+. This characteristic implies that the accuracy of the pressure measurement depends directly onthe tolerance of the bias supply. It also provides a convenient means for temperature compensation. The bridge resistors are silicon resistors that have positive temperature coefficients. Therefore, when they are placed in series with zero TCtemperature compensation resistors RC1 and RC2 the amount of voltage applied to the bridge increases with temperature. This increase in voltage produces an increase in electrical sensitivity which offsets and compensates for the negative temperature coefficient associated with piezoresistance.

TYPES OF PRESSURE SENSORS

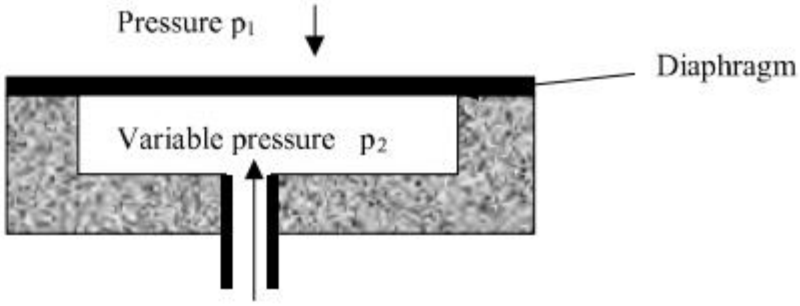
1. ABSOLUTE SENSOR-An absolute pressure sensor measures static, dynamic or total pressure with reference to a vacuum



1. RELATIVE SENSOR- relative pressure sensor measures static, dynamic or total pressure with reference to ambient atmospheric pressure



3. DIFFERENTIAL SENSOR-A differential pressure sensor measures a static, dynamic or total pressure with reference to an unspecified variable pressure p2



ADVANTAGES

- ✓ High output signal level
- ✓ Adaptable to many applications
- ✓ Technology robustness

APPLICATIONS

1) Security purposes- pressure sensors are nowadays used as alarms to detect any change in pressure in vaults and sensitive areas.

2) Aerodynamics of automobiles: The wind tunnelling tests of automobiles or defence equipments are dependent on their pressure characterstics which are sensed by pressure sensors

3.4 GAS SENSOR

FC-22 GAS SENSOR

When a gas interacts with this sensor, it is first ionized into its constituents and is then adsorbed by the sensing element. This adsorption creates a potential difference on the element which is conveyed to the processor unit through output pins in form of current

The **gas sensor module** consists of a steel exoskeleton under which a sensing element is housed. This sensing element is subjected to current through connecting leads.

This changes the resistance of the sensing element which alters the value of the current going out of it.

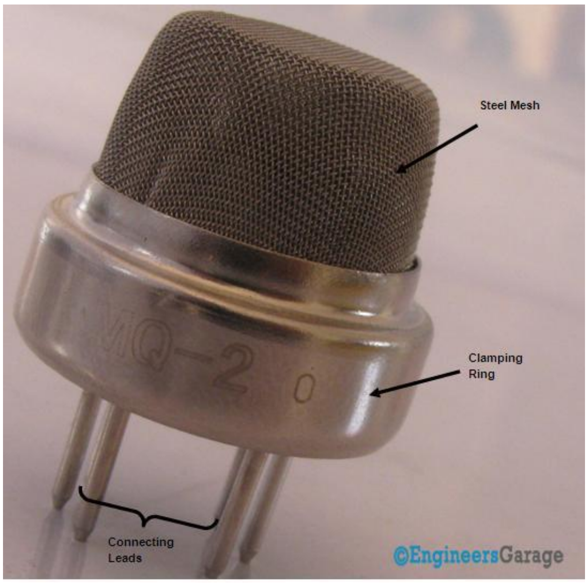


Fig 3.8 Gas Sensor

APPLICATIONS:-

- Typical carbon monoxide detection applications include installing gas detection equipment in enclosed parking structures, ambulance bays, fire halls, warehouses, loading docks.
- Ammonia as refrigerant (R717) – used extensively in food processing applications and ice rink applications
- Hydrogen sulphide sensors are used in paper pulp processing and water treatment plants because such gases are generated in in these manufacturing plants.

3.5 HUMIDITY SENSOR

Humidity is the presence of water in air. The amount of water vapor in air can affect human comfort as well as many manufacturing processes in industries. The presence of water vapor also influences various physical, chemical, and biological processes. Humidity measurement in industries is critical because it may affect the business cost of the product and the health and safety of the personnel. Hence, **humidity sensing** is very important, especially in the control systems for industrial processes and human comfort.

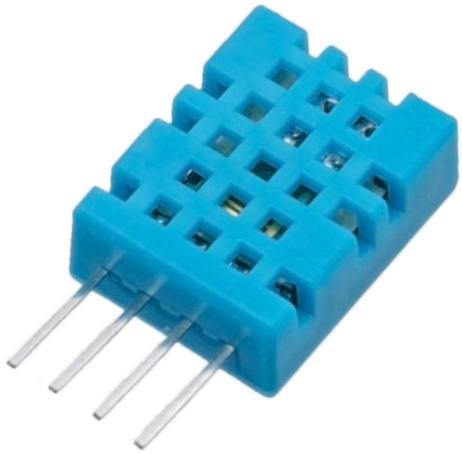


Fig 3.9 DHT11 HUMIDITY SENSOR

CHAPTER 4
GSM MODULE

4.1 GSM AND ITS HISTORY

The main focus of this study is to establish a wireless man-to-machine communication through (based on) GSM networks. The section below is a general overview of the GSM technology, from its origin, the type of services available, the network structure and briefly how it operates.

GSM is a standard for digital mobile telephony developed in Europe to substitute the existing analog mobile telephony technology which by that time, was confronted to a number of problems such as increased demand, capacity, and incompatibility with other networks.

In 1982, the Conference of European Posts and Telecommunications (CEPT) established a study group whose objective was to study and develop a public land mobile system for Europe known as “Groupe Speciale Mobile” (GSM). In 1991 the commercial service was started. From that time, GSM gained worldwide popularity and GSM which originally was an acronym for “Groupe Speciale mobile”, was later set to stand for Global System for Mobile Communication. The GSM recommendations, do not specify the actual hardware requirements, but instead specify the network functions and interfaces in detail, guaranteeing the proper interworking between the components of the system. This allows hardware designers to use their creativity to provide the actual functionality and at the same time makes it possible for operators to buy equipment from different suppliers.

GSM SERVICES

GSM offers three categories of services. The first category of services is related to the transportation of data to or from an ISDN terminal. These services are referred to as bearer services. The second category of services is referred to as Tele-services. This category includes services such as telephony and SMS. The third category of services is referred to as supplementary services. This include services such as caller identification, call forwarding, call waiting, multiparty conversations, and barring of outgoing calls.

4.2 GSM ARCHITECTURE

The GSM network can be divided into three main subsystems: the Mobile Station

Subsystem which is used by the subscriber, the Base Station Subsystem which

controls the radio link with the Mobile Station, and the Network Subsystem which mainly performs the switching of calls between a mobile and other fixed or mobile network users.

