A

MAJOR PROJECT REPORT ON

SMART SAFETY MONITERING SYSTEM FOR SEWAGE WORKERS WITH TWO WAY COMMUNICATION

Submitted in partial fulfilment of the requirement for the award of degree of

BACHELOR OF TECHNOLOGY

IN

ELECTRONICS AND COMMUNICATION ENGINEERING

SUBMITTED BY

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CMR ENGINEERING COLLEGE

UGC AUTONOMOUS

(Approved by AICTE, Affiliated to JNTU Hyderabad, Accredited by NBA)
Kandlakoya(V), Medchal(M), Telangana – 501401

(2024-2025)

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CERTIFICATE

This is to certify that the major-project work entitled **"SMART SAFETY MONITERING SYSTEM FOR SEWAGEWORKERS WITH TWO WAY COMMUNICATION"** is being submitted by **B. ABHIRAM** bearing Roll No **218R1A04J8,** in B.Tech IV-II semester, Electronics and Communication Engineering is a record Bonafide work carried out during the academic year 2024-25. The results embodied in this report have not been submitted to any other University for the award of any degree.

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ACKNOWLEDGEMENT

I sincerely thank the management of our college **CMR Engineering College** for providing required facilities during our project work. I derive great pleasure in expressing our sincere gratitude to our Principal **Dr. A. S. Reddy** for his timely suggestions, which helped us to complete the project work successfully. It is the very auspicious moment I would like to express our gratitude to **Dr. SUMAN MISHRA,** Head of the Department, ECE for his consistent encouragement during the progress of this project.

I take it as a privilege to thank our project coordinator and internal guide Dr. T.AMRU, Associate Professor, Department of ECE for the ideas that led to complete the project work and I also thank him for his continuous guidance, support and unfailing patience, throughout the course of this work.

DECLARATION

I hereby declare that the major project entitled **"SMART SAFETYMONITERING SYSTEM FOR SEWAGE WORKERS WITH TWO WAY COMMUNICATION"** is the work done by me in campus at **CMR ENGINEERING COLLEGE,** Kandlakoya during the academic year 2024-2025 and is submitted as major project in partial fulfilment of the requirements for the award of degree of **BACHELOR OF TECHNOLOGY** in **ELECTRONICS AND COMMUNICATION ENGINEERING FROM JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY, HYDERABAD.**

B. ABHIRAM **(218R1A04J8)**

ABSTRACT

A large number of sanitation workers die every year due to erratic and lack of facilities available, and harmful toxic gases released while cleaning the sewage. Real time health monitoring systems for such workers will prove helpful. This real time health monitoring device will work in a sewage as a safety equipment. In this paper, the device presented will monitor the pulse rate of a person using a pulse oximetry sensor, the methane concentration and the atmospheric oxygen concentration and provide alert to worker and exterior unit. when parameters deviate from the safe range. This parameters in real time will promptly alert the workers to stay safe and detect toxic gases before any harm. The Smart Safety Monitoring System for Sewage Workers with Two-Way Communication is designed to improve the safety and well-being of sewage workers. Sewage workers face numerous health and safety risks while working in confined and hazardous environments.

The proposed system integrates wearable technology, environmental sensors, and real-time communication to ensure the safety of sewage workers. The system consists of a wearable device, environmental sensors, a communication module, and a control center. The wearable device monitors the worker's vital signs, such as heart rate, blood oxygen level, and body temperature. Environmental sensors monitor environmental conditions, such as gas levels, temperature, and humidity. The communication module transmits data from the wearable device and environmental sensors to the control center. The control center receives and analyzes the data, sending alerts and notifications to the worker's wearable device and emergency services in case of an emergency. The system enables real-time two-way communication between the worker and the control center, allowing for prompt response to emergencies and ensuring the worker's safety. The proposed system offers numerous benefits, including improved safety, increased efficiency, and reduced costs. Enhanced monitoring of worker vital signs and environmental conditions reduces the risk of accidents and injuries.

Real-time communication and automated data analysis optimize work processes and reduce response times. Minimized risk of accidents and injuries reduces costs associated with medical treatment and lost productivity. The system is designed to be scalable, flexible, and adaptable to different sewage systems and worker requirements.

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CHAPTER 1

INTRODUCTION

The project aims to design and develop a smart safety monitoring system for sewage workers that integrates wearable devices, environmental sensors, and a two-way communication system. The system will provide real-time monitoring of workers' vital signs, location, and environmental conditions, enabling prompt response to emergencies and improved decision-making. Design and develop a smart safety monitoring system for sewage workers. Integrate wearable devices, environmental sensors, and a two-way communication system. Provide real-time monitoring of workers' vital signs, location, and environmental conditions. Enable prompt response to emergencies and improved decision-making.

Methodology Conduct a needs assessment to identify specific requirements and challenges. Design the system architecture and components. Develop and test the system. Conduct pilot testing and evaluation. Implement the system on a full scale. Expected Outcomes Improved safety and well-being of sewage workers. Enhanced real-time monitoring and communication capabilities. Increased efficiency and productivity. Reduced costs associated with accidents and injuries. Improved safety and well-being of sewage workers. Enhanced operational efficiency and productivity. Reduced costs associated with accidents and injuries. Improved decision-making and response to emergencies.

