

A SMART HELMET FOR AIR QUALITY AND HAZARDOUS EVENT DETECTION FOR THE MINING INDUSTRY

Submitted in partial fulfillment of the requirements for the award of
**Bachelor of Engineering Degree in
Electrical and Electronics Engineering**

BY

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ENGINEERING
SCHOOL OF ELECTRICAL AND ELECTRONICS ENGINEERING**

SATHYABAMA

**INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)**

Accredited with Grade “A” by NAAC

JEPPIAAR NAGAR, RAJIV GANDHI SALAI, CHENNAI - 600 119

MAY – 2022



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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **ANANTHA KUMAR S (38140006)** and **MANOJ KUMAR R (38140026)** who carried out the project entitled **"A SMART HELMET FOR AIR QUALITY AND HAZARDOUS EVENT DETECTION FOR THE MINING INDUSTRY"** under our supervision from November 2021 to May 2022.

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DECLARATION

We **ANANTHA KUMAR S (38140006)** and **MANOJ KUMAR R (38140026)** hereby declare that the Project Report entitled “**A SMART HELMET FOR AIR QUALITY AND HAZARDOUS EVENT DETECTION FOR THE MINING INDUSTRY**” done by us under the guidance of **Dr. S. NIRMAL RAJ** is submitted in partial fulfillment of the requirements for the award of Bachelor of Engineering degree in Electrical and Electronics Engineering.



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ACKNOWLEDGEMENT

We are pleased to acknowledge our sincere thanks to Board of Management of **SATHYABAMA** for their kind encouragement in doing this project and for completing it successfully. We are grateful to them.

We convey our thanks to **Dr. N. M. NANDHITA**, Dean, School of Electrical and Electronics Engineering and **Dr. V. SIVACHIDAMBARANATHAN**, Head of the Department, Dept. of Electrical and Electronics Engineering for providing us necessary support and details at the right time during the progressive reviews.

We would like to express our sincere and deep sense of gratitude to our Project Guide **Dr. S. NIRMAL RAJ** for his valuable guidance, suggestions and constant encouragement paved way for the successful completion of our project work.

We wish to express our thanks to all Teaching and Non-teaching staff members of the Department of Electrical and Electronics Engineering who were helpful in many ways for the completion of the project.

ABSTRACT

A smart helmet has been developed that is able to detect of hazardous events in the mines industry. In the development of helmet, we have considered the three main types of hazards such as air quality, helmet removal, and collision. The first is the concentration level of the hazardous gases such as CO, SO₂, NO₂, and particulate matter. The second hazardous event was classified as a miner removing the mining helmet off their head. IR sensor was then used to successfully determine when the helmet is on the miner's head.

The third hazardous event is defined as an event where miners are struck by an object against the head with a force. An accelerometer was used to measure the acceleration of the head and the HIC was calculated in software. Tests were successfully done to calibrate the accelerometer. The experimental prototype consists of three sensors namely gas, infra-red and proximity sensor for their usage and the sensor data are monitored in pc via Node MCU transceiver unit.

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LIST OF ABBREVIATIONS

AC	- Alternating Current
AFH	- Adaptive Frequency Hopping
DC	- Direct Current
DSP	- Digital Signal Processor
DVR	- Distance Vector Routing
HIC	- Head Injury Criteria
IDE	- Integrated Development Environment
IoT	- Internet of Things
LED	- Light Emitting Diode
OHS	- Occupational Health and Safety
PCB	- Printed Circuit Board
RNG	- Random Number Generator
TVOC	- Total Volatile Organic Compounds
USB	- Universal Serial Bus
WSN	- Wireless Sensor Network

CHAPTER 1

INTRODUCTION

For years, safety has been a significant concern within the mining business, particularly in sub-surface mining. Mining accidents occur throughout the method of mining minerals or metals. Thousands of miners die from mining accidents every year, particularly within the method of coal mining and laborious rock mining. Collapsing of mining slopes is one amongst the most explanation for most these accidents.

Most of the collapse of mining slopes isn't forever fatal. Immediate care will facilitate the separated miners. However, it's hard to spot that an exact manual laborer is in bother in dark underground mines. Therefore, we'd like a system to watch the well-being of individual miners in these mines.

One accent that every one miners use is that the safety helmet. So, we will use this helmet to find the well-being of the person mistreatment it and facilitate pass the knowledge to the office outside the mines. This project makes an attempt to try to to a similar mistreatment web of things.

Sensor Devices ar placed on every helmet that the miners use. This sensing unit is connected to a force device that checks if there's any dangerous load that the manual laborer is experiencing on his head. If the load is just too serious, the manual laborer could also be in peril and should want immediate care. So, the atoms try and contact the mounted area Manager mote that encompasses a reference to the middle and therefore the adjacent area Manager motes. Corresponding area Manager of the distressed atom tries to tell the middle concerning the prevalence of such AN accident. It additionally asks manual laborers from adjacent rooms/sectors to voluntarily notice and facilitate the miner in peril. As shortly because the Center gets to understand that an exact manual

laborer is in bother, they will send out a team to assist. If there are additional miners in bother, the space may be declared dangerous and therefore the Center will activate the siren at the doorway of the space. Thus, the manual laborer from the adjacent area may be aware to not enter that area. During this method, we will cut back the amount of casualties. Providing immediate facilitate and declaring an exact region dangerous are 2 further novel concepts bestowed during this project. Observance and reduction of the amount of casualties and providing immediate facilitate are the most goals of this project.

A smart helmet has been developed that's able to find out dangerous events within the mines business. Within the development of helmet, we've thought of the 3 main forms of hazard like air quality, helmet removal, and collision. The primary is that the concentration level of the dangerous gases like CO, SO₂, NO₂, and material. The second dangerous event was classified as a manual laborer removing the mining helmet off their head. IR device was then went to with success verify once the helmet is on the miner's head. The third dangerous event is outlined as an occurrence wherever miners are stricken by an object against the top with a force. An measuring instrument was went to live the acceleration of the top and therefore the HIC was calculated in software package. Tests were with success done to calibrate the measuring instrument. The experimental paradigm consists of 3 sensors specifically gas, below red and proximity device for his or her usage and therefore the device knowledge are monitored in computer via Node MCU. The helmet removal take a look at was done mistreatment IR sensors employed in our project by mistreatment completely different sizes, shapes and completely different colours device given satisfactory and 100% results and every one numerous sorts of take a look ating done throughout performance test of helmet device program wiped out Arduino controller done mistreatment digital pins run alright displayed helmet price on computer further as send to receiver mistreatment Node MCU.

CHAPTER 2

LITERATURE SURVEY

Shabina. S (2014) good Helmet mistreatment RF and WSN Technology for Underground Mines Safety.

The underground mines everywhere the planet are adversely tormented by numerous hazards together with gassy explosions, landslides, fireplace hazards, etc. This results in the importance of safety for the mine staff. A stronger communication technology should be used for an intelligent sensing and warning system. For this, RF technology is chosen for the communication within the mines. The wireless device network is provided for the sensing of adverse operating atmosphere conditions. Combining each these technologies, a brand new good helmet module is developed. The wireless device network consisting of assorted sensors senses mine atmosphere parameters like temperature, pressure, humidity, gases like paraffin, CO, etc. The measured parameters are processed and are used for an early intelligence warning system with the assistance of programmed alarm sounds, if there's any serious deviation from the conventional parameter price vary. The RF technology is additionally used as locating system, that helps in locating the mine-workers. This RF based mostly wireless device network is reliable with straightforward installation and quick sensing and locating system. The look provides 3 modules, specifically helmet module, localizer module, and room module. The helmet module contains of assorted sensors, microcontroller, antennas, encoders, decoders, etc. The helmet module acts as an intelligent, low power node within the wireless device network. The room module contains antennas, PC, decoder, etc. The sensors {are|ar|area unit|square live} wont to measure the variations within the temperature, humidity, pressure, fireplace and take selections for needed actions supported the measured knowledge to make sure the protection of the underground mine staff. The RF

technology additionally ensures the localization of the mine staff for his or her safety in a very dangerous operating platform. Therefore the projected system ensures safety and a reliable wireless communication within the underground mines.

Bushra Tabassum (2018), Dr. Baswaraj Gadgay, Veeresh Pujari (2018) a sensible Helmet for Air Quality and dangerous Event Detection for the Mining

A smart helmet has been developed that is able to detect of hazardous events in the mines industry. In the development of helmet, we have considered the four main types of hazard such as air quality, helmet removal, fire and mercury sensor. The first is the concentration level of the hazardous gases such as CO, SO₂, NO₂, and particulate matter. The second hazardous event was classified as a miner removing the mining helmet off their head. An IR sensor was developed unsuccessfully but an off-the shelf IR sensor was then used to successfully determine when the helmet is on the miner's head. The third hazardous event is fire sensor, it is used as a simple and compact device for protection against fire. The module makes use of IR sensor and comparator to detect fire up to a range of 1 metre. The fourth hazardous event is Mercury sensor, which is a very toxic element that is widely spread in the atmosphere, lithosphere, and surface water

Dr. B. Paulchamy (2019) An Intelligent Helmet for Miners with Air Quality and Destructive Event Detection using Zigbee

An intelligent helmet has been developed to assist the miners working in the mining industry. Harmful events tend to occur in the mining industry that can lead to severe injury or be fatal. LED miner's helmet is the most commonly used helmet because of light weight and low power consumption. However it does not improve the safety of miners apart from providing illumination. Zigbee wireless sensor networks are used to collect sensor data and transmit them. The zigbee based system is cost effective and details are shared with central control unit. This paper presents a study of the mining environment and its hazards and how a zigbee is used for transmission from miner to ground control system in case of hazardous events.