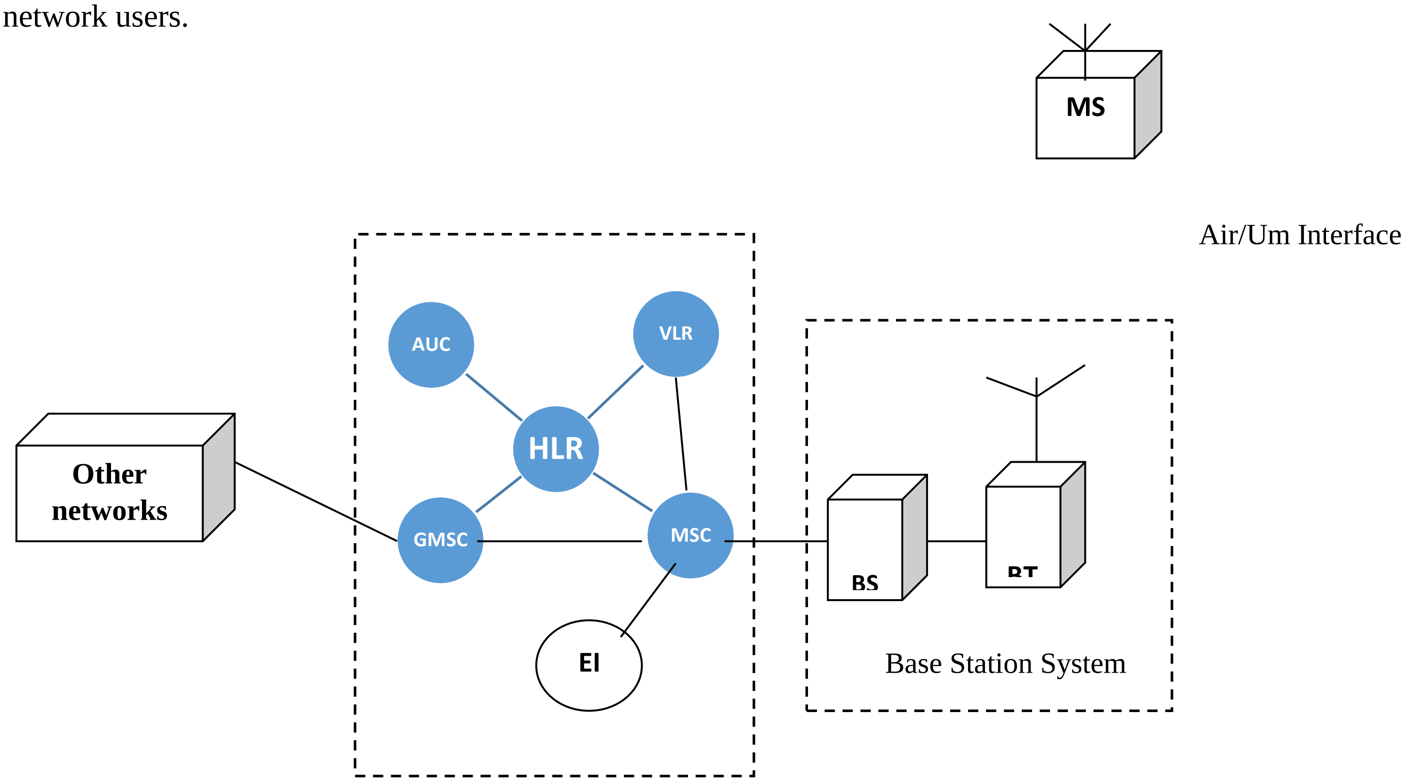


FIGURE 4.1 GSM NETWORK ARCHITECTURE

The Mobile Station subsystem and the Base Station subsystem communicate through the air interface, also known as the air interface or radio link. The Base Station subsystem and the network subsystem communicate through the A interface. A block diagram of the GSM network is shown in Figure 4.1.

4.3 Technique used

Time-division switching uses time-division multiplexing (TDM) inside a switch. The most popular technology is called the time-slot interchange (TSI).Time-Slot Interchange Figure 8.19 shows a system connecting four input lines tofour output lines. Imagine that each input line wants to send data to an output lineaccording to the following pattern:

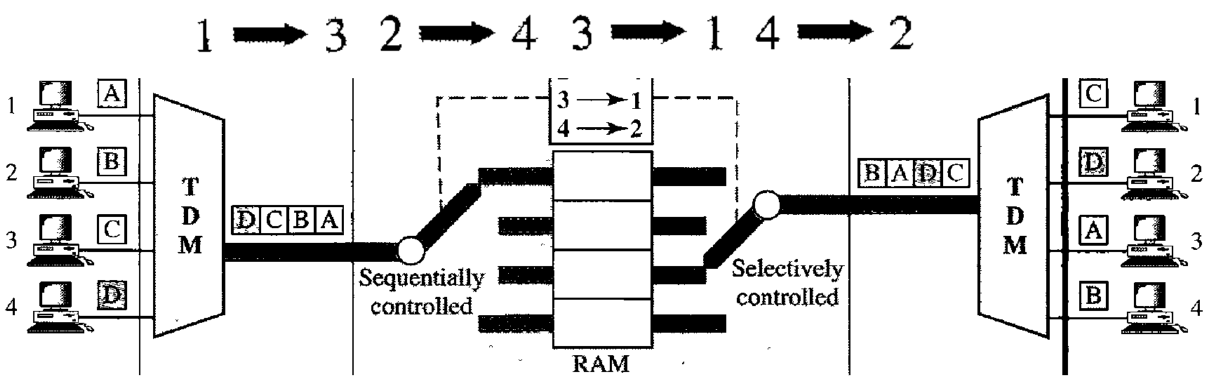


Fig 4.2 TDM

The figure combines a TDM multiplexer, a TDM demultiplexer, and a TSI consisting of random access memory (RAM) with several memory locations. The size of each location is the same as the size of a single time slot. The number of locations is the same as the number of inputs (in most cases, the numbers of inputs and outputs are equal). The RAM fills up with incoming data from time slots in the order received. Slots are then sent out in an order based on the decisions of a control unit.

Time-Division Multiplexing

Time-division multiplexing (TDM) is a digital process that allows several connections to share the high bandwidth of a linle Instead of sharing a portion of the bandwidth as in FDM, time is shared. Each connection occupies a portion of time in the link. Figure 4.3. gives a conceptual view of TDM. Note that the same link is used as in FDM; here, however, the link is shown sectioned by time rather than by frequency. In the figure, portions of signals 1,2,3, and 4 occupy the link sequentially.