1.1 OBJECTIVE OF THE PROJECT

Primary Objectives Improve Safety: Enhance the safety and well-being of sewage workers by providing real-time monitoring of their vital signs, location, and environmental conditions. Enable Real-time Communication: Establish a two-way communication system that enables real-time voice and data communication between workers and the control center. Enhance Operational Efficiency: Optimize work processes and reduce response times to emergencies by providing real-time monitoring and communication capabilities. Secondary Objectives Reduce Accidents and Injuries: Minimize the number of accidents and injuries by providing early warnings and alerts to workers and the control center. Improve Decision-Making: Provide data-driven insights to inform decision-making and improve overall operational efficiency. Reduce

Costs: Minimize costs associated with accidents, injuries, and equipment damage by providing real-time monitoring and communication capabilities.

1.2 ORGANIZATION OF THE PROJECT

1. **Project Manager:** Oversees the entire project, ensuring timely completion, budget management, and stakeholder satisfaction.
2. **Technical Lead:** Responsible for the technical aspects of the project, including system design, development, and testing.
3. **Safety Expert:** Provides expertise on safety protocols, regulations, and best practices for sewage workers.
4. **Stakeholder Engagement Team:** Responsible for communicating with stakeholders, including sewage workers, management, and regulatory bodies.
5. **Hardware Development Team:** Designs and develops the wearable devices, environmental sensors, and communication infrastructure.
6. **Software Development Team:** Develops the software applications for data collection, analysis, and visualization.
7. **Testing and Quality Assurance Team:** Conducts thorough testing and quality assurance of the system.
8. **Deployment and Maintenance Team**: Deploys the system and provides ongoing maintenance and support.
9. **Requirements Gathering**: Identify project requirements, stakeholder needs, and technical specifications.
10. **System Design:** Design the system architecture, hardware, and software components.
11. **Development:** Develop the hardware and software components.
12. **Testing and Quality Assurance:** Conduct thorough testing and quality assurance
13. **Deployment:** Deploy the system.
14. **Maintenance and Support:** Provide ongoing maintenance and support.

CHAPTER 2

LITERATURE SURVEY

2.1 EXISTING SYSTEM

The sewage maintenance support is important to keep the society neat, clean safe and healthy. If the waste upkeep is may quite good at environment and also the human being it causes the form a dangerous gas in the water. The wireless sensor networks are mainly used to identify the environment changes and stored information in the database. T. Machappa, M. Sasikala, and M. V. N. Ambika Prasad exhibited a framework that electrical obstruction Weinan Deng and Huaxing Zhang, the building of highways in China has led to an increasingly serious problem leaving more and more coal under highways. Having as much as possible the unexploited coal and maintaining highway safety at the same time becomes a problem that must be addressed as a matter of urgency.

The paper addressed the characteristics of road deformations caused by underground mining, suggesting the rules to be followed while mining under highway protective coal pillar. Methods for the security mining of protective coal pillar under highway were put forward in the study on the basis of improving and integrating the existing methods for mining protective coal pillar.

The importance of the Coal Mine Production Safety Supervision and the specific issues that might occur under the concept of safety supervision function is proposed to create the Coal Mine Safety Production Supervision Program. The results, show that the addition of independent third parties to the coal mine production process implementation services in compliance with applicable guidelines, laws, rules and regulations and technical standards and the conduct of coal mining companies to establish an effective restriction framework can compensate for the government's macroscopic control and its own limitations.

The establishment of the system to provide a reliable guarantee for coal mine safety production. Yiqing Zhao, Yaodong Zhou, Cuiping Li and Zhiguo Cao, In the supply chain management (SCM) of coal companies, the volatility of the occurrence of raw coal and coal quality and the various limitations on mine production capacity are the major factors that need to be taken into account. This paper combines a supply chain model for coal mine planning with a linear programming model for production

scheduling to allow coal companies respond quickly to changes in customer demand and boost supply chain and logistics management level.

The aim of production management and scheduling optimization model is to optimize sales volume with customer demand constraints, lead time, resource constraints and supply chain inventory. To illustrate the model application and its ability to reduce planning and scheduling time and respond to uncertainty, an example of an open pit coal mine is used. Liu Xianglan, Big data has infiltrated various industries and their functions, has become important development factors in Research Article Volume 9 Issue No.10 IJESC, October 2019 23932 http://ijesc.org/ the global economy. Big data processing is the cornerstone of the big data development process. Big data technology should concentrate on processing, analyzing, combining and visualizing unstructured data and semi-structured data. Big data will no longer be the core of traditional structured data.

Based on the theory of the life cycle, new digital technologies such as collection, processing, storage, organization and copyright protection, clusters of highly competitive retrieval and flexible scheduling, smart digital display, coal mine industry information data can be collected and incorporated, centralized management, coordinated retrieval, and joint information resource exhibition Lab VIEW programming environment is developed to connect large area. The leakage level of a gas concentration.

2.2 PROPOSED SYSTEMS

Hardware Components

1. Wearable Devices: Design and develop wearable devices (e.g., smart vests, wristbands) with sensors to monitor workers' vital signs (e.g., heart rate, blood oxygen level).
2. Environmental Sensors: Install environmental sensors (e.g., gas detectors, temperature sensors) in the sewage system to monitor environmental conditions.
3. Communication Infrastructure: Establish a reliable communication infrastructure (e.g., Wi-Fi, cellular networks) to enable real-time communication between workers and the control center.

Software Components

1. Data Collection and Analysis: Develop software to collect and analyze data from wearable devices and environmental sensors.
2. Real-time Monitoring: Design a real-time monitoring system to display worker vital signs and environmental conditions.
3. Alert and Alarm System: Develop an alert and alarm system to notify workers and the control center of potential hazards.
4. Two-Way Communication: Implement a two-way communication system to enable real-time voice and data communication between workers and the control center.