G Pradeepkumar, S Sanjay Rahul, N Sudharsanaa, S Suvetha, Dineshkumar Ponnusamy (2021) A Smart Helmet for the Mining Industry using LoRaWAN

Air Quality becomes an important factor in mining areas where the health condition of the workers is prominently considered. The composition of many toxic gases under the mining area causes many fatalities that keep on increasing day by day. The Total Volatile Organic Compounds (TVOC) and Carbon-di-oxide creating a significant role in the health system of the workers. The unstable levels of these TVOC's cause many health issues like nausea, emesis, fatigue, epistaxis and dyspnoea. Exceeding the standard levels of these toxic compounds in the air causes many problems like severe breathing trouble and headache. In this proposed work, Smart Helmet has been developed for mining workers using LoRaWAN to overcome the above mentioned problems. This device helps to alert user on the air quality.

Raghavendra Rao B, Karthik NS, NA Poojitha, Divya L (2019) A Smart Helmet for Air Quality and Hazardous Event Detection

The critical levels of the hazardous gases such as CO, SO₂ and NO₂ in the mines industry has been indicated through alerting unit. The helmet removal test was done successfully with an off the-shelf IR distance sensor. The IR sensor designed from first principles was working device.

N. Balaji, B. Chandrakala (2020) An Intelligent Device for Hazardous Event Detection for Mining Industry - Smart Helmet

A savvy framework is being proposed here, that can distinguish and assess air quality (Toxic gasses) and Hazardous occasions in the underground mining industry. It gives another technique for dissecting risky occasions occurring in the mining, for example, Methane, Propane, Butane, Benzene, Carbon monoxide and other lethal gasses. This proposed framework is given detail depiction of a framework to assess the centralization of dangerous gasses. This framework is produced with Raspberry pi separated from this the proposed

framework will show the cap position on the individual and in addition any outer contribution on the protective cap and to quantify these occasions appropriate sensors will be utilized and interfaced to Raspberry pi with wi-fi.

C.J. Beher,Anuj,Kumar, G. Hancke (2018) A smart helmet for air quality and hazardous event detection for the mining industry

A smart helmet has been developed that is able to detect of hazardous events in the mines industry. In the development of helmet, we have considered the three main types of hazard such as air quality, helmet removal, and collision (miners are struck by an object). An IR sensor was developed unsuccessfully but an off-the shelf IR sensor was then used to successfully determine when the helmet is on the miner's head. The third hazardous event is defined as an event where miners are struck by an object against the head with a force exceeding a value of 1000 on the HIC (Head Injury Criteria). An accelerometer was used to measure the acceleration of the head and the HIC was calculated in software. The layout of the visualisation software was completed, however the implementation was unsuccessful. Tests were successfully done to calibrate the accelerometer.

A. Dhanalakshmi (2015) A Smart Helmet For Improving Safety In Mining Industry

Temperature and Pressure sensors are used for the continuous monitoring of environmental conditions .The information are sent to the control room through wireless network. The layout of the visualization was completed and displayed in the control room with the help of a Lab VIEW software .This paper presents the undertaken design detailing solutions to issues raised in previous research.

Pranjal Hazarika, Implementation of Smart Safety Helmet for Coal Mine Workers

This paper presents implementation of safety helmet for coal mine workers. This helmet is equipped with methane and carbon monoxide gas sensor. This sensor sense the gas and the data is transmitted to the control room

wirelessly, through a wireless module called X-Bee connected with the helmet. When the methane or carbon-monoxide gas concentration is beyond the critical level, controller in the control room triggers an alarm and keeps the plant and the workers safe by preventing an upcoming accident.

Rohith Revindran, Hansini Vijayaraghavan, Mei-Yuan Huang, Smart Helmets for Safety in Mining Industry

The mining industry is pivotal to the world's economy. However, it is not one of the safest industries to work in. The life of miners is always at stake. This project attempts to help the miners in distress so that they receive immediate help. The helmet used by the miner can be improved by adding a wireless sensor mote and necessary sensors, which will help in monitoring the health condition of the miner. In doing so, a network of wireless sensors can be formed. This wireless sensor network (WSN) can be used to monitor the well-being of all the miners who are at work. The routing protocol developed for this project is based on Distance vector routing (DVR) and finds the best path based on shortest hop. The protocol is also robust to deal with failures. It does not require synchronization of the nodes. The protocol is pro-active to minimize delays. Whenever the load felt on the force sensor on the helmet is more than a threshold value, the mote in the helmet attempts to send a distress message to its Room Manager through the saved route. When a miner sends a distress message via its Room Manager, officials from Center can send in a medical team. The miners in the neighboring rooms are also informed so that they can help voluntarily. At times, the mote may not have a route to its Room Manager. In such cases a failure recovery procedure is carried out. The functioning of the project was successfully tested.

S.A. Ngubo, C.P. Kruger, G.P. Hancke and B.J. Silva, An Occupational Health and Safety Monitoring System

Hazardous environments at the workplace are a significant contributor to injuries due to accidents as well as chronic diseases. There are many occupational health and safety (OHS) systems, but they are costly or not flexible. This paper presents a low-cost OHS. It consists of various sensors that can be used to monitor whether a safety helmet is being worn, the worker is mobile and

safety boots are being worn. The system interfaces with a wireless sensor network and is suitable for operation in environments such as underground mines and sawmills.

Chunlong Ma 'Jinming Huo, Xiaohui Yang, Experimental Design of Gas Monitoring System in Mine Safety helmet Based on Wireless Sensors Networks

In order to solve such problems of the mine cable gas monitoring system as high costs, inconvenient maintenance, hindering wiring and unmovable monitoring information points, a mine safety helmet is designed, based on wireless sensors networks, which studies the hardware design, gas concentration calculations and its dynamic compensation algorithm, as well as the experimental design of gas monitoring system in mine safety helmet so as to ensure the correct calculation of the gas concentration. The innovative point of this essay is the combination of the ordinary LED cap lamp and the wireless sensors networks, which ensures a real-time, dynamic collection of the information of the gas concentration around the workers.

CHAPTER 3

EXISTING SYSTEM AND PLANNED SYSTEMS

3.1 EXISTING SYSTEM

There is no implementation of excellent helmet among the amount mines but some analysis comes planned the concept of the same with Bluetooth technologies were Bluetooth have several disadvantages of property and power supply.

In the existing system mining helmet ensures to protect the miners head from several injuries. Being attentive to the standing becomes a troublesome an area of the current system. Since the helmet is simply too serious, uncomfortable to work with the miners tend to urge obviate the helmet off their head. Simply just in case of its removal miners unit of measurement vulnerable to unsafe conditions. There is not any existing smart helmet which is able to study the environment and build alternatives to sustain worker protection. Element supply is not provided for the miners simply just in case of harmful gas escape. Establishing hurdle free a communication surroundings is that the largest challenge the mining organizations face.

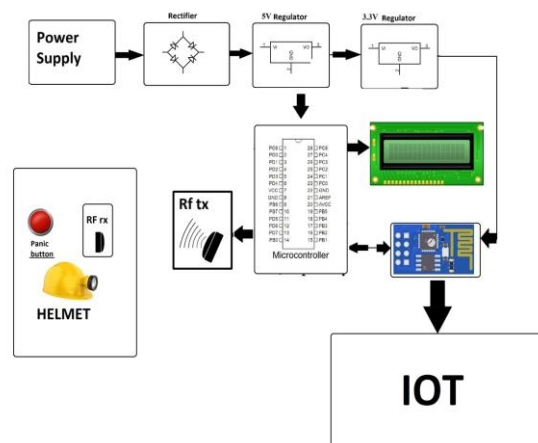


Fig. 3.1: Existing system diagram

The other existing systems offer real time observance of mines from base station. The transmitter unit is placed on helmet of worker and receiver unit placed on all-time low station. The Zigbee wireless technology is used for data transmission from coal mines to the base station. The Zigbee communication network offer two-way communication implies that from base station to mines and from mines to base station. The transmitter unit consists of air quality sensor, helmet removal sensor and person fall detection sensor. The air quality sensors monitor the quantity of harmful gases like LPG, Methane, CO and jointly temperature.

Disadvantages

- Not more correct
- Hazardous gases affects the human

3.2 PLANNED SYSTEM

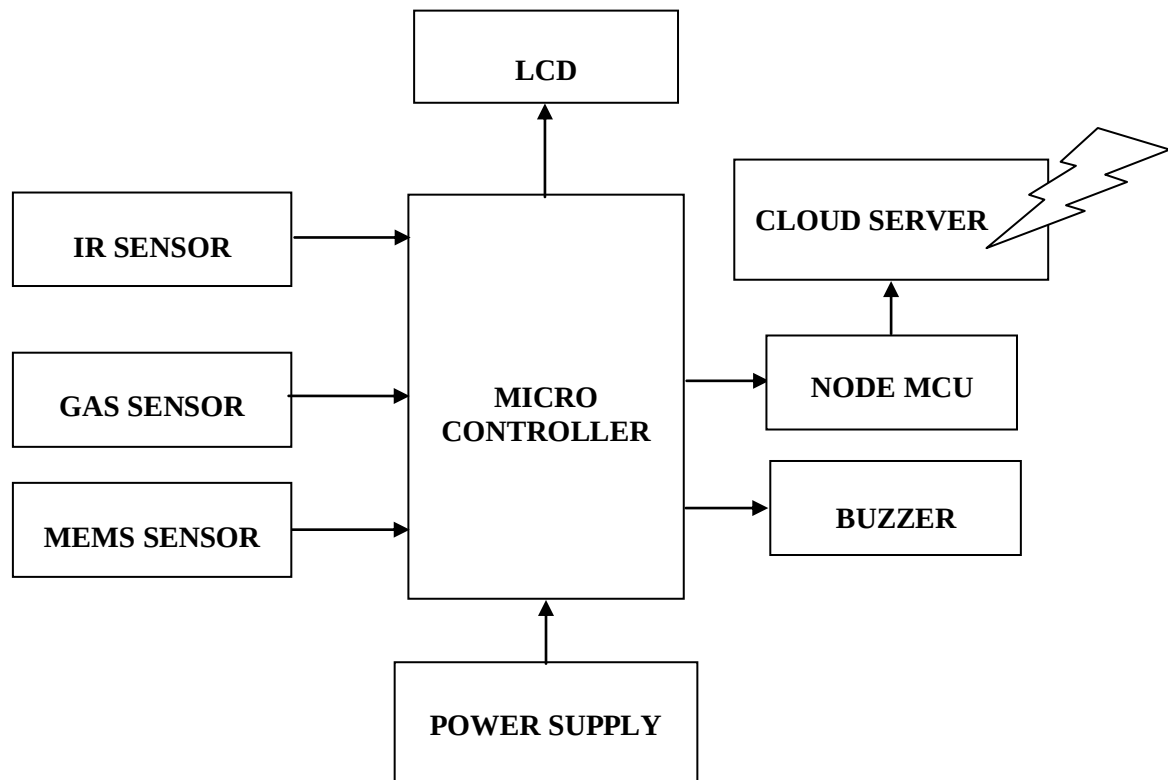
The system provides real time observance of mines from base station. The transmitter unit is placed on helmet of worker and receiver unit placed on all-time low station. The IOT based wireless technology is used for data transmission from coal mines to all-time low station. The node MCU communication network offer two manner communication implies that from base station to mines and from mines to base station. The transmitter unit consists of air quality sensor, helmet removal sensor and person fall detection sensor.