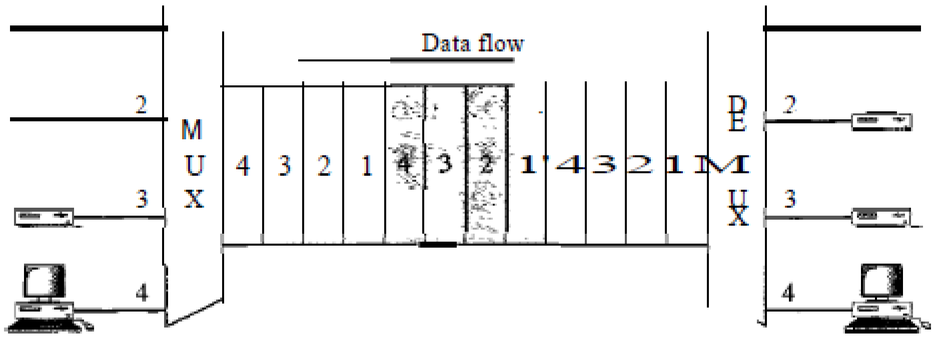


Fig 4.3 TDMA

Note that in Figure4.3 we are concerned with only multiplexing, not switching. This means that all the data in a message from source 1 always go to one specific destination, be it 1, 2, 3, or 4. The delivery is fixed and unvarying, unlike switching. We also need to remember that TDM is, in principle, a digital multiplexing technique. Digital data from different sources are combined into one timeshared link. However, this does not mean that the sources cannot produce analog data; analog data can be sampled, changed to digital data, and then multiplexed by using TDM.

4.4 APPLICATIONS

1) GSM module used in our project can help send SMS to a distant cell phone and hence get update on weather conditions at a specific place.
2) GSM network is used in most of the modern telecom networks due to its durability.

CHAPTER 5

IMPLEMENTATION OF PROJECT

5.1 ROBOT DESIGN

Generally, the design of a robot requires a main control unit, sensors, input and output interfaces, response units, and a power supply. This is a general block diagram of a robot.

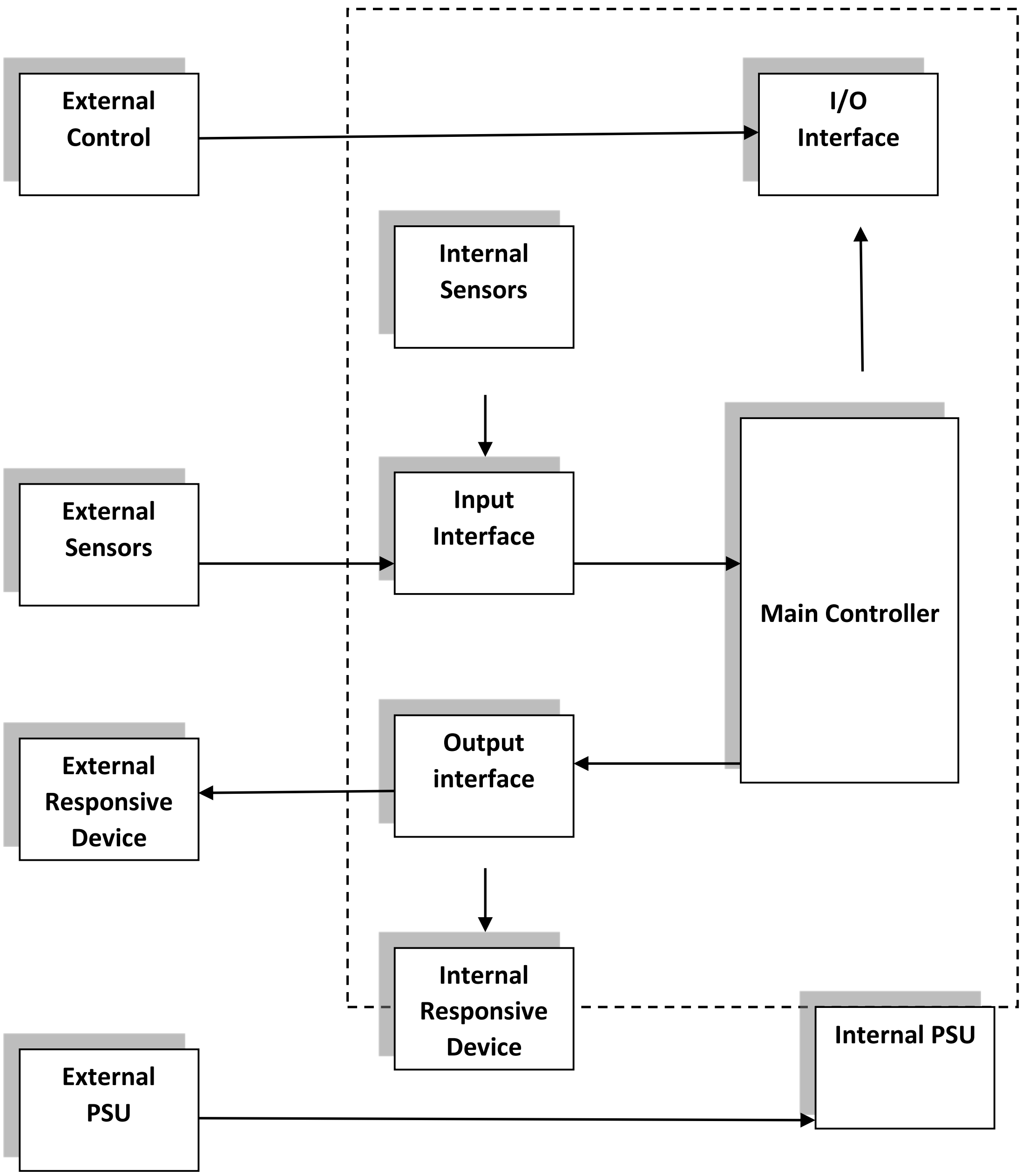


Fig 5.1 ROBOT GENERAL BLOCK DIAGRAM

The mainframe: It is the mechanical housing and the supporting framework for the machine. Much of the machine's physical appearance is dictated by the nature of the mainframe assembly.

Internal power supply: This is the source of electrical power. It directly supplies all internal electrical circuits and external response mechanisms.

External power supply: This is used to recharge the internal batteries and provide electrical power for test and troubleshooting procedures.

The internal response mechanisms: These are devices that provide responses relevant to the machine's internal operation.

The external response mechanisms: These are devices such as motors and loudspeakers that provide the means for making responses that alter the machine's external environment.

The design of robots in general and of mobile robots in particular, is based on the use of some kind of drive to power the system (motors), sensors, software and control techniques and algorithms. The following section will discuss the devices, tools and techniques most used in the design of robots.

Actuators or drive systems used

A drive system is basically a device used to make a robot move and perform tasks such as lifting or moving other objects. There are many types of drive systems in use, the three main types are:

- Hydraulic
- Pneumatic
- Electric motor

Electric motor drives

Electric motor drives are mostly used where mobility and precision are required rather than big force. Electric motors are by far the most common drive system to be found in mobile (and hobby) robots. These motors can work with very great accuracy, controlling movements up to some fractions of a centimeter but when a very big force is needed, electric motors tend to get very bulky, and the power-to weight ratio is no longer interesting.

a) Different types of motors

There are many different types of DC motors. The most used one's in the field of robotics are simple DC motors, stepper motors and servo-motors.

b) Selecting DC motors

In order to implement some mechanical motion in any project, there is a need for drive systems like motors, hydraulic, or pneumatic drives. Motors might be fairly large or rather small, depending on the amount of mechanical loading that will be applied to them. One of the important requirements for selecting a motor is to get one that is large enough for the job at hand, but not excessively large. Overly large motors add needless bulk to the project and, in many cases, waste valuable electrical power.