System Implementation

1. Needs Assessment: Conduct a needs assessment to identify specific requirements and challenges.
2. System Design: Design the system architecture and components.
3. Prototype Development: Develop a prototype of the system.
4. Testing and Evaluation: Conduct thorough testing and evaluation of the system.
5. Deployment: Deploy the system in the sewage workplace.

Evaluation Metrics

1. Safety Incident Reduction: Measure the reduction in safety incidents and accidents.
2. Worker Satisfaction: Evaluate worker satisfaction with the system.
3. Response Time: Measure the response time to emergencies and potential hazards.
4. System Reliability: Evaluate the reliability and uptime of the system.

Advantages

1. Improved Safety: Enhances the safety and well-being of sewage workers by providing real-time monitoring of their vital signs and environmental conditions.
2. Real-time Communication: Enables real-time voice and data communication between workers and the control center, facilitating prompt response to emergencies.

3. Increased Efficiency: Optimizes work processes and reduces response times to emergencies, leading to increased productivity and efficiency.
4. Cost Savings: Reduces costs associated with accidents, injuries, and equipment damage.
5. Enhanced Decision-Making: Provides data-driven insights to inform decision-making and improve overall operational efficiency.

Limitations

1. Technical Issues: Technical problems, such as connectivity issues or sensor malfunctions, may affect the system's reliability.
2. Cost: Implementing and maintaining the system may require significant investment.
3. User Acceptance: Workers may resist adopting new technology, requiring training and support.
4. Data Security: Ensuring the security and confidentiality of worker data and system communications is crucial.
5. Scalability: The system may require modifications to accommodate changing workforce sizes or new technologies.

Features

1. Real-time Monitoring: Continuous monitoring of workers' vital signs and environmental conditions.
2. Two-Way Communication: Real-time voice and data communication between workers and the control center.
3. Alert and Alarm System: Automated alerts and alarms for potential hazards and emergencies.
4. Location Tracking: GPS tracking of workers' locations within the sewage system.
5. Data Analytics: Advanced data analytics to identify trends, patterns, and potential hazards.

CHAPTER 3

HARDWARE IMPLEMENTATION

Gas sensors are electronic devices that detect and identify different types of gasses. They are commonly used to detect toxic or explosive gasses and measure gas concentration. The tin oxide layer acts as a reacting component. When tin dioxide (semiconductor particles) is heated in air at high temperature, oxygen is adsorbed on the surface. In clean air, donor electrons in tin dioxide are attracted toward oxygen which is adsorbed on the surface of the sensing material. This prevents electric current flow. In the presence of reducing gases, the surface density of adsorbed oxygen decreases as it reacts with the reducing gases. Electrons are then released into the tin dioxide, allowing current to flow freely through the sensor.

3.1 AIR QUALITY SENSOR & GAS SENSOR

The MQ-135 Gas sensors are used in air quality control equipments and are suitable for detecting or measuring of NH3, NOx, Alcohol, Benzene, Smoke, CO2.The MQ-135 sensor module comes with a Digital Pin which makes this sensor to operate even without a microcontroller and that comes in handy when you are only trying to detect one particular gas. If you need to measure the gases in PPM the analog pin need to be used. The analog pin is TTL driven and works on 5V and so can be used with most common microcontroller

Fig 3.1: Gas Sensor

3.2 TEMPERATURE SENSOR

LM35 is a precession Integrated circuit Temperature sensor, whose output voltage varies, based on the temperature around it. It is a small and cheap IC which can be used to measure temperature anywhere between -55°C to 150°C. It can easily be interfaced with any Microcontroller that has ADC function or any development platform like

Arduino.It has an output voltage that is proportional to the Celsius temperature.The scale factor is 0.1V/ºC. The sensor has a sensitivity of 10mV /ºC.

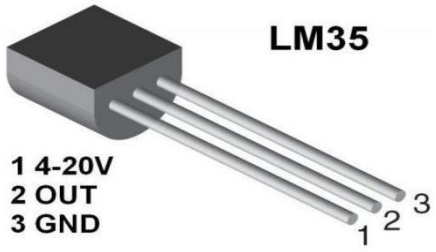

Fig 3.2: Temperature Sensor

3.3 HEART BEAT SENSOR

Heart Beat Sensor is designed to give digital output of heat beat when a finger is placed on it. When the heart beat detector is working, the beat LED flashes in unison with each heart beat. This digital output can be connected to microcontroller directly to measure the Beats Per Minute (BPM) rate. The heartbeat sensor is based on the principle of photoplethysmography. It measures the change in volume of blood through any organ of the body which causes a change in the light intensity through that organ**.**

Fig 3.3: Heart Beat Sensor

3.4 ARDUINO UNO

Arduino board is being used used here. It also reffered as brain which means act as a main part in the project. It is connected with GSM which sends message to the user. Also an application _Ubidots‘ being implied here which used as conversion. Wifi modules and LCD display is being connected. Arduino Uno is a MC board based on 8-bit ATmega328P MC. Along with ATmega328P, it consists other components such as crystal oscillator, serial communication, voltage regulator, etc. to support the MC. Arduino Uno has 14 digital input/output pins (out of which 6 can be used as PWM outputs), 6 analog input pins, a USB connection, A Power barrel jack, an ICSP header and a reset button.