Advantages

A smart mining helmet was developed that is able to notice three types of risky events like danger level of risky gases, workman helmet removing, and collision or impact.

3.3 BLOCK DIAGRAM

Transmitter



Receiver

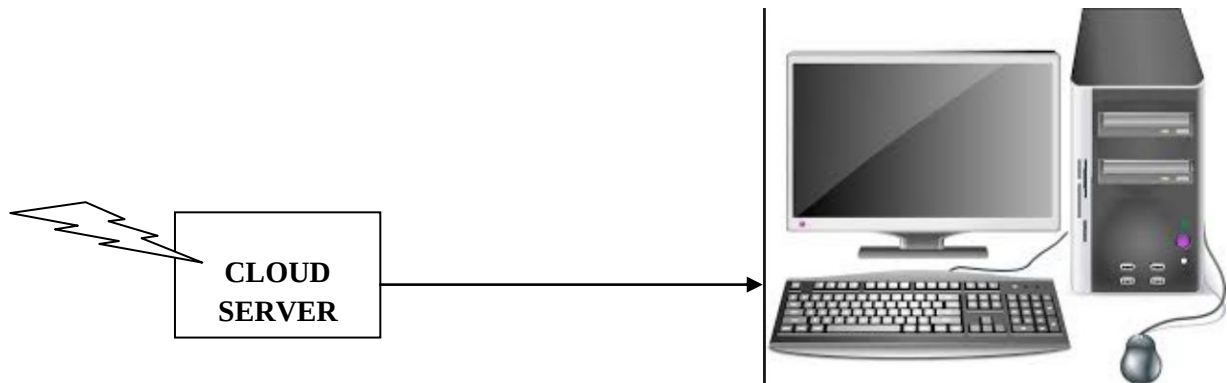


Fig. 3.2: Circuit Block Diagram

CHAPTER 4

HARDWARE DESCRIPTION

4.1 ARDUINO

Arduino is Associate in Nursing open offer, part and package company, project, and user community that designs and manufactures Single-board microcontrollers and microcontroller kits for building digital devices and interactive objects which is able to sense and management objects among the physical world.

Arduino is Associate in Nursing computer code document physics platform supported easy-to-use hardware and package. Arduino boards unit of measurement able to browse inputs - light-weight on a sensor, a finger on a button, or a Twitter message - and switch it into Associate in Nursing output - activating a motor, turning on Associate in Nursing junction rectifier, publication one factor on-line.

The Arduino Uno is a microcontroller board supported the ATmega328 (datasheet). It's fourteen digital input/output pins (of that vi square measure typically used as PWM outputs), vi analog inputs, a sixteen rate generator, a USB association, associate influence jack, Associate in Nursing ICSP header, and a button.

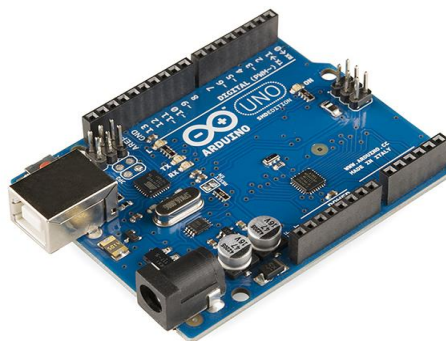


Fig. 4.1: Arduino UNO

Arduino is Associate in Nursing computer code document project that created microcontroller-based kits for building digital devices and interactive objects which is able to sense and management physical devices. The project depends on microcontroller board designs, created by several vendors, exploitation varied microcontrollers. These systems offer sets of digital and analog input/output (I/O) pins which is able to interface to varied enlargement boards (termed shields) and totally different circuits. The boards feature serial communication interfaces, beside Universal Serial Bus (USB) on some models, for loading programs from personal computers. For programming the microcontrollers, the Arduino project provides Associate in Nursing integrated development surroundings (IDE) supported a artificial language named method, that jointly supports the languages C and C++.

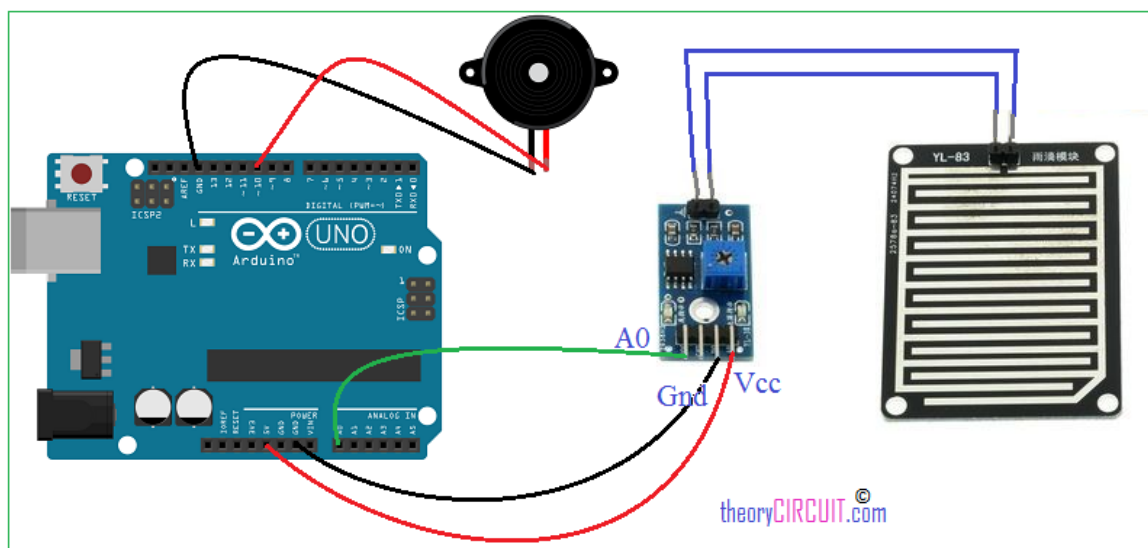


Fig. 4.2: Arduino UNO interface with sensor & buzzer

Arduino Uno could also be a microcontroller board supported the ATmega328P. it's fourteen digital input/output pins (of that vi square measure typically used as PWM outputs), vi analog inputs, a sixteen rate quartz, a USB association, associate influence jack, Associate in Nursing ICSP header and a button. It contains everything needed to support the microcontroller; just connect it to a laptop computer with a USB cable or power it with a AC-to-DC adapter. Arduino Uno options a range of facilities for act with a laptop computer, another Arduino board, or totally different microcontrollers.

Features

- Microcontroller: ATmega328P
- Operating voltage: 5V
- Input voltage: 7-12V
- Flash memory: 32KB
- SRAM: 2KB
- EEPROM: 1KB

Applications

- Real time natural science
- Robotic applications
- Robotic applications

4.2 ATMEGA328 IC

The ATmega328 is a single-chip microcontroller created by Atmel in the mega AVR family. The Atmel 8-bit AVR RISC-based microcontroller combines thirty two kB ISP flash memory with read-while-write capabilities 32 general purpose working registers, 3 versatile timer/counters with compare modes, internal and external interrupts, serial programmable USART a byte-oriented 2-wire serial interface, SPI serial port, 6-channel 10-bit A/D converter (8-channels in TQFP and QFN/MLF packages), programmable watchdog timer with internal oscillator, and five software selectable power saving modes. The device operates between 1.8-5.5 volts. The device achieves throughput approaching 1 MIPS per MHz.