Another part of motor selection is to come up with a motor system that runs at the desired speed. Motors that are not geared down to achieve lower operating speeds are rarely useful in robot projects. The speed adjustment is generally achieved by the use of gear motors.

The ideal situation is to calculate the speed and torque requirements for the motors and then purchase the motors according to those requirements. In practice, it is extremely expensive to buy new motors according to specifications, especially when more than one motor is needed. So it sometimes becomes necessary to use surplus motors or gear motors.

The amount of current that a motor can draw from the voltage source is equal to the voltage divided by the winding impedance. This means that the motor current is directly proportional to the amount of applied voltage. The running speed of a motor is proportional to the applied voltage and inversely proportional to the mechanical loading on the shaft. Also the current demand of the motor is inversely proportional to the running speed and proportional to the mechanical loading.

Torque is the measure of the ability of the motor to do useful work. In other words, it is an indication of the motors twisting force or power. It can be calculated using Equation 2.1:

$$T = F_{tan} * l = F * l * \sin\phi \qquad (2.1)$$

Here,

***T*: Torque in Newton meter (N.m).**

***F*: Force in Newton (N).**

F_{tan} : Tangential component of the force in Newton (N).

***l*: Distance between the force and axis of rotation in meter (m).**

In the case of winch or wheel, the force is always tangent, so Equation 2.1 can

simply be written as:

$$T = Fl \qquad (2.2)$$

The first step in selecting a motor is to determine as reasonably as possible the mechanical specifications of the system relevant to the motor: rpm, torque and power. This will help determine the electrical specification for the power supply as well.

$$P = F \times d = F \times v \qquad (2.3)$$

Here,

***P*: required mechanical power in watt (W).**

***F*: Amount of weight to be moved in Newton (N).**

***t*: Time interval required for moving the weight in seconds (s).**

***d*: distance of displacement in meters (m).**

***v*: Linear speed in meter per second (m/s).**

5.2 Sensors

What makes a robot versatile, powerful and fascinating is its ability to collect data, and react or change its behaviour based on that data. Much of the information a robot requires to perform its job comes from sensors. These are devices that collect information about the robot itself or some part of the world around it, and transmit it to the robot's computerized controller. Without sensors a robot would be nothing more than an automated machine. Sight, hearing, touch and other senses, though, give it the means to think for itself. Sensors are transducers that convert a certain measurable quantity in the real world into an electric signal. There are many different types of sensors that can be used in robotic applications but they can be divided in **4** main groups:

- Light sensors
- Sound sensors
- Force sensors
- Position sensors.

Ultrasound Sensors

Ultrasound is very high frequency sound that cannot be heard by humans. Ultrasonic sensors rely on a principle known as echo-location to locate an obstacle. An ultrasonic sensor has two parts, a transmitter and a receiver.

The transmitter sends out a signal as continuous pulses of ultrasound. If the pulses hit an obstacle they are reflected back towards the sensor. The time it takes for the signals to bounce back is converted into an exact measure of distance. Ultrasonic sensing depends on the reflective surface or object's density, which affects its ability to reflect sound. Providing an object is dense enough to return the sound signal, ultrasonic sensors can tell whether the object is there, whether it is see-through or not.

So ultrasonic sensors are the best choice for industrial robots designed to work with clear glass or plastic bottles and containers, which lasers, for example, may not detect. Ultrasonic detectors also work in fire or smoke-filled environments. Ultrasonic sensors use sound waves above the range of human hearing. As the sound signal returns after bouncing off an object, it is collected and the time measured for it to return can be easily converted into a measure of distance.

Power supply

For a robot to operate properly, there is a need for a power system to supply electrical power to the motors, relays, electronic circuits, and other electrical devices.

The main power supplies for robotics applications are either the standard utility power sources or batteries. The big disadvantage of the utility power source is that the robot will be limited in its motion by a power cable. So the most suited type of power supply for a mobile robot are on-board batteries.

Battery operated mobile robots require a power scheme with the following components:

- On-board batteries
- Battery recharging system
- Power distribution and control system

In order to simplify the design of the power supply scheme, it is essential to consider using a battery which voltage rating matches that of the motors and most of the other devices to be powered in the system.

There are two possible configurations when using batteries. The first configuration is to use a single battery to supply the entire system, and the second configuration is to use two or more batteries. One to supply the high-current electromechanical devices and another supply the noise sensitive electronic circuits. The two main types of batteries suitable for robotics applications are lead-acid and gel-cell batteries. Nickel cadmium (nicad) and carbon-zinc batteries can also be use to supply electronic circuits.

The battery recharging system needs to match the specifications of the battery, this refers mainly to the charging rate, since charging the battery faster than as specified, reduces the battery's life span.

The power distribution and control system consists of the wiring, protecting circuits (fuses), regulators, voltage step up and voltage step down circuits, and current limiting circuits.

AVAILABLE STUDY ON ROBOTS AND CONTROL

Many trends and many different approaches have emerged over the years in robot design. It will not be practical not even possible to go through all that has been done in the field of robotics until now, but an overview of some approaches can be given. In this section, examples of a passive system and a very complex and advanced controlled system are discussed.

PASSIVE SYSTEM

The passive system considered here is the “passive dynamic walker”. This robot is capable of walking down an incline without any actuation and without control. In other words, there are no motors and there is no microprocessor on the robot; it is brainless, so to speak.

Fig 5.2 PASSIVE DYNAMIC WALKER

This passive motion has been achieved by exploiting the dynamics of the robot, its body and its limbs. This kind of walking is very energy efficient and there is an intrinsic naturalness to it. Figure 5.2 shows the passive dynamic walker.

COMPLEX SYSTEM

In this second case, reference will be made of Asimo, designed by Honda’s Engineers using a different approach than the passive dynamic walker. Asimo was designed to perform a larger number of different types of movements. This Honda robot is able to do things such as walk up and down stairs, push a cart and open a door.

“The methodology was to record human movements and then to reproduce them on the robot which leads to a relatively natural behavior of the robot.” In this specific case, the

movement is not energy efficient. Figure 5.3 shows Honda’s Asimo

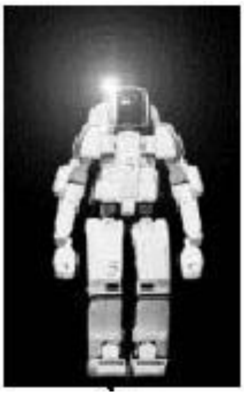


Fig 5.3 HONDA ROBOT ASIMO

5.3 RESEARCH FIELDS

Advances in robotics introduced a new field of research called artificial intelligence which aims at developing advanced and intelligent robots. Artificial Intelligence can be defined as a discipline that deals with programming computers to carry out tasks that would require intelligence if carried out by humans. It deals with tasks considered to require knowledge, perception, reasoning, learning, understanding, and other cognitive abilities.

EAMI (Evolutionary Adaptive machine intelligence): Refers to a particular process for developing a hierarchy of machine intelligence. Using Evolutionary adaptive Machine Intelligence, it is possible to build an intelligent machine gradually.