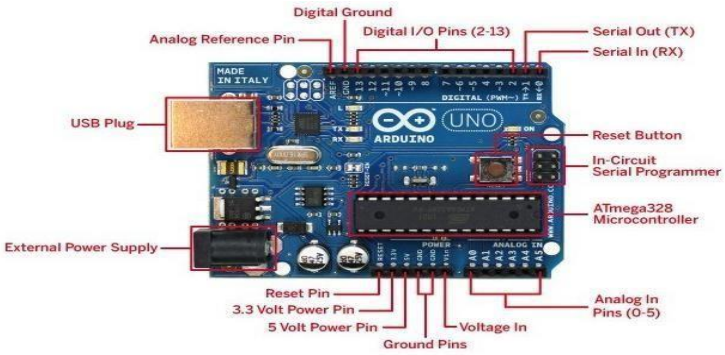

Fig 3.4: Arduino UNO

3.5 ARDUINO MEGA

The MEGA 2560 is designed for more complex projects. With 54 digital I/O pins (of which 15 can be used as PWM outputs), 16 analog inputs, 4 UART, a 16 MHz crystal oscillator,a 16 MHz crystal oscillator, a USB connection, a

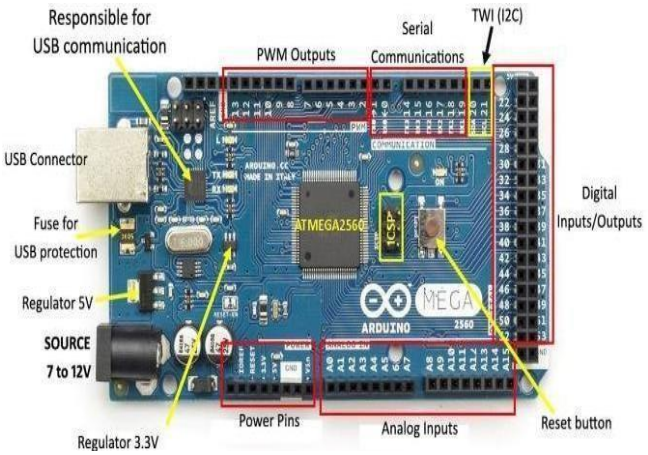

Fig 3.5: Arduino Mega

power jack, an ICSP header and a reset button.The ATmega1280 has 128 KB of flash memory for storing code (of which 4 KB is used for the bootloader), 8 KB of SRAM and 4 KB of EEPROM.

3.6 IOT MODULE

The ESP8266 is the name of a micro controller designed by Espressif Systems. The ESP8266 itself is a self-contained Wi-Fi networking solution offering as a bridge from existing micro controller to Wi-Fi.Core processor ESP8266 in smaller sizes of the module encapsulates Tensilica L106 integrates industry-leading ultra-low power 32-bit MCU micro, with the 16-bit short mode, Clock speed support 80 MHz, 160 MHz, supports the RTOS, integrated Wi-Fi MAC/BB/RF/PA/LNA, on-board antenna. The module supports standard IEEE802.11 b/g/n agreement, complete TCP/IP protocol stack. Users can use the add modules to an existing device networking, or building a separate network controller. ESP8266 is high integration wireless SOCs, dthe entire solution, including front-end module, is designed to occupy minimal PCB area.

Fig 3.6: ESP8266- IOT Module

3.7 GSM MODULE

A GSM module or a GPRS module is a chip or circuit that will be used to establish communication between a mobile device or a computing machine and a GSM or GPRS system. GSM/GPRS Modem-RS232 is built with Dual Band GSM/GPRS engine-SIM900, works on frequencies 900/ 1800 MHz. The Modem is coming with RS232 interface, which allows you connect PC as well as MC with RS232 Chip(MAX232). The baud rate is configurable from 9600-115200. The GSM/GPRS Modem is having internal TCP/IP stack to enable you to connect with internet via GPRS. It is suitable for SMS, Voice as well as Data transfer application in M2M interface. The onboard Regulated Power supply allows you to connect wide range unregulated power supply .

Using this modem, you can make audio calls, SMS, Read SMS, attend the incoming calls and internet through simple AT commands.

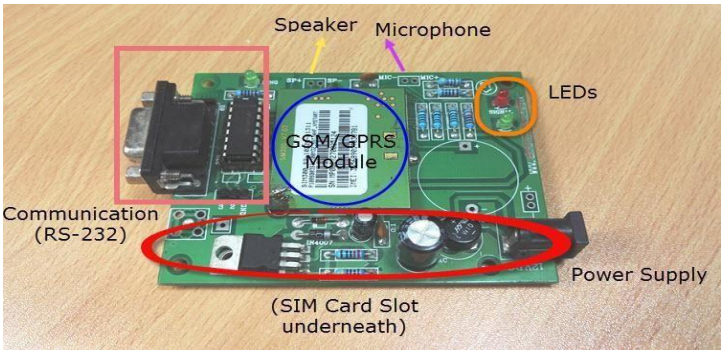

Fig 3.7: GSM Module

3.8 ZIGBEE MODULE

Zigbee is a wireless communication module which use IEEE 802.15.4 standard. 802.15.4 is a IEEE standard for low power applications of radio frequency. It used serial communication to send and receive data.The nRF24L01+ is a single chip 2.4GHz transceiver with an embedded baseband protocol engine, suitable for ultra - low power wireless applications. The nRF24L01+ is designed for operation in the world wide ISM frequency band at 2.4 - 2.4835GHz. The nRF24L01+ is configured in Serial Peripheral Interface (SPI). The register map, which is accessible through the SPI, contains all configuration registers in then RF24L01+ and is accessible in all operation modes of the chip. The radio front end uses GFSK modulation. Baud Rate: 250 kbps to 2 Mbps