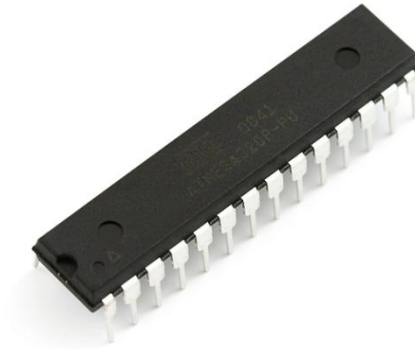


Fig.4.3: ATmega328P IC

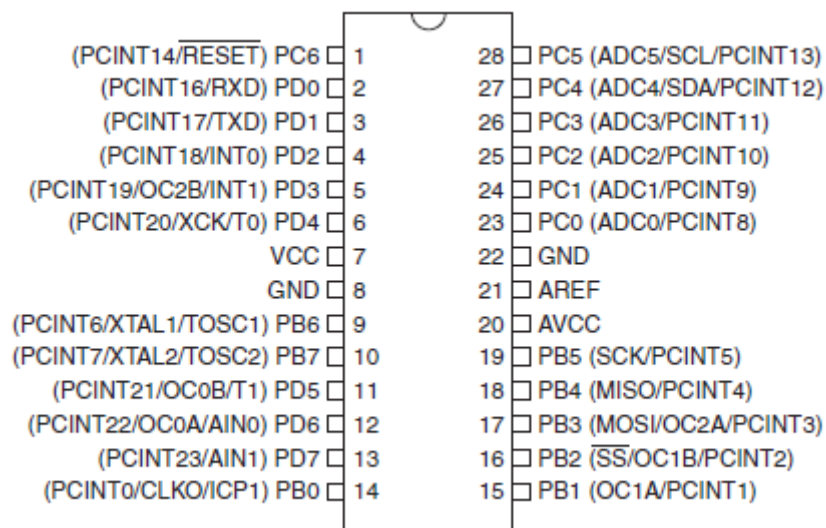


Fig. 4.4: Pin Diagram

- High Performance, Low Power Atmel®AVR® 8-Bit Microcontroller Family
- Advanced RISC Architecture
 - 131 Powerful Instructions
 - Most Single Clock Cycle Execution
 - 32 x 8 General Purpose Working Registers
 - Fully Static Operation
 - Up to 20 MIPS Throughput at 20MHz

- On-chip 2-cycle Multiplier
- High Endurance Non-volatile Memory Segments
- 4/8/16/32KBytes of In-System Self-Programmable Flash program memory
- 256/512/512/1KBytes EEPROM
- 512/1K/1K/2KBytes Internal SRAM
- Write/Erase Cycles: 10,000 Flash/100,000 EEPROM C(1)°C/100 years at 25° Data retention: 20 years at 85
- Optional Boot Code Section with Independent Lock Bits In-System Programming by On-chip Boot Program
- True Read-While-Write Operation
- Programming Lock for Software Security Atmel® QTouch® library support
- Capacitive touch buttons, sliders and wheels– QTouch and QMatrix® acquisition
- Up to 64 sense channels
- Peripheral Features
 - Two 8-bit Timer/Counters with Separate Prescaler and Compare Mode
 - One 16-bit Timer/Counter with Separate Prescaler, Compare Mode, and Capture Mode
 - Real Time Counter with Separate Oscillator
 - Six PWM Channels
 - 8-channel 10-bit ADC in TQFP and QFN/MLF package
 - Temperature Measurement
 - 6-channel 10-bit ADC in PDIP Package

- Temperature Measurement
- Programmable Serial USART–Master/Slave SPI Serial Interface
- Byte-oriented 2-wire Serial Interface (Philips I2 C compatible)
- Programmable Watchdog Timer with Separate On-chip Oscillator
- On-chip Analog Comparator
- Interrupt and Wake-up on Pin Change

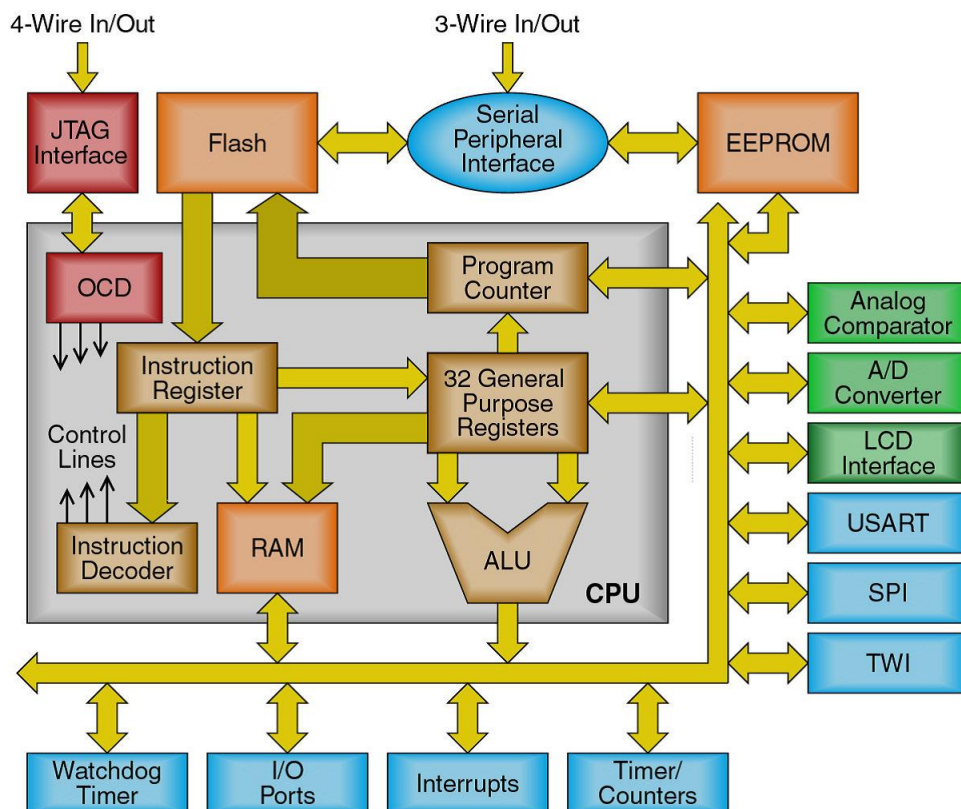


Fig .4.5: Architecture diagram

- Special Microcontroller Features
 - Power-on Reset and Programmable Brown-out Detection
 - Internal Calibrated Oscillator
 - External and Internal Interrupt Sources
 - Six Sleep Modes: Idle, ADC Noise Reduction, Power-save, Power-down, Standby, and Extended Standby

- I/O and Packages
 - 23 Programmable I/O Lines
 - 28-pin PDIP, 32-lead TQFP, 28-pad QFN/MLF and 32-pad QFN/MLF
- Operating Voltage: 1.8 - 5.5V
- Temperature Range: -40 °C to 85°
- Speed Grade: 0 - 4MHz@1.8 - 5.5V, 0 - 10MHz@2.7 - 5.5V, 0 - 20MHz @ 4.5 - 5.5V C°
- Power Consumption at 1MHz, 1.8V, 25
 - Active Mode: 0.2Ma
 - Power-down Mode: 0.1µA
 - Power-save Mode: 0.75µA (Including 32kHz RTC)

4.3 PIN DISCRIPTION

VCC Digital supply voltage

GND Ground.

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

Port B is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port B output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port B pins that are externally pulled low will source current if the pull-up resistors are activated. The Port B pins are tri-stated when a reset condition becomes active, even if the clock is not running. Depending on the clock choice fuse settings, PB6 is used as input to the inverting generator electronic equipment and input to the interior clock in operation circuit. Looking on the clock choice fuse settings, PB7 is used as

output from the inverting generator electronic equipment. If the Internal Calibrated RC Oscillator is used as chip clock source, PB7.6 is used as TOSC2.1 input for the Asynchronous Timer/Counter2 if the AS2 bit in ASSR is set.

Port C (PC5:0)

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

PC6/RESET

If the RSTDISBL Fuse is programmed, PC6 is used as an I/O pin. Note that the electrical characteristics of PC6 differ from those of the other pins of Port C. If the RSTDISBL Fuse is unprogrammed, PC6 is used as a Reset input. A low level on this pin for longer than the minimum pulse length will generate a Reset, even if the clock is not running. The minimum pulse length is given in Table 28-3 on page 308. Shorter pulses are not guaranteed to generate a Reset.

Port D (PD7:0)

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

AVCC

VCC is that the provide voltage pin for the A/D convertor, PC3:0, and ADC7:6. It ought to be outwardly connected to VCC, even though the ADC isn't used. If the ADC is employed, it ought to be connected to VCC through a low-pass filter. Note that PC6.4 use digital provide voltage, VCC ANALOG PORTS.

AREF

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

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

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

4.4 ANALOG PORTS

In electronics, an analog-to-digital converter (ADC, A/D, A–D, or A-to-D) may be a system that converts an analog signal, like a sound picked up by a microphone or light-weight getting into getting into camera, into a digital signal. associate ADC may additionally give associate isolated measure like like converts associate input analog voltage or current to a digital variety proportional to the magnitude of the voltage or current.

In an embedded system, A/D conversion is extremely necessary as embedded systems take care of digital values; their surroundings sometimes occupy numerous analog signals. Analog signals have to be compelled to be altered into digital before being treated by the microcontroller. At present, we will observe the way to scan associate external associate log signal victimisation PIC microcontroller and exhibit the digital o/p conversion on an liquid crystal {display|LCD|digital display|alphanumeric display} display The Arduino UNO board has 5 analog input pins A0 through A5. These pins will scan the signal from associate analog detector just like the wetness detector or temperature detector and convert it into a digital worth that may be scan by the micro chip.

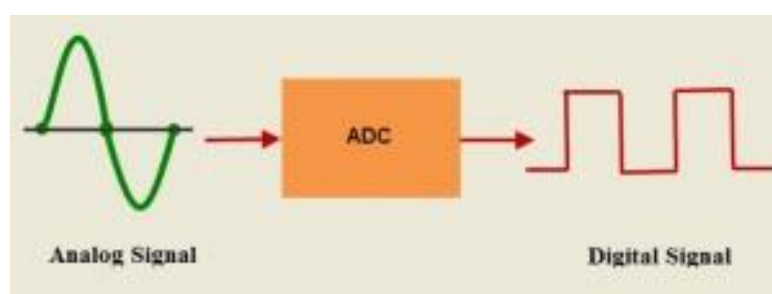


Fig. 4.6: ADC Conversion

The Arduino UNO board has five analog input pins A0 through A5. These pins can read the signal from an analog sensor like the humidity sensor or temperature sensor and convert it into a digital value that can be read by the microprocessor.

In the world of Arduino associate Analog signal is just an indication that may be HIGH (on), LOW (off) or something in between these 2 states. this implies associate Analog signal encompasses a voltage worth that may be something between 0V and 5V (unless you mess with the Analog Reference pin). Analog permits you to send output or receive input regarding devices that run at percentages in addition as on and off. The Arduino will this by sampling the voltage signal sent to those pins and examination it to a voltage reference signal (5V). looking on the voltage of the Analog signal when put next to the Analog Reference signal the Arduino then assigns a numerical worth to the signal somewhere between zero (0%) and 1023 (100%). The digital system of the Arduino will then use this variety in calculations and sketches.