There are three different classes in the EAMI: Alpha-Class Intelligence, Beta-Class Intelligence, and Gamma-Class Intelligence. An Alpha-Class machine responds to its environment in a purely random fashion. It learns and remembers nothing. A Beta-Class machine does remember responses to conditions it experienced directly at some time in the past. It responds according to remembered experiences, but it cannot anticipate situations never dealt with on a first-hand basis. The shortcoming of the Beta- Class machine is covered by the third, and final step in the EAMI program which is the Gamma-Class machine.

ADVANTAGES AND DISADVANTAGES OF ROBOTICS

The use of machines has a very high initial cost, but it increases production since machines can work faster and for longer periods of time than humans can. Machines have improved the working conditions of humans by assuming hazardous and monotonous jobs and reduce production costs because they produce fewer "rejects" that humans sometimes produce through fatigue or boredom. Robots improve productivity in a variety of applications from processing raw materials to assembling automobiles. They are especially useful or work in hostile or dangerous environments. They provide challenging opportunities to everyone from hobbyist to the most advanced robotic designers. Industrial robots have been used in a wide variety of manufacturing applications.

Hot, dirty, dangerous foundry work in which molten metal is poured into castings was one of the first jobs in which robots were successfully used. Welding operations, in which consistency of the spot or seam weld is essential but which also produces a hot, ozone atmosphere annoying or hazardous to humans, has become another widely used application. Hazardous spray painting is another application in which robots are important, because robots can safely apply extremely thin coats of paint consistently. Back-breaking, dangerous, and tedious machine loading and unloading is another task to which robots are often applied. Most robots used in these applications are deaf, dumb, blind, and stationary. Thus, these robots are not used so differently from other kinds of automated machines.

However, an entirely new phase in robotics applications has been initiated with the development of "intelligent" robots. An intelligent robot is basically one that is equipped with some sort of sensory apparatus that enables it to sense and respond to variables in its environment. Much of the research in robotics has been and is still concerned with how to equip robots with seeing "eyes" and tactile "fingers". Artificial intelligence that will enable the robot to respond, adapt, reason, and make decisions in reaction to changes in the robot's environment are also inherent capabilities of the intelligent robot.

The main disadvantage which may result from the increasing reasoning power of nowadays and future robots is the loss of jobs, and the danger sophisticated robots may become to humanity as predicted by science fiction writers.

INTRODUCTION TO GCAAR

A robot is a mechatronics system, which is made not only of mechanical and electronics components, but also of built-in software constituents for controlling them. Designing such a system requires multidisciplinary expertise since the disciplines involved span from electronics, sensor technology, computers, software development, control engineering, mechanical design, materials and manufacturing. GCAAR is no exception to the rule.

Looking at the robot and the functions to be implemented as a complete system, the design of it was done in two phases. **The first phase was to draw a conceptual design of the system as a whole. The system was divided into five different parts: Mechanical, Electronics, Software, Motor control, and Telecommunication.**

CONCEPTUAL DESIGN

The aim of the project was to develop a wheeled auto-path finder and anti-falling robot, which can interact with people through the GSM network. The shape of the machine was not of the utmost importance but rather the robot had to be able to move forward, backward, turn left and right, reply and execute commands originating from a mobile phone.

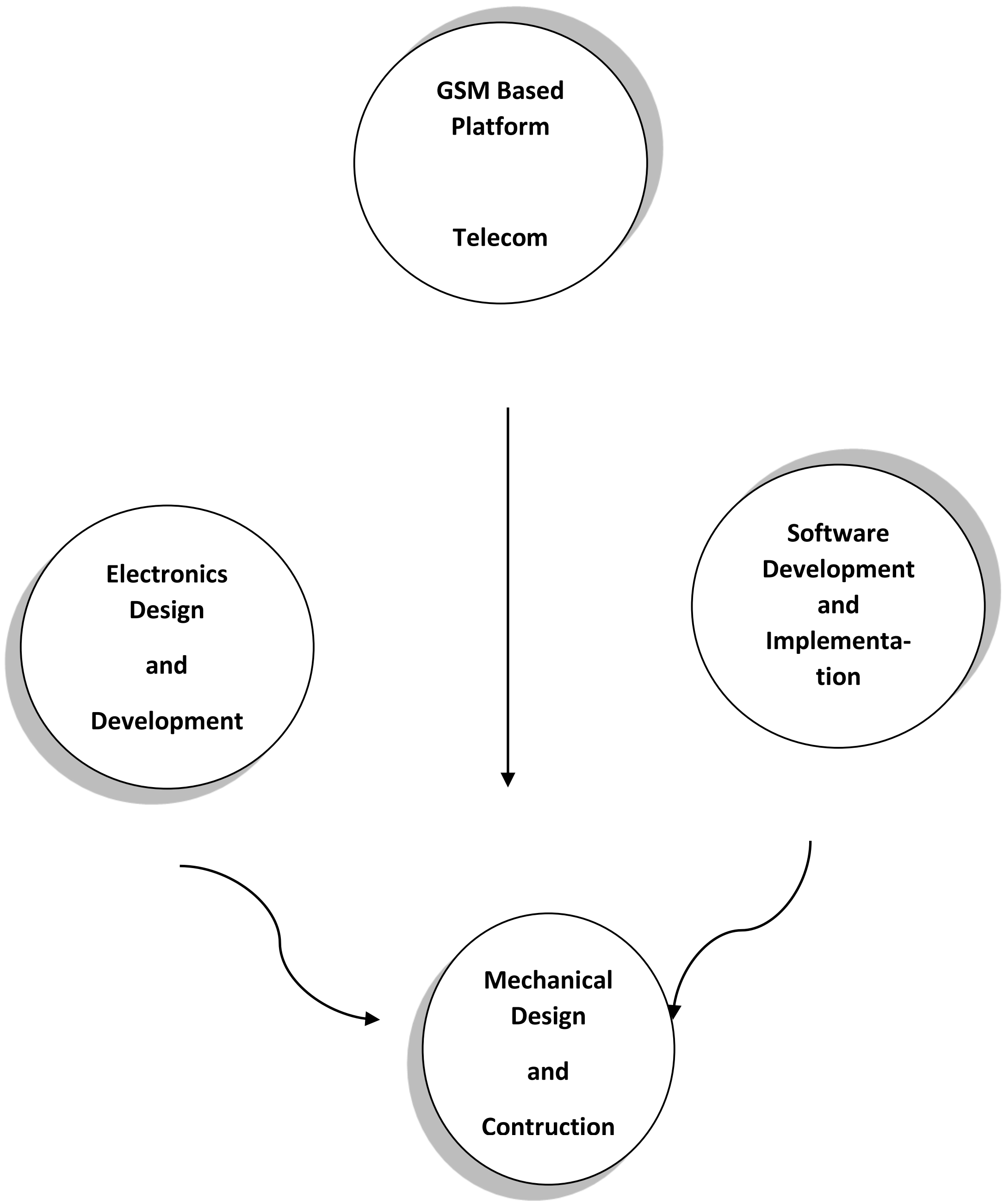


Fig 5.4 SYSTEM DESIGN APPROACH

The approach to the design was to develop a GSM based platform, and then build all the telecommunication functions on it, develop the electronics and software for motion and control, and finally construct a mechanical structure or a frame in which all the other parts could be integrated.