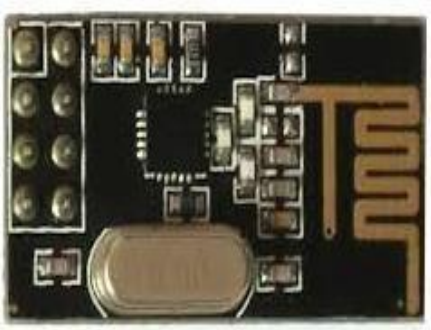

Fig 3.8: nRF24L01+ - Zigbee Module

3.9 BUZZER

Buzzer operates based on piezoelectric effect. Piezoelectric Effect is the ability of certain materials to generate an electr ic charge in response to applied mechanical stress. Piezoelectric buzzer is mainly composed of multi-resonator, piezoelectric plate, impedance match, resonance box, housing, etc. Some of the piezoelectric buzzers are also equipped with light-emitting diodes. The multi-resonator consists of transistors or

integrated circuits. When the power supply is switched on (1.5~15V DC operating voltage), the multi-resonator oscillates and outputs 1.5~2.5kHz audio signal.

Fig 3.9: Buzzer

BLOCK DIAGRAM

3.2.1 BLOCK DIAGRAM

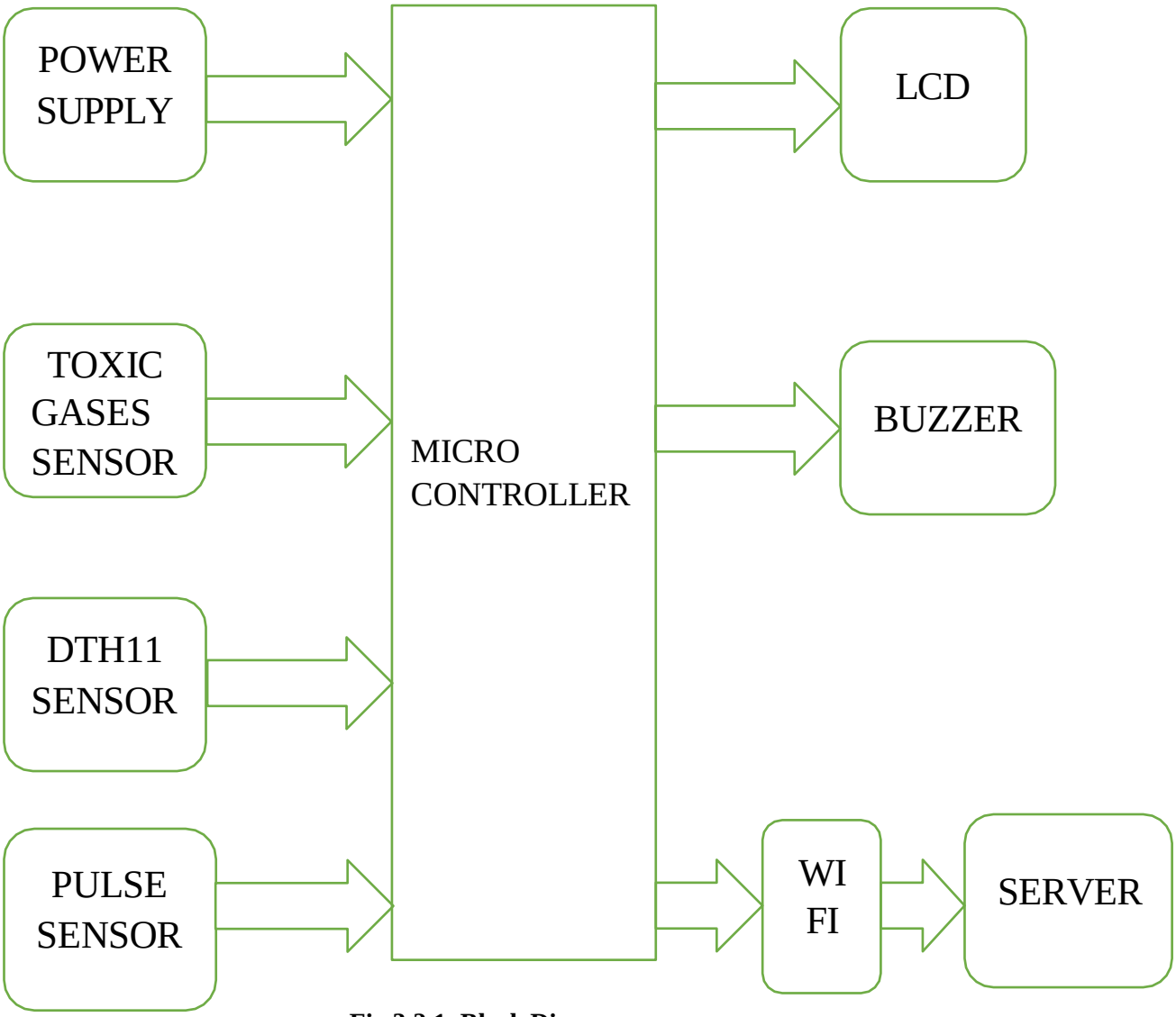

Fig 3.2.1: Block Diagram

POWER SUPPLY

Fig 3.2.2 Power Supply

CHAPTER 4

SOFTWARE IMPLEMENTATION

4.1 ARDUINO IDE

Arduino IDE stands for Integrated Development Environment‖:it is an official software introduced by Arduino.cc, that is mainly used for editing, compiling and uploading the code in the Arduino Device. It is a cross-platform application (for Windows, macOS, Linux) that is written in functions from C and C++.Arduino IDE is an open source software that is mainly used for writing and compiling the code into the Arduino Module. I serial monitor mainly for interacting with the Arduino board using the computer, and is a great tool for real-time monitoring and debugging.