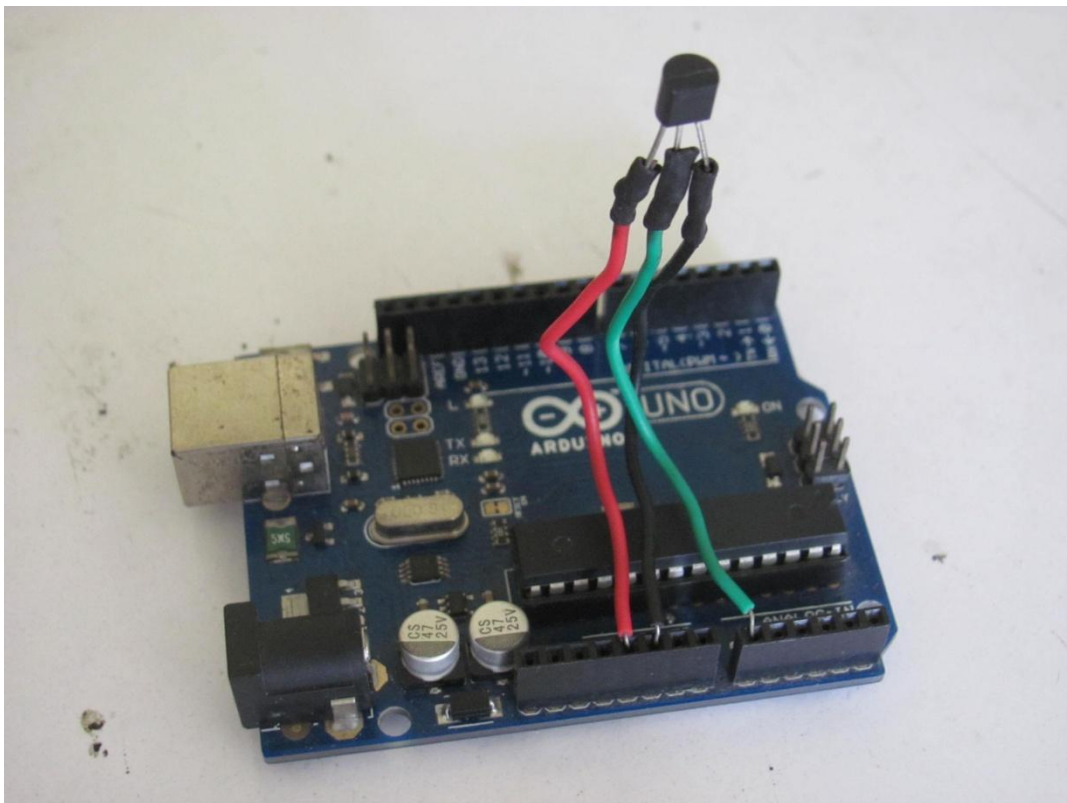


Fig. 4.7: Temperature sensor interface with Arduino

To receive Analog Input the Arduino uses Analog pins # 0 - # 5. These pins are designed for use with components that output Analog information and can be used for Analog Input. There is no setup necessary, and to read them use the command: `analog-Read (pin Number)`; where pin Number is the Analog In pin to which the Analog component is connected. The `analog-Read` command will return a number including or between 0 and 1023.

4.5 CRYSTAL OSCILLATOR

A crystal oscillator is associate that uses the mechanical resonance of a vibrating crystal of electricity material to make associate electrical signal with a particular frequency. An associate electronic circuit that produces a periodic, periodical sign, usually a wave or a sq. wave. Oscillators convert electricity (DC) from an influence provide to associate electricity (AC) signal. They're electronic devices.



Fig. 4.8: Crystal oscillator

Inside a quartz clock or watch, the battery sends electricity to the quartz crystal through an electronic circuit. The quartz crystal oscillates (vibrates back and forth) at a precise frequency: exactly 32768 times each second.

An oscillator is a device that can give you a clock at a certain frequency given a constant voltage. One part of the oscillator is a crystal that is basically a

very good filter. Most microcontrollers only require a crystal because they contain all other parts of an oscillator already.

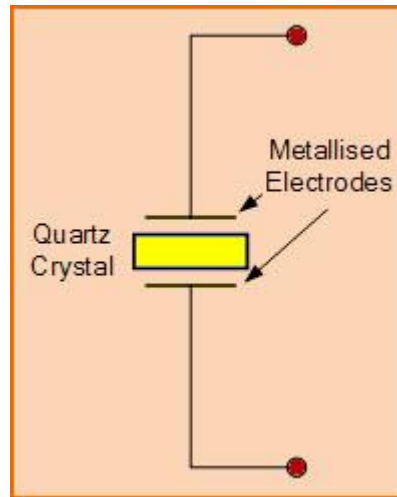


Fig. 4.9: Circuit diagram

In general, we know that, crystal oscillators are used in the microprocessors and microcontrollers for providing the clock signals. Let us consider 8051 microcontroller for which an external crystal oscillator circuit of 12MHz is essential, even though (based on model) 8051 microcontroller is capable to run at 40 MHz (max). 8051 requires 12 clock cycles for one machine cycle, such that to give effective cycle rate at 1MHz (considering 12MHz clock) to 3.33MHz (considering maximum 40MHz clock). This crystal oscillator is used to generate clock pulses required for the synchronization of all the internal operations.

Application of Crystal Quartz in Military and Aerospace

The use of quartz oscillator in military and region, is to ascertain to ascertain system, for the navigation purpose, military action, within the steering systems, and so on.

Use of quartz oscillator in analysis and measure

The quartz oscillator is employed in analysis and measure for celestial navigation, house following purpose, within the measurement instruments and medical devices, and so on.

Industrial Applications of quartz oscillator

There are unit an enormous variety of business applications of quartz oscillator like in computers, digital systems, instrumentation, part bolted loop systems, marine, modems, sensors, telecommunications, disk drives, and so on.

Use of quartz oscillator in Automotive

Crystal oscillator is employed for engine dominant, stereo, clock and to trip pc, and in GPS system.

Consumer Applications of quartz oscillator

Crystal oscillators are unit utilized in several commodity like cable tv systems, personal computers, video cameras, toys and video games, radio systems, cellular phones, and so on.

4.6 BATTERY (9 VOLTS)

Batteries are a set of 1 or a lot of cells whose chemical reactions produce a flow of electrons during a circuit. All batteries are made of 3 basic components: AN anode (the '-' side), a cathode (the '+' side), and a few quite solution (a substance that with chemicals reacts with the anode and cathode).

When the anode and cathode of A battery is connected to a circuit, a reaction takes place between the anode and also the solution. This reaction causes electrons to flow through the circuit and into the cathode where another reaction takes place. Once the fabric within the cathode or anode is consumed or now not ready to be utilized in the reaction, the battery is unable to provide electricity. At that time, your battery is "dead."

Batteries that has got to be thrown away once use square measure celebrated batteries. Batteries which will be recharged square measure square measure batteries.

9-volt battery, in its commonest kind was introduced for the first semiconductor radios. It's an oblong prism form with rounded edges and a polarized snap instrumentation at the highest. This kind is usually utilized in walkie talkies, clocks and smoke detectors. They're conjointly used as backup power to stay the time in bound electronic clocks.

This format is usually obtainable in primary carbon-zinc and base-forming chemistry, in primary atomic number 3 sulfide, and in reversible kind in nickel metallic element, nickel-metal binary compound and lithium-ion. Mercury chemical compound batteries during this kind haven't been factory-made in a few years because of their mercury content.

9V battery features a rectangular prism form with rounded edges and a polarized snap instrumentation at the highest. A zinc–carbon (6F22) battery could be a Leclanche cell battery that delivers a possible of one.5 volts between a Zn metal conductor AND a carbon rod from an chemical science reaction between Zn and metal oxide mediate by an acceptable solution.

It was introduced for the first semiconductor radios. it's sometimes handily packaged during a Zn will that conjointly is the anode with a negative potential, whereas the inert carbon rod is that the positive cathode. a plus is that many nine-volt batteries may be connected to every different nonparallel to produce higher voltages.

Features

- Output voltage: 9v
- Current capacity: 400mAh
- Approximate Volume: 0.2 cu. in. (3.3 cu. cm.)
- Approximate Weight: 0.4 oz. (11 gm.)

Applications

- Walkie talkies.
- It is used to assorted electronics projects.
- Use a 9V battery clip to easily connect your 9V battery to your Arduino.
- The "9V clip" is also used on some batter holders of assorted voltages.

4.7 NODE MCU ESP32

ESP32 could be a single a pair of.4 gigahertz Wi-Fi-and-Bluetooth band chip designed with the TSMC ultra-low-power four0 nm technology. it's designed to attain the most effective power and RF performance, showing hardiness, skilfulness and dependability during a wide range of applications and power eventualities.

The ESP32 series of chips includes ESP32-D0WD-V3, ESP32-D0WDQ6-V3, ESP32-D0WD, ESP32-D0WDQ6, ESP32-D2WD, ESP32-S0WD, and ESP32-U4WDH, among which, ESP32-D0WD-V3, ESP32-D0WDQ6-V3, and ESP32-U4WDH are based on ECO V3 wafer.