Before implementing this design procedure, a general view of the final outcome was necessary. Considering the possible size and the weight of the robot to be developed, it was

found more suitable to base the design on a stable wheel configuration. Generally, the greater the number of wheels, the better the stability. A three wheels system is more stable than a 2 wheels system. the design of GCAAR is based on a four wheel configuration. In order to simplify the control and the steering of the system, two of the wheels are driven by motors and the other one is castor wheel for increased stability. Based on this wheel configuration, GCAAR has two main motors.

For the robot to demonstrate the use of GSM services and especially in in-door environment, there is in fact no need for great physical power, the electric motor drive system is the most suitable in this case. The main parts of the robot to be mobile are the wheels only on this first prototype. Since GCAAR has two driven wheels and one castor wheel, therefore there will be one motor for each driven wheel.

Many different configurations could be used for the system's internal architecture,

linking all the components together. A centralized architecture could be used whereby all the devices and electronics circuitry are connected and controlled by the main processor of the system. A decentralized architecture could also be used whereby each subsystem has a microcontroller and makes decisions by itself, this is called distributed microcontroller architecture.

DETAILED DESIGN

This section is an attempt to a detailed design of GCAAR prototype robot. In order to simplify this, the whole system will be divided in 5 subsystems: Telecommunication, Electronics, Motion control, Software and Mechanical. The design of each of these subsystems will be considered at a time.

TELECOMMUNICATION

The telecommunication part of the system deals with the establishment of communication between the robot and a GSM network. With certain changes in the enhancement settings of the receiver phone i.e. turning the auto-answer feature ON, it is ready to receive any command after few rings. With the help of the transmitter phone we press DTMF codes. Receiving phone receives these code signals, decodes them and immediately responds with the aid of the built-in circuit therby, controlling the movement of the vehicle as per the given command

CHAPTER 6

CONCLUSION AND PROBLEMS

INTRODUCTION

Designing a mobile robot to be used as a “GSM technology demonstrator” and assessing its performance was the main objective of this project. The design of the complete system was discussed in chapter 2 and the circuitry, explanation of operation and key elements to the performance of the robot were evaluated in chapter 3. In this chapter, all the conclusions drawn from the design and implementation of subsystems as well as the integration of the complete system are described. The current status of the GCAAR’s performance is discussed and finally some recommendations in the design as well as the performance of the system as a whole, are discussed.

6.1 CONCLUSIONS

DESIGN CONCLUSIONS

The design of GCAAR is based on the concept developed during the early stage of the project, inspired by both the nature and the goal of the project. As a demonstrator to be used in exhibitions, certain basic requirements such as being transparent to display the technology used in the design, easy access of internal components for maintenance purposes, a simple architecture for ease of maintenance and modular design to make the system as independent as possible were of great importance. The aim was to cater for as many of these aspects as possible in the design process.

The design concept of GCAAR is supported by two different architectures brought together, mainly the electronic architecture and the mechanical architecture.

The electronic architecture of the system is semi-centralized, meaning that the main control of the system controls only some critical devices like motors while others like sensor units are quite independent and only communicates with the main control for data transfer. This has been achieved by using distributed microcontroller architecture. All electronic circuits have been implemented on PCB, and have all been mounted on the circuit panel to keep everything inside the robot neat and robust. The wiring has also been taken care of in order to keep the interior clear and presentable. In terms of maintenance, this has great value, since a faulty unit can just be removed and changed without necessarily affecting the operation of the whole system.The mechanical design is adapted to facilitate mobility of the robot. It mainly comprises of the chassis.

PERFORMANCE CONCLUSIONS

GCAAR performs a number of communication and mechanical functions. Mobility is one of the most important requirements of the project, and GCAAR does move forward, backward and turn left as well as right at the operator’s command. The performance as far as the motion is concerned is satisfactory. The electronics and mechanics used to implement motion in GCAAR are far from being perfect.

The concept of controlling the robot with a mobile phone, has also been implemented with great success. Though the reliability of the use of a mobile phone as a remote control depends on many factors some of which are some, external to the designed system such as the GSM network, no failure was observed during the test period. An obstacle detection system has been implemented in GCAAR to detect obstacles within a limited range in front of the robot. This detection system can be improved to a higher level of sensitivity to detect obstacles all around the robot.

6.2 PROBLEMS ENCOUNTERED AND APPROACH TO SOLUTIONS

Many problems were encountered during the course of this project and in each case, they were dealt with in a way or another. In this section a number of the problems encountered and how they were attended to will be discussed.

PROBLEMS WITH MOTORS

The choice of the motor is based on its torque and the torque is a function of the weight to be moved and the real weight of the robot was not known at the start. Wiper motors are suitable for positioning on the same side, either left or right. Using them in the robot as left motor and right motor makes them run in opposite directions.The motors could not run both at the same time, there was a short circuit problem.

The first problem was solved by estimating the final weight of the robot and calculating the minimum required torque. For the second problem, the polarity across the motors was reverse to make them move in the same direction.

PROBLEMS WITH MICROCONTROLLERS

It happened that with the same code and the same baud rate it was not possible to obtain the same results from two identical microcontrollers (same part number) when transmitting data to a terminal application and generating the PWM signal. This problem was not solved because not well understood, since the various tested microcontrollers were all in good working conditions.

APPENDIX

PROGRAM CODE

```
org 0000h

 sjmp main
main:

        jnb p3.1,forward
        jnb p3.3,reverse
        jnb p3.4,left
        jnb p3.5,right
        sjmp main


forward:

        clr p1.0        ; forward
        setb p1.1
        jnb p3.1,$
        ljmp stop

stop:

        mov p1,#0ffh
        ljmp main
reverse:
        setb p1.0       ;reverse
        clr  p1.1
        jnb p3.3,$
        ljmp stop
left:

       setb p1.6
        clr  p1.7
        jnb p3.4,$
        ljmp stop


right:
   clr  p1.6
    setb p1.7
```

```
jnb  p3.5,$
ljmp stop
```