The Arduino IDE is a comprehensive software platform for writing, compiling, and uploading code to Arduino boards. It provides an intuitive interface for programming and debugging, making it an ideal choice for beginners and experienced developers alike. To program a 16x2 LCD display using the Arduino IDE, users must first install the Liquid Crystal library. This library provides a set of functions for controlling the LCD display, including initializing the display, setting the cursor position, and printing text. Once the library is installed, users can create a new sketch in the Arduino IDE and import the Liquid Crystal library.

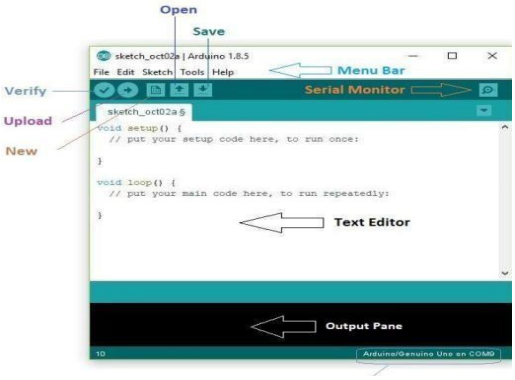

Fig 4.1: Arduino IDE

They can then define the LCD pins and initialize the display in the setup () function. In the loop () function, users can use the Liquid Crystal functions to print text to the LCD display. For example, they can use the print () function to print a message to the display, or the set Cursor () function to set the cursor position. The Arduino IDE also provides a range of debugging tools, including a serial monitor and a debugger. These tools allow users to monitor the output of their code and identify any errors that may

occur.Overall, the Arduino IDE provides a powerful and intuitive platform for programming a 16x2 LCD display. Its comprehensive library and debugging tools make it an ideal choice for developers of all levels. Arduino IDE stands for Integrated Development Environment‖:it is an official software introduced by Arduino.cc, that is mainly used for editing, compiling and uploading the code in the Arduino Device. It is a cross-platform application (for Windows, macOS, Linux) that is written in functions from C and C++.Arduino IDE is an open source software that is mainly used for writing and compiling the code into the Arduino Module. I serial monitor mainly for interacting with the Arduino board using the computer, and is a great tool for real-time monitoring and debugging.

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4.2 IOT CLOUD STORAGE WEBPAGE

IOT describes the network of physical object things that are embedded with sensors, software, and other technologies for the purpose of connecting and exchanging data with other devices and systems over the internet with unique identifiers (UIDs). A host of network protocols for the internet has made it easy to connect sensors to the cloud and to other things for efficient data transfer. The data‘s get stored in the cloud.

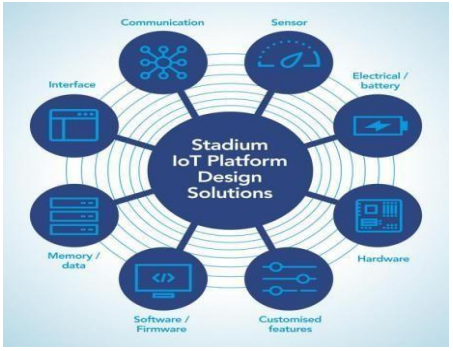

Fig 4.2: IOT

The IOT concept was coined by a member of the Radio Frequency Identification (RFID) development community in 1999, and it has recently become more relevant to the practical world largely because of the growth of mobile devices, embedded and ubiquitous communication, cloud computing and data analytics. Imagine a world where billions of objects can sense, communicate and share information, all interconnected over public or private Internet Protocol (IP) networks. These interconnected objects have data regularly collected, analysed and used to initiate action, providing a wealth of intelligence for planning, management and decision making.

This is the world of the Internet of Things (IOT). Internet of things common definition is defining as: Internet of things (IOT) is a network of physical objects. The internet is not only a network of computers, but it has evolved into a network of device of all type and sizes , vehicles, smart phones, home appliances, toys, cameras, medical instruments and industrial systems, animals, people, buildings, all connected ,all communicating & sharing information based on stipulated protocols in order to achieve smart reorganizations, positioning, tracing, safe & control & even personal real time online monitoring , online upgrade, process control & administration We define IOT into three categories as below. IOT describes the network of physical object things that are embedded with sensors, software, and other technologies for the purpose of connecting and exchanging data with other devices and systems over the internet with unique identifiers (UIDs). A host of network protocols for the internet has made it easy to connect sensors to the cloud and to other things for efficient data transfer. The data‘s get stored in the cloud.

CHAPTER 5

COMPONENTS DISCRIPTION

5.1 Arduino

Overview The Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter. Revision 2 of the Uno board has a resistor pulling the 8U2 HWB line to ground, making it easier to put into DFU mode. Revision 3 of the board has the following new features.

pinout: added SDA and SCL pins that are near to the AREF pin and two other new pins placed near to the RESET pin, the IOREF that allow the shields to adapt to the voltage provided from the board. In future, shields will be compatible both with the board that use the AVR, which operate with 5V and with the Arduino Due that operate with 3.3V. The second one is a not connected pin, that is reserved for future purposes. Stronger RESET circuit.

At mega 16U2 replace the 8U2. "Uno" means one in Italian and is named to mark the upcoming release of Arduino 1.0. The Uno and version 1.0 will be the reference versions of Arduino, moving forward. The Uno is the latest in a series of USB Arduino boards, and the reference model for the Arduino platform; for a comparison with previous versions, see the index of Arduino boards. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter.