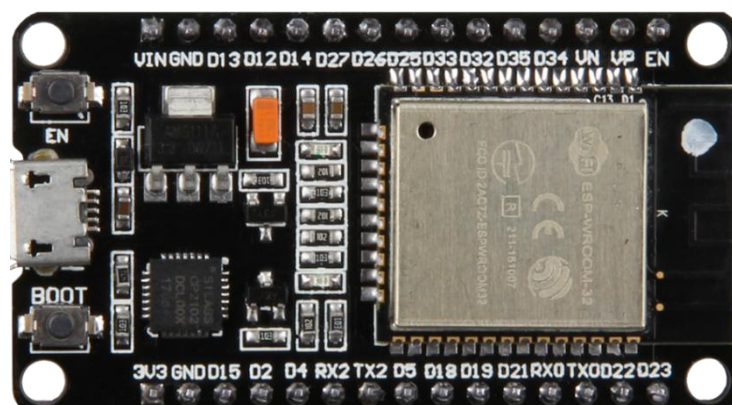


Fig. 4.10: NODE MCU ESP32

Featured Solutions

➤ Ultra-Low-Power Solution

ESP32 is intended for mobile, wearable physics, and Internet-of-Things (IoT) applications. It options all the progressive characteristics of low-power chips, together with fine-grained clock gating, multiple power modes, and dynamic power scaling. For example, during a low-power IoT device hub application state of affairs, ESP32 is woken up sporadically and only if a such condition is detected. Low-duty cycle is employed to reduce the number of energy that the chip expends. The output of the ability electronic equipment is additionally adjustable, so conducive to AN optimum trade-off between communication vary, rate and power consumption.

➤ Complete Integration Solution

ESP32 could be a highly-integrated answer for Wi-Fi-and-Bluetooth IoT applications, with around twenty external elements. ESP32 integrates AN antenna switch, RF balun, power electronic equipment, low-noise receive electronic equipment, filters, and power management modules. As such, the complete answer occupies lowest computer circuit Board (PCB) space. ESP32 uses CMOS for single-chip fully-integrated radio and baseband, whereas conjointly group action advanced standardization circuitries that enable the answer to get rid of external circuit imperfections or comply with changes in external conditions. As such, the production of ESP32 solutions doesn't need high-ticket and specialised Wi-Fi testing instrumentality.

Wi-Fi Key Features

- ✓ 802.11 b/g/n
- ✓ 802.11 n (2.4 GHz), up to 150 Mbps
- ✓ WMM
- ✓ TX/RX A-MPDU, RX A-MSDU

- ✓ Immediate Block ACK
- ✓ Defragmentation
- ✓ Automatic Beacon monitoring (hardware TSF)
- ✓ 4 × virtual Wi-Fi interfaces
- ✓ Simultaneous support for Infrastructure Station, SoftAP, and Promiscuous modes Note that when ESP32 is in Station mode, performing a scan, the SoftAP channel will be changed.
- ✓ Antenna diversity

BT Key Features

- Compliant with Bluetooth v4.2 BR/EDR and BLE specifications
- Class-1, class-2 and class-3 transmitter while not external power electronic equipment
- increased Power management
- +12 dBm transmittal powe
- NZIF receiver with −94 dBm BLE sensitivity
- Adaptative Frequency Hopping (AFH)
- Normal HCI supported SDIO/SPI/UART
- High-speed UART HCI, up to four Mbps
- Bluetooth four.2 BR/EDR BLE twin mode controller
- Synchronous Connection-Oriented/Extended (SCO/eSCO)
- CVSD and SBC for audio codec
- Bluetooth Piconet and Scatternet
- Multi-connections in Classic BT and BLE
- Cooccurring advertising and scanning
- Adjustive Frequency Hopping (AFH)

- Commonplace HCI supported SDIO/SPI/UART
- High-speed UART HCI, up to four Mbps
- Bluetooth four.2 BR/EDR BLE twin mode controller
- Synchronous Connection-Oriented/Extended (SCO/eSCO)
- CVSD and SBC for audio codec
- Bluetooth Piconet and Scatternet
- Multi-connections in Classic BT and BLE
- Synchronal advertising and scanning

MCU and Advanced Features

CPU and Memory

- Xtensa® single-/dual-core 32-bit LX6 microprocessor(s), up to 600 unit of measurement (200 unit of measurement for ESP32-S0WD/ESP32-U4WDH, four hundred unit of measurement for ESP32-D2WD) Xtensa® single-/dual-core 32-bit LX6 microprocessor(s), up to 600 MIPS (200 MIPS for ESP32-S0WD/ESP32-U4WDH, 400 MIPS for ESP32-D2WD)
- 448 K storage
- 520 K SRAM
- sixteen K SRAM in RTC
- QSPI supports multiple flash/SRAM chips

Clocks and Timers

- Internal eight megacycle per second generator with standardization
- Internal RC generator with standardization

- External a pair of megacycle per second ~ sixty megacycle per second quartz oscillator (40 megacycle per second just for Wi-Fi/BT functionality)
- External thirty two kilohertz quartz oscillator for RTC with standardization
- 2 timer teams, together with a pair of $\times$ 64-bit timers and one $\times$ main watchdog in every cluster
- One RTC timer
- RTC watchdog Internal 8 MHz oscillator with calibration

Advanced Peripheral Interfaces

- thirty four $\times$ programmable GPIOs
- 12-bit SAR ADC up to eighteen channels
- a pair of $\times$ 8-bit DAC
- ten $\times$ bit sensors
- 4 $\times$ SPI
- 2 $\times$ I²S
- 2 $\times$ I²C
- three $\times$ UART
- one host (SD/eMMC/SDIO)
- one slave (SDIO/SPI)
- LAN mack interface with dedicated DMA and IEEE 1588 support
- Two-Wire Automotive Interface (TWAI®, compatible with ISO11898-1)
- IR (TX/RX)
- Motor PWM

- crystal rectifier PWM up to sixteen channels
- Hall sensing element

Security

- Secure boot
- Flash cryptography
- 1024-bit OTP, up to 768-bit for purchasers
- scientific discipline hardware acceleration: – AES – Hash (SHA-2) – RSA – ECC – Random range Generator (RNG)

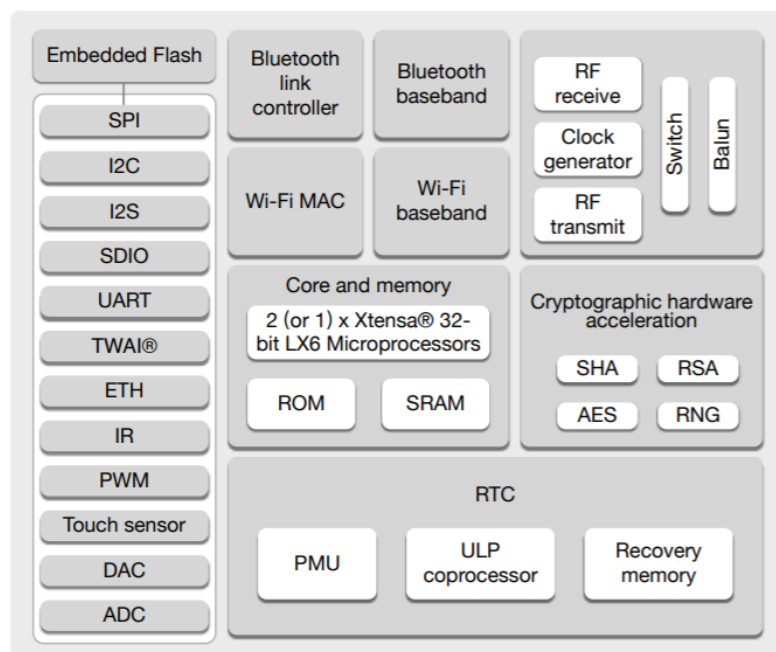


Fig. 4.11: Block Diagram

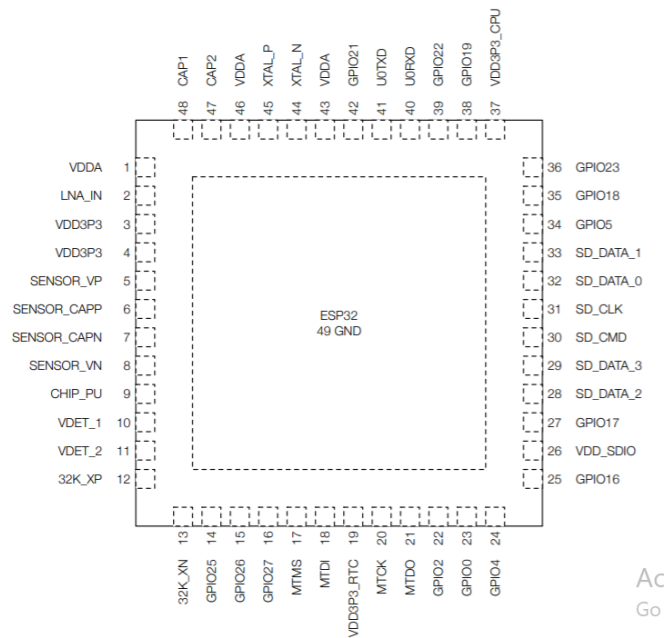


Fig.4.12: Pin Layout

CPU and Memory

CPU

ESP32 contains one or 2 low-power Xtensa® 32-bit LX6 microprocessor(s) with the subsequent features:

- ESP32-S0WD, ESP32-D2WD, and ESP32-U4WDH)
- 16/24-bit Instruction Set provides high code-density
- Support for Floating purpose Unit
- Support for DSP directions, like a 32-bit multiplier factor, a 32-bit divider, and a 40-bit mack
- Support for thirty two interrupt vectors from concerning seventy interrupt sources The single-/dual-CPU interfaces include:
- Xtensa RAM/ROM Interface for directions and knowledge
- Xtensa native Memory Interface for quick peripheral register access

- External and internal interrupt sources
- JTAG for debugging

Internal Memory

ESP32's internal memory includes:

- 448 K of storage for booting and core functions
- 520 K of on-chip SRAM for knowledge and directions
- eight K of SRAM in RTC, that is named RTC quick Memory and might be used for knowledge storage; it's accessed by the most mainframe throughout RTC Boot from the Deep-sleep mode.
- eight K of SRAM in RTC, that is named RTC SLOW Memory and might be accessed by the co-processor throughout the Deep-sleep mode.
- one Kbit of eFuse: 256 bits square measure used for the system (MAC address and chip configuration) and also the remaining 768 bits square measure reserved for client applications, together with flash-encryption and chip-ID.
- Embedded flash

External Flash and SRAM

ESP32 supports multiple external QSPI flash and SRAM chips. additional details are often found in Chapter SPI within the ESP32 Technical manual. ESP32 conjointly supports hardware encryption/decryption supported AES to safeguard developers' programs and knowledge in flash.