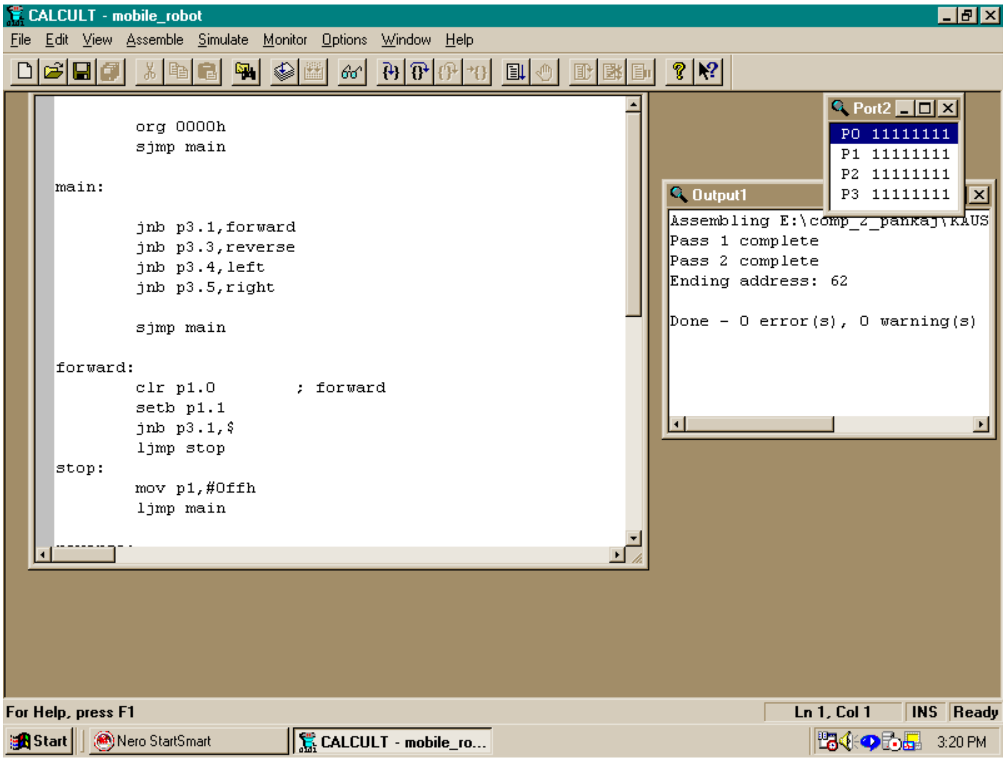


Fig A.1

CODE FOR GSM AND DTMF

```
$include <89S52.h>

sbit DTMF_EN = P3.3;

sbit DTMF_D0 = P3.4;

sbit DTMF_D1 = P3.5;

sbit DTMF_D2 = P3.6;

sbit DTMF_D3 = P3.7;

sbit DTMF_OUT = P1.0;

sbit CAMARA = P1.1;

sbit GPS_LED = P1.2;

sbit MOTOR_L_CW = P1.4;

sbit MOTOR_L_AW = P1.5;
```

```
sbit MOTOR_R_CW = P1.6;

sbit MOTOR_R_AW = P1.7;


void delay(unsigned int);

void transmit_byte(unsigned char x);


bit flag;

unsigned char sda1,sda2,sda3,sda4,sda5,sda6,sda7,sda8,sda9,sda10;

unsigned char sda11,sda12,sda13,sda14,sda15,sda16,sda17,sda18,sda19,sda20;

unsigned char sda21,sda22,sda23,sda24,sda25,sda26,sda27,sda28,sda29,sda30;

unsigned char lat1,lat2,lat3,lat4,lat5,lat6,lat7,lat8,lat9,lat10;

unsigned char lon1,lon2,lon3,lon4,lon5,lon6,lon7,lon8,lon9,lon10,lon11;


void recieve()interrupt 4 setting 1

{

unsigned char recv;

while(!RI);

RI = 0;

recv = SBUF;

        sda30 = recv;

        if(sda1 == 'L' && sda14 == 'N' && sda28 == 'E')

                {

                        flag = 1;

                        lat1 = sda3;

                        lat2 = sda4;

                        lat3 = sda5;
```

```
            lat4 = sda6;
            lat5 = sda7;
            lat6 = sda8;
            lat7 = sda9;
            lat8 = sda10;
            lat9 = sda11;
            lat10 = sda12;
            lon1 = sda16;
            lon2 = sda17;
            lon3 = sda18;
            lon4 = sda19;
            lon5 = sda20;
            lon6 = sda21;
            lon7 = sda22;
            lon8 = sda23;
            lon9 = sda24;
            lon10 = sda25;
            lon11 = sda26;
        }
else
        {
            sda1 = sda2;
            sda2 = sda3;
            sda3 = sda4;
            sda4 = sda5;
            sda5 = sda6;
```

```
                sda6 = sda7;
                sda7 = sda8;
                sda8 = sda9;
                sda9 = sda10;
                sda10 = sda11;
                sda11 = sda12;
                sda12 = sda13;
                sda13 = sda14;
                sda14 = sda15;
                sda15 = sda16;
                sda16 = sda17;
                sda17 = sda18;
                sda18 = sda19;
                sda19 = sda20;
                sda20 = sda21;
                sda21 = sda22;
                sda22 = sda23;
                sda23 = sda24;
                sda24 = sda25;
                sda25 = sda26;
                sda26 = sda27;
                sda27 = sda28;
                sda28 = sda29;
                sda29 = sda30;
        }
}
```

```
void transmit_byte(unsigned char x)

{

SBUF = x;

while(!TI);

TI = 0;

}

void delay(unsigned int time)

{

            for(;time > 0;time--);

}

void send_gsm()

{

            transmit_byte('A');

            delay(30);

            transmit_byte('T');

            delay(30);

            transmit_byte(0x0D);

            delay(30);

            delay(60000);

            delay(60000);

            delay(60000);

            delay(60000);

            transmit_byte('A');

            delay(30);

            transmit_byte('T');

            delay(30);
```

```
delay(30);

transmit_byte(lat10);

delay(30);

transmit_byte(',');

delay(30);

transmit_byte('N');

delay(30);

transmit_byte(',');

delay(30);

transmit_byte(0x0A);

delay(30);

transmit_byte('L');

delay(30);

transmit_byte('O');

delay(30);

transmit_byte('N');

delay(30);

transmit_byte(':');

delay(30);

transmit_byte(lon1);

delay(30);

transmit_byte(lon2);

delay(30);

transmit_byte(lon3);

delay(30);
```

```
transmit_byte(lon4);
delay(30);
transmit_byte(lon5);
delay(30);
transmit_byte(lon6);
delay(30);
transmit_byte(lon7);
delay(30);
transmit_byte(lon8);
delay(30);
transmit_byte(lon9);
delay(30);
transmit_byte(lon10);
delay(30);
transmit_byte(lon11);
delay(30);
transmit_byte(',');
delay(30);
transmit_byte('E');
delay(30);
transmit_byte(',');
delay(30);
transmit_byte(0x1A);
delay(30);
delay(600000);
```

```
}
void main()
{
	P0 = 0xFF;
	P1 = 0xFF;
	P2 = 0xFF;
	P3 = 0xFF;
	TMOD = 0x20;
	SCON = 0x50;
	TH1 = 0xFB;
	flag = 0;
	lat1 = 0;
	lat2 = 0;
	lat3 = 0;
	lat4 = 0;
	lat5 = 0;
	lat6 = 0;
	lat7 = 0;
	lat8 = 0;
	lat9 = 0;
	lat10 = 0;
	lon1 = 0;
	lon2 = 0;
	lon3 = 0;
	lon4 = 0;
	lon5 = 0;
```

```
lon6 = 0;
lon7 = 0;
lon8 = 0;
lon9 = 0;
lon10 = 0;
lon11 = 0;
delay(1);
TR1 = 1;
ES = 1;
EA = 1;

while(1)
    {
    if(DTMF_D0 == 0 && DTMF_D1 == 1 && DTMF_D2 == 0 && DTMF_D3 == 0 &&
DTMF_EN == 1)
        {
            do
                {
                    MOTOR_L_CW = 0;
                    MOTOR_L_AW = 1;
                    MOTOR_R_CW = 0;
                    MOTOR_R_AW = 1;
                    DTMF_OUT = 0;
                }while(DTMF_EN == 1);
            DTMF_OUT = 1;
        }
```

```
if(DTMF_D0 == 0 && DTMF_D1 == 0 && DTMF_D2 == 0 && DTMF_D3 == 1 && DTMF_EN == 1)
    {
        do
        {
            MOTOR_L_CW = 1;
            MOTOR_L_AW = 0;
            MOTOR_R_CW = 1;
            MOTOR_R_AW = 0;
            DTMF_OUT = 0;
        }while(DTMF_EN == 1);
        DTMF_OUT = 1;
    }
if(DTMF_D0 == 0 && DTMF_D1 == 0 && DTMF_D2 == 1 && DTMF_D3 == 0 && DTMF_EN == 1)
    {
        do
        {
            MOTOR_L_CW = 0;
            MOTOR_L_AW = 1;
            MOTOR_R_CW = 1;
            MOTOR_R_AW = 0;
            DTMF_OUT = 0;
        }while(DTMF_EN == 1);
        DTMF_OUT = 1;
    }
```

```
		if(DTMF_D0 == 0 && DTMF_D1 == 1 && DTMF_D2 == 1 && DTMF_D3 == 0 && DTMF_EN == 1)
			{
				do
					{
						MOTOR_L_CW = 1;
						MOTOR_L_AW = 0;
						MOTOR_R_CW = 0;
						MOTOR_R_AW = 1;
						DTMF_OUT = 0;
					}while(DTMF_EN == 1);
				DTMF_OUT = 1;
			}
		if(DTMF_D0 == 1 && DTMF_D1 == 0 && DTMF_D2 == 1 && DTMF_D3 == 0 && DTMF_EN == 1)
			{
				do
					{
						MOTOR_L_CW = 1;
						MOTOR_L_AW = 1;
						MOTOR_R_CW = 1;
						MOTOR_R_AW = 1;
						DTMF_OUT = 0;
					}while(DTMF_EN == 1);
				DTMF_OUT = 1;
			}
```

```
if(DTMF_D0 == 0 && DTMF_D1 == 1 && DTMF_D2 == 0 && DTMF_D3 == 1 &&
DTMF_EN == 1)
    {
        do
        {
            CAMARA = 0;
            DTMF_OUT = 0;
        }while(DTMF_EN == 1);
        DTMF_OUT = 1;
    }
if(DTMF_D0 == 1 && DTMF_D1 == 1 && DTMF_D2 == 0 && DTMF_D3 == 1 &&
DTMF_EN == 1)
    {
        do
        {
            CAMARA = 1;
            DTMF_OUT = 0;
        }while(DTMF_EN == 1);
        DTMF_OUT = 1;
    }
if(DTMF_D0 == 1 && DTMF_D1 == 0 && DTMF_D2 == 0 && DTMF_D3 == 0 &&
DTMF_EN == 1)
    {
        do
        {
            delay(3000);
            DTMF_OUT = 0;
```

```
            }while(DTMF_EN == 1);
        DTMF_OUT = 1;
        ES = 0;
        send_gsm1();
        ES = 1;
    }
    if(DTMF_D0 == 1 && DTMF_D1 == 1 && DTMF_D2 == 0 && DTMF_D3 == 0 && DTMF_EN == 1)
    {
        do
            {
                delay(3000);
                DTMF_OUT = 0;
            }while(DTMF_EN == 1);
        DTMF_OUT = 1;
        ES = 0;
        send_gsm2();
        ES = 1;
    }
    if(DTMF_D0 == 1 && DTMF_D1 == 1 && DTMF_D2 == 1 && DTMF_D3 == 0 && DTMF_EN == 1)
    {
        do
            {
                delay(30000);
                DTMF_OUT = 0;
            }while(DTMF_EN == 1);
```

```
                    DTMF_OUT = 1;
                    ES = 0;
                    send_gsm3();
                    ES = 1;
                }
            if(flag == 1)
                {
                    flag = 0;
                    GPS_LED = 0;
                }
            }
}
```