Summary:

Microcontroller ATmega328

Operating Voltage 5V

Input Voltage (recommended) 7-12V

Input Voltage (limits) 6-20V

Digital I/O Pins 14 (of which 6 provide PWM output)

Analog Input Pins 6

DC Current per I/O Pin 40 mA

DC Current for 3.3V Pin 50 mA

Flash Memory 32 KB (ATmega328) of which 0.5 KB used by bootloader

SRAM 2 KB (ATmega328)

EEPROM 1 KB (ATmega328)

Clock Speed 16 MHz

Clock Speed 16 MHz

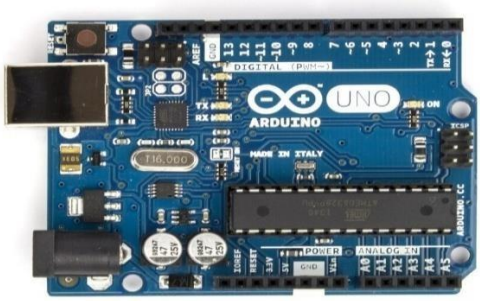

Fig 5.1: Arduino

Schematic & Reference Design

EAGLE files: arduino-uno-Rev3-reference-design.zip (NOTE: works with Eagle 6.0 and newer) Schematic: arduino-uno-Rev3-schematic.pdf Note: The Arduino reference design can use an Atmega8, 168, or 328, Current models use an ATmega328, but an Atmega8 is shown in the schematic for reference. The pin configuration is identical on all three processors

Power

The Arduino Uno can be powered via the USB connection or with an external power supply. The power source is selected automatically.

External (non-USB) power can come either from an AC-to-DC adapter (wall-wart) or battery.

The adapter can be connected by plugging a 2.1mm center-positive plug into the board's power jack.

Leads from a battery can be inserted in the Gnd and Vin pin headers of the POWER connector.

The board can operate on an external supply of 6 to 20 volts.

If supplied with less than 7V, however, the 5V pin may supply less than five volts and the board may be unstable.

If using more than 12V, the voltage regulator may overheat and damage the board. The recommended range is 7 to 12 volts.

The power pins are as follows:

VIN. The input voltage to the Arduino board when it's using an external power source (as opposed to 5 volts from the USB connection or other regulated power source). You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin.

5V. This pin outputs a regulated 5V from the regulator on the board. The board can be supplied with power either from the DC power jack (7 - 12V), the USB connector (5V), or the VIN pin of the board (7-12V). Supplying voltage via the 5V or 3.3V pins bypasses the regulator, and can damage your board. We don't advise it. 3V3. A 3.3volt supply generated by the on-board regulator. Maximum current draw is 50 mA.

GND. Ground pins.

Memory: The ATmega328 has 32 KB (with 0.5 KB used for the bootloader). It also has 2 KB of SRAM and 1 KB of EEPROM (which can be read and written with the EEPROM library).

Input and Output: Each of the 14 digital pins on the Uno can be used as an input or output, using pin Mode(), digital Write(), and digital Read() functions. They operate at 5 volts. Each pin can provide or receive a maximum of 40 mA and has an internal pull-up resistor (disconnected by default) of 20-50k Ohms. In addition, some pins have specialized functions.

- **Serial:** 0 (RX) and 1 (TX). Used to receive (RX) and transmit (TX) TTL serial data. These pins are connected to the corresponding pins of the ATmega8U2 USB-to-TTL Serial chip.
- **External Interrupts**: 2 and 3. These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value. See the attachInterrupt() function for details.
- **PWM**: 3, 5, 6, 9, 10, and 11. Provide 8-bit PWM output with the analogWrite() function.
- SPI: 10 (SS), 11 (MOSI), 12 (MISO), 13 (SCK). These pins support SPI communication using the SPI library.
- **LED**: 13. There is a built-in LED connected to digital pin 13. When the pin is HIGH value, the LED is on, when the pin is LOW, it's off. The Uno has 6analog inputs, labelled A0 through A5, each of which provide 10 bits of resolution (i.e. 1024 different values). By default they measure from ground to 5 volts, though is it possible to change the upper end of their range using the AREF pin and the analog Reference () function. Additionally, some pins have specialized functionality:
- **TWI**: A4 or SDA pin and A5 or SCL pin. Support TWI communication using the Wire library. There are a couple of other pins on the board:
- **AREF**. Reference voltage for the analog inputs. Used with analog Reference .
- Reset. Bring this line LOW to reset the microcontroller. Typically used to add a reset button to shields which block the one on the board. See also the mapping between Arduino pins and ATmega328 ports. The mapping for the Atmega8, 168, and 328 is identical.

Communication:

The Arduino Uno has a number of facilities for communicating with a computer, another Arduino, or other microcontrollers. The ATmega328 provides UART TTL (5V) serial communication, which is available on digital pins 0 (RX) and 1 (TX). An ATmega16U2 on the board channels this serial communication over USB and appears as a virtual com port to software on the computer. The '16U2 firmware uses the standard USB COM drivers, and no external driver is needed. However, on Windows, a .inf file is required.

The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the Arduino board. The RX and TX LEDs on the board will flash when data is being transmitted via the USB-to-serial chip and USB connection to the computer (but not for serial communication on pins 0 and 1). A Software Serial library allows for serial communication on any of the Uno's digital pins. The ATmega328 also supports I2C (TWI) and SPI communication. The Arduino software includes a Wire library to simplify use of the I2C bus; see the documentation for details. For SPI communication, use the SPI library.