ESP32 will access the external QSPI flash and SRAM through high-speed caches.

- Up to sixteen MB of external flash are often mapped into mainframe instruction memory area and ROM area at the same time.

- once external flash is mapped into mainframe instruction memory area, up to eleven MB + 248 K are often mapped at a time. Note that if quite three MB + 248 K square measure mapped, cache performance are going to be reduced because of speculative reads by the mainframe.
- once external flash is mapped into read-only knowledge memory area, up to four MB are often mapped at a time. 8-bit, 16-bit and 32-bit reads square measure supported.
- External SRAM are often mapped into mainframe knowledge memory area. SRAM up to eight MB is supported and up to four MB are often mapped at a time. 8-bit, 16-bit and 32-bit reads and writes square measure supported.

4.8 GAS SENSOR (MQ2)

Gas discoverors are often accustomed detect flammable, burnable and ototoxic gases, and oxygen depletion. This sort of device is employed wide in trade and might be found in locations, like on oil rigs, to watch manufacture processes and rising technologies such as photovoltaic. They will be used in firefighting.

In current technology state of affairs, watching of gases made is incredibly vital. From home appliances like air conditioners to electrical chimneys and safety systems at industries watching of gases is incredibly crucial. Gas sensors ad lib react to the gas gift, so keeping the system updated concerning any alterations that occur within the concentration of molecules at aeriform state. The gas sensing element module An infrared sensor is associate degree device, that emits so as to sense some aspects of the environment. Associate degree IR sensing element will live the warmth of associate degree object similarly as detects the motion. These kinds of sensors measures solely infrared emission, instead of

emitting it that's referred to as as a passive IR sensing element. Typically within the spectrum.



Fig. 4.13: Gas Sensor (MQ2)

This sensing element is subjected to current through connecting leads. This current is known as heating current through it, the gases coming close to the sensing element get ionized and are absorbed by the sensing element. This changes the resistance of the sensing element which alters the value of the current going out of it. The connecting leads of the sensor are thick so that sensor can be connected firmly to the circuit and sufficient amount of heat gets conducted to the inside part. They are casted from copper and have tin plating over them.

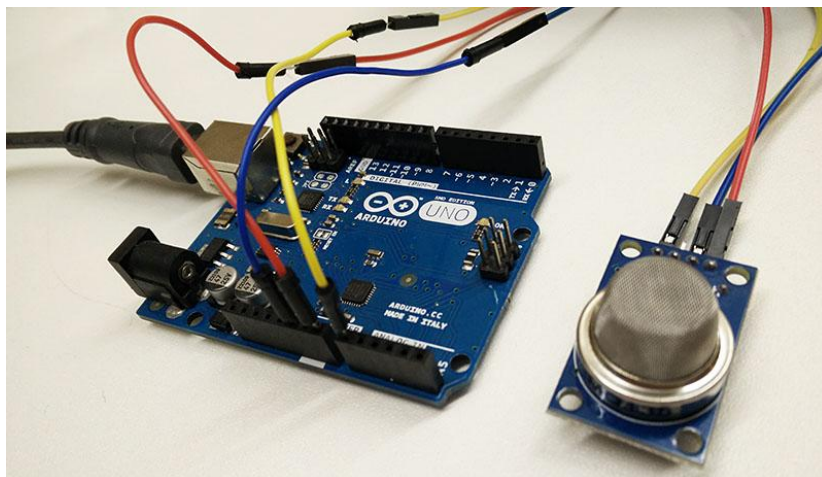


Fig. 4.14: Gas Sensor Interface with Arduino

MQ-2 gas sensor is designed with sensitive material of SnO_2 , which with lower conductivity in clean air. When the target combustible gas exists, the sensor's conductivity is higher. Signal conditioning circuit is used to convert the change of conductivity to correspond output signal with the input gas concentration. MQ-2 gas sensor has high sensitivity to LPG, Propane and Hydrogen, also could be used to Methane and other combustible steam, it is with low cost and suitable for different application. The MQ-2 gas module is mounted on a pcb board which has an operating voltage of 5VDC. The sensor output values can be get by means of both analog and digital.

Features

- Analog and Digital output
- Good sensitivity to Combustible gas in wide range
- High sensitivity to LPG, Propane and Hydrogen
- Operation voltage: 5VDC
- Simple drive circuit
- Long life and low cost

Applications

- Domestic gas leakage detector
- Industrial Combustible gas detector
- Portable gas detector

4.9 IR SENSOR

An infrared sensor is an electronic device, that emits in order to sense some aspects of the surroundings. An IR sensor can measure the heat of an object as well as detects the motion. These types of sensors measures only infrared radiation, rather than emitting it that is called as a passive IR sensor.

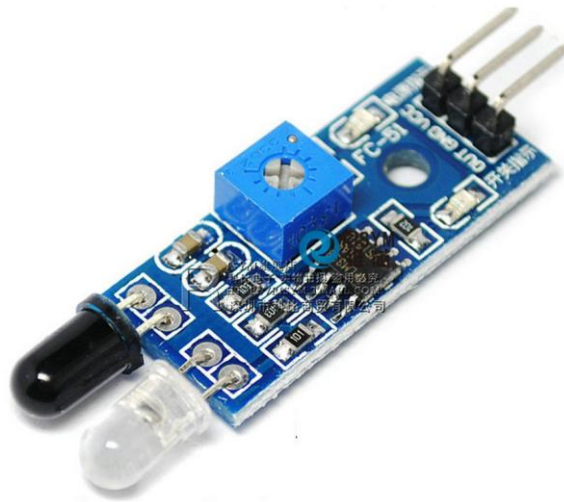


Fig. 4.15: IR Sensor

An infrared sensor is an electronic device, that emits in order to sense some aspects of the surroundings. An IR sensor can measure the heat of an object as well as detects the motion. These types of sensors measures only infrared radiation, rather than emitting it that is called as a passive IR sensor. Usually in the infrared spectrum, all the objects radiate some form of thermal radiations. These types of radiations are invisible to our eyes, that can be detected by an infrared sensor. The emitter is simply an IR LED (Light Emitting Diode) and the detector is simply an IR photodiode which is sensitive to IR light of the same wavelength as that emitted by the IR LED. When IR light falls on the photodiode, The resistances and these output voltages, change in proportion to the magnitude of the IR light received.

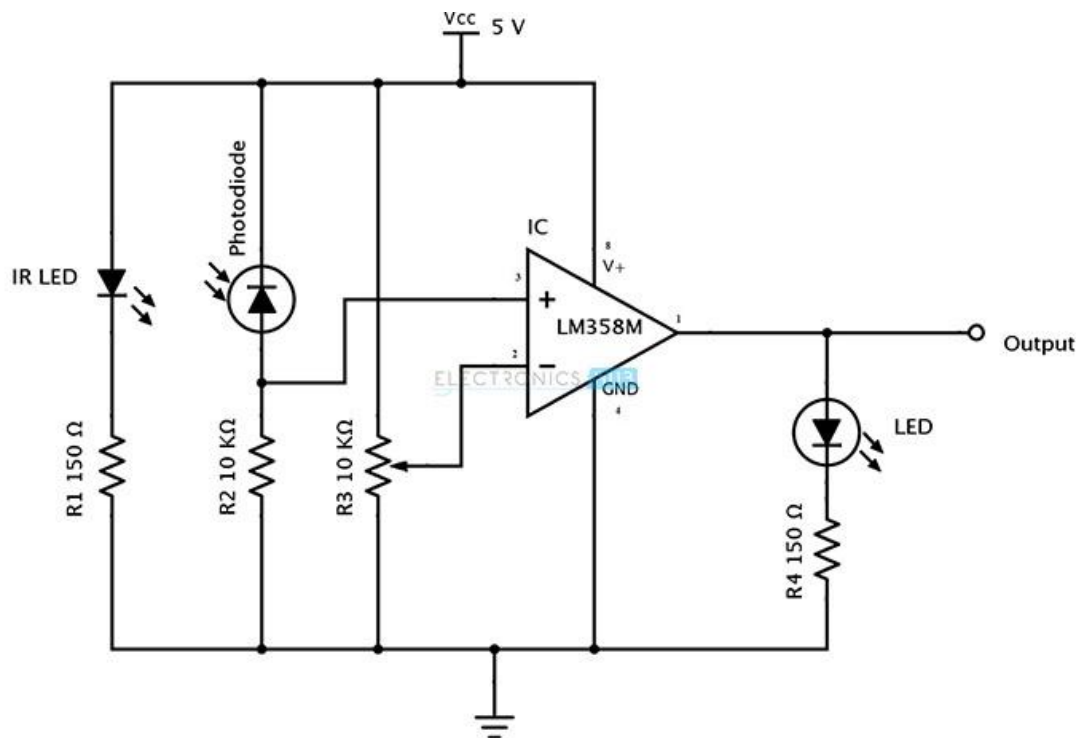


Fig. 4.16: Circuit Diagram

Features

- Input voltage : 3.3v
- Output : analog

Application

- Radiation Thermometers
- Flame Monitor
- Moisture Analyzers
- Gas Analyzers

4.10 MEMS SENSOR

Microelectromechanical system (MEMS, conjointly written a micro-electro-mechanical, MicroElectroMechanical or microelctronic and microelectromechanical systems and also the connected micromechatronics) is that the technology of microscopic devices, significantly those with moving components.