OUR SENSOR CODE

```
#include <avr/io.h>
#define F_CPU 8000000UL
#define lcd PORTD
#define rs PD0
#define rw PD1
#define en PD2
#include <util/delay.h>
void init();
void lcd_cmd(unsigned char);
void lcd_data(unsigned char);
void lcd_string(unsigned char *str);
```

```
void lcd_number(unsigned int);

void adc_init();

unsigned int adc_read(unsigned char);

int main()

{

DDRA=0x00; //used as input

DDRD=0xFF; //used as output

int t,y;

lcd_init();

adc_init();

while(1)

{

unsigned int a=adc_read(0); //LM 35 in the 0th pin of the 7 pins in ADC

lcd_cmd(0xc0); // start from 0th box of 2nd row

lcd_string("temp is:");

_delay_ms(1000);

y=a*(5000/1024);

t=(y/10);

_delay_ms(1000);

lcd_cmd(0xc8);

lcd_number(t);

_delay_ms(1000);

}

}

void lcd_init()

{
```

```
lcd_cmd(0x02);// configures the 1st row of lcd

lcd_cmd(0x28);//configures the 2nd  row of lcd

lcd_cmd(0x01); //clear lcd screen

lcd_cmd(0x0e);// display on cursor on

lcd_cmd(0x80);//set cursor on 0th position

lcd_cmd(0x06);//ready to enter data

}

void lcd_cmd(unsigned char com)

        {

        lcd = com & 0xF0;           //send higher bit

        lcd &= ~(1<<rs);            //rs =0

        lcd &= ~(1<<rw);            //rw =0

        lcd |=  (1<<en);            //en =1

        _delay_ms(1);

        lcd &= ~(1<<en);            //en =0

        _delay_ms(1);

        lcd = (com<<4) & 0xF0;      //send lower bit

        lcd &= ~(1<<rs);            //rs =0

        lcd &= ~(1<<rw);            //rw =0


        lcd |=(1<<en);          //en =1

        _delay_ms(1);

        lcd &= ~(1<<en);            //en =0

        _delay_ms(1);

        }

void lcd_data(unsigned char value)
```

```
        {
        lcd =value & 0xF0;              //send higher bit
        lcd |= (1<<rs);                 //rs =1
        lcd &= ~(1<<rw);                //rw =0
        lcd |=(1<<en);          //en =1
        _delay_ms(1);
        lcd &= ~(1<<en);                //en =0
        _delay_ms(1);
        lcd =(value<<4) & 0xF0;         //send lower bit
        lcd |= (1<<rs);                 //rs =1
        lcd &= ~(1<<rw);                //rw =0
        lcd |=(1<<en);          //en =1
        _delay_ms(1);
        lcd &= ~(1<<en);                //en =0
        _delay_ms(1);
        }
void lcd_string(unsigned char *str)
{
        char i=0;
        while(str[i]!='\0')
        {
        lcd_data(str[i]);
        i++;
        }
}
void lcd_number(unsigned int value)
```

```
{
        unsigned int d=0;
        if(value==0)
        lcd_data(value+48);   //48 is the ASCII value of 0
        while(value!=0)
        {
        d=value%10;
        lcd_data(d+48);
        value=value/10;
        }
        lcd_cmd(0x06);          //auto increment mode
}
```

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