The measuring system may be a low power, low profile electrical phenomenon small machined measuring system that includes signal acquisition, a 1-pole low pass filter, temperature Compensation, self test, 0g-Detect that detects linear freefall, and g-Select that permits for the choice between two sensitivities Zero-g offset and sensitivity is works set and needs no external devices. This includes a Sleep Mode that produces it ideal for hand-held battery steam-powered elect You can use Associate in Nursing accelerometer's ability to sense acceleration to live a range of things that area unit terribly helpful to electronic and robotic comes and designs:

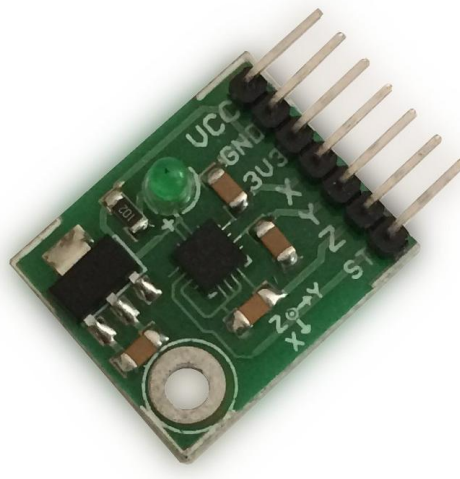


Fig. 4.17: Tilt Sensor

You can use an accelerometer's ability to sense acceleration to measure a variety of things that are very useful to electronic and robotic projects and designs:

- Acceleration
- Tilt and tilt angle

- Incline
- Rotation
- Vibration
- Collision
- Gravity

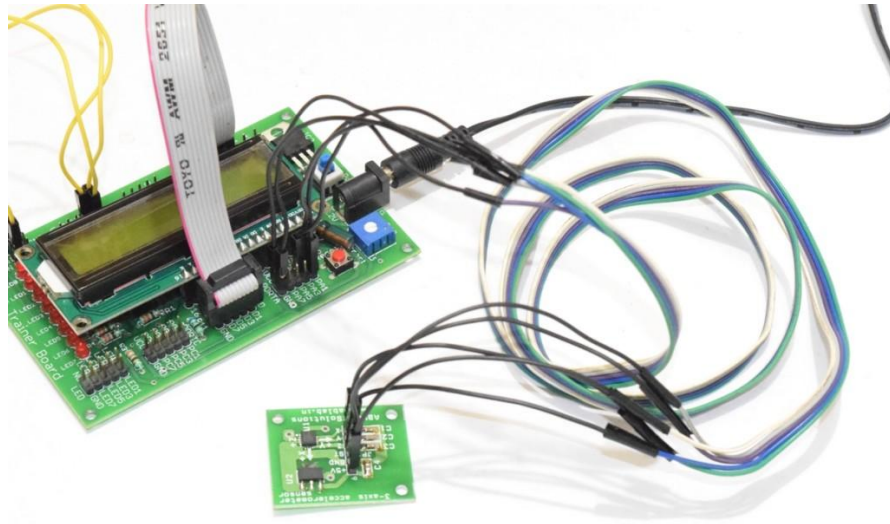


Fig. 4.18: Sensor Interface with Controller

Acceleration may be a live of however quickly speed changes. even as a speed indicator may be a meter that measures speed, Associate in Nursing measuring system may be a meter that measures acceleration. Accelerometers are useful for sensing vibrations in systems or for orientation applications. Accelerometers can measure acceleration on one, two, or three axis. 3-axis units are becoming more common as the cost of development for them decreases. You can use an accelerometer's ability to sense acceleration to measure a variety of things that are very useful to electronic and robotic projects.

Features

- Low Current Consumption: 400 Ma
- Sleep Mode: 3 μ A
- Low Voltage Operation: 2.2 V – 3.6 V

- High Sensitivity (800 mV/g @ 1.5g)
- Selectable Sensitivity ($\pm 1.5g$, $\pm 6g$)
- Fast Turn on Time (0.5 ms Enable Response Time)
- Self Test for Freefall Detect Diagnosis

Applications

- Self balancing robots
- Tilt-mode game controllers
- Model airplane auto pilot
- Car alarm systems
- Crash detection/airbag deployment



Fig. 4.19: Hardware

CHAPTER 5

SOFTWARE DETAILS

5.1 ARDUINO IDE

The Arduino Integrated Development atmosphere - or Arduino computer code (IDE) - contains a text editor for writing code, a message space, a text console, a toolbar with buttons for common functions and a series of menus. It connects to the Arduino and Genuino hardware to transfer programs and communicate with them.

Programs written victimization Arduino computer code (IDE) area unit area unit. These sketches area unit written within the text editor and area unit saved with the file extension .ino. The editor has options for cutting/pasting and for searching/replacing text. The message space provides feedback whereas saving and commerce and conjointly displays errors. The console displays text output by the Arduino computer code (IDE), including complete error messages and other information. The bottom righthand corner of the window displays the configured board and serial port. The toolbar buttons allow you to verify and upload programs, create, open, and save sketches, and open the serial monitor.

Before uploading your sketch, you need to select the correct items from the **Tools > Board** and **Tools > Port** menus. The boards are described below. On the Mac, the serial port is probably something like **/dev/tty.usbmodem241** (for an Uno or Mega2560 or Leonardo) or **/dev/tty.usbserial-1B1** (for a Duemilanove or earlier USB board), or **/dev/tty.USA19QW1b1P1.1** (for a serial board connected with a Keyspan USB-to-Serial adapter). On Windows, it's probably COM1 or COM2 (for a serial board) or COM4, COM5, COM7, or higher (for a USB board) - to find out, you look for USB serial device in the ports section of the Windows Device Manager. On Linux, it should

be `/dev/ttyACMx` , `/dev/ttyUSBx` or similar. Once you've selected the correct serial port and board, press the upload button in the toolbar or select the **Upload** item from the **Sketch** menu. Current Arduino boards will reset automatically and begin the upload. With older boards (pre-Diecimila) that lack auto-reset, you'll need to press the reset button on the board just before starting the upload. On most boards, you'll see the RX and TX LEDs blink as the sketch is uploaded. The Arduino Software (IDE) will display a message when the upload is complete, or show an error.

When you transfer a sketch, you are victimization the Arduino bootloader, atiny low program that has been loaded on to the microcontroller on your board. It permits you to transfer code while not victimization any further hardware. The bootloader is active for a couple of seconds once the board resets; then it starts whichever sketch was last uploaded to the microcontroller. The bootloader can blink the on-board (pin 13) semiconductor diode once it starts (i.e. once the board resets).

5.2 PROGRAMMING LANGUAGE

Embedded C is a collection of language extensions for the C programming language by the C Standards Committee to deal with commonality problems that exist between C extensions for different embedded systems.

Embedded C is a collection of language extensions for the C programming language by the C Standards Committee to address commonality problems that exist between C extensions for different embedded systems. traditionally, embedded C programming needs nonstandard extensions to the C language so as to support exotic options such as fixed-point arithmetic, multiple distinct memory banks, and basic I/O operations.

An embedded system is a computer system with a dedicated function within a larger mechanical or electrical system, often with real-time computing constraints. It is embedded as part of a complete device often including hardware and mechanical parts. Embedded systems control many devices in

common use today. Ninety-eight percent of all microprocessors are manufactured as components of embedded systems.

Examples of properties of typical embedded computers compared with general counterparts are unit low power consumption, small size, rugged operative ranges, and low per-unit price. This comes at the value of restricted process resources, that build them considerably tougher to program and to act with. However, by building intelligence mechanisms on prime of the hardware, taking advantage of doable existing sensors and also the existence of a network of embedded.

Modern embedded systems are unit typically based mostly on microcontrollers (i.e. CPU's with integrated memory or peripheral interfaces), however standard microprocessors (using external chips for memory and peripheral interface circuits) also are common, particularly in more-complex systems.

Since the embedded system is dedicated to specific tasks, design engineers can optimize it to reduce the size and cost of the product and increase the reliability and performance. Some embedded systems are mass-produced, benefiting from economies of scale.

Embedded systems range from portable devices such as digital watches and MP3 players, to large stationary installations like traffic lights, factory controllers, and largely complex systems like hybrid vehicles, MRI, and avionics. Complexity varies from low, with a single microcontroller chip, to very high with multiple units, peripherals and networks mounted inside a large chassis or enclosure.

5.3 INTERNET OF THINGS (IoT)

The Internet of things (IoT) describes the network of physical objects “things” that are unit embedded with sensors, software, and different technologies for the aim of connecting and exchanging information with different devices and systems over the web.

Things have evolved thanks to the convergence of multiple technologies, period of time analytics, machine learning, trade goods sensors, and embedded systems. ancient fields of embedded systems, wireless device networks, management systems, automation (including home and building automation), et al all contribute to enabling the web of things. The IoT is that the strategy for gadgets that case hardware, and network, that allows these devices to repair, act along and switch data. IoT incorporates broadening web helpful than normal gadgets, as an example, work areas to any call of typically non internet get to material gadgets and on on a daily basis by day supply objects. Inserted through innovation, these gadgets will banter and coordinate over the web, and that they is a bit checked and restricted.

The IoT is the strategy for gadgets that encase hardware, and network, which enables these devices to fix, act together and switch information. IoT incorporates broadening Internet beneficial than standard gadgets, for example, work areas to any decision of generally non web get to material gadgets and on a day by day source objects. Inserted through innovation, these gadgets can banter and coordinate over the Internet, and they can be a little checked and restricted.



Fig. 5.1: IOT in Health care

CHAPTER 6

CONCLUSION AND FUTURESCOPE

6.1 CONCLUSION

Monitoring and reduction of the amount of casualties and providing immediate facilitate to the miners in distress were the most goals of this project. employing a microcontroller and node mcu on the helmet utilized by the miners, a wireless device network was shaped. Mems device was hooked up to the device atom to envision the well-being the user. Whenever the force veteran by the helmet was over the pre-set threshold worth, the microcontroller within the helmet tried to send a sms or email notification message to its area Manager victimization the saved route.

6.2 FUTURESCOPE

Thus, a sensible helmet for unsafe event detection, watching the encompassing environmental conditions and change data like GPS location and device information to the central console for simple pursuit and providing chemical element supplements to avoid the inhalation of toxic gases is intended. The system may also be more developed with the implementation of web of Things (IOT). The information is created that monitors the device modules unceasingly.

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