5.2 POWER SUPPLY:

The input to the circuit is applied from the regulated power supply. The a.c. input i.e., 230V from the mains supply is step down by the transformer to 12V and is fed to a rectifier. The output obtained from the rectifier is a pulsating d.c voltage. So, in order to get a pure d.c voltage, the output voltage from the rectifier is fed to a filter to remove any a.c components present even after rectification. Now, this voltage is given to a voltage regulator to obtain a pure constant dc voltage. A power supply is a crucial device that provides power to a device or system, converting input power from the grid or a battery to the required output voltage. It's essential to choose a power supply that matches the device's or system's voltage and current requirements. Different types of power supplies are available, including wall adapters.

ATX power supplies for desktop computers, and switching power supplies. When using a power supply, safety precautions should be taken, such as using the correct voltage, avoiding overheating, and handling the device with care.

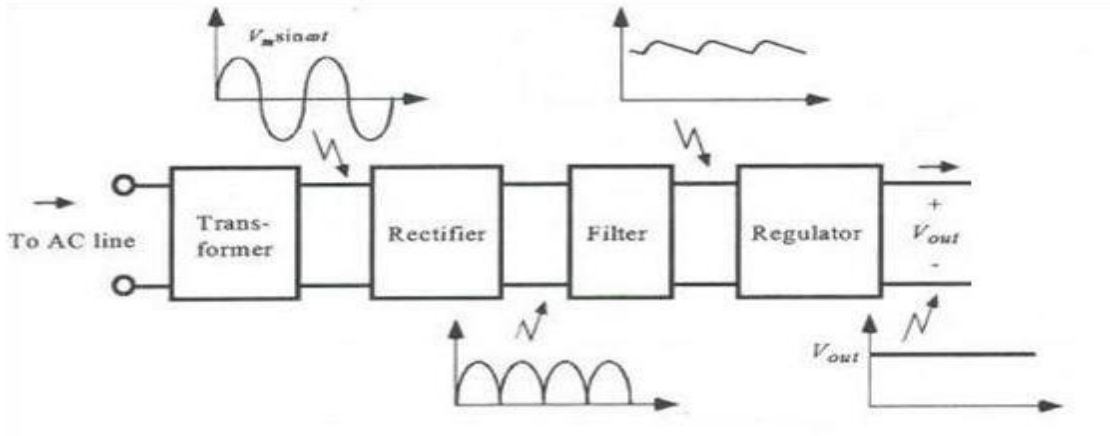

Fig 5.2: Block Diagram Of Power Supply

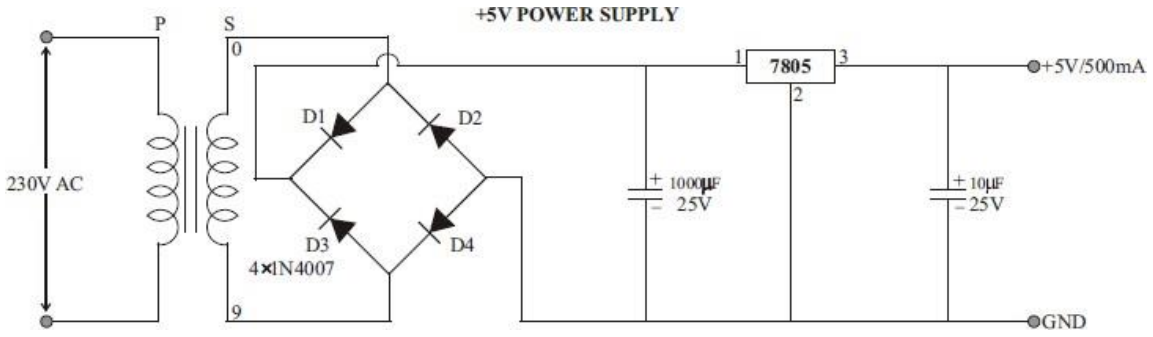

Fig 5.3: Circuit Diagram of Power supply

5.3 STEP DOWN TRANSFORMER:

A Stepdown Transformer is the one which reduces the output voltage that means it functions for converting high voltage with low current into a low voltage with high current. Usually, DC voltages are required to operate various electronic equipment and these voltages are 5V, 9V or 12V. But these voltages cannot be obtained directly. Thus, the a.c input available at the mains supply i.e., 230V is to be brought down to the required voltage level. This is done by a transformer. Thus, a stepdown transformer is employed to decrease the voltage to a required level. Depending on the different areas sometimes, voltages are stepped down to 230v or 440v for the safety reasons.

But to make this reduction in voltages a reality, the number of turns on secondary winding or coils is kept less than the primary winding or coils that ultimately result in less voltage being induced at the secondary output of the transformer.

5.4 RECTIFIER:

The output from the transformer is fed to the rectifier. It converts A.C. into pulsating D.C. The rectifier may be a half wave or a full wave rectifier. In this project, a bridge rectifier is used because of its merits like good stability and full wave rectification.
The process is known as , since it "straightens" the direction of current. Rectifiers have many uses, but are often found serving as components of DC power supplies and high voltage direct current power transmission systems. Depending on the type of alternating current supply and the arrangement of the rectifier circuit, the output voltage may require additional smoothing to produce a uniform steady voltage.

5.5 FILTER:

Capacitive filter is used in this project.In power supplies, capacitors are used to smooth (filter) the pulsating DC output after rectification so that a nearly constant DC voltage is supplied to the load. The pulsating output of the rectifiers has an average DC value and an AC portion that is called ripple voltage. Filter capacitors reduce the amount of ripple voltage to a level that is acceptable.In a filter circuit the capacitor is charged to the peak of the rectified input voltage during the positive portion of the input. When the input goes negative, the capacitor begins to discharge into the load. It removes the ripples from the output of rectifier and smoothens the D.C. Output received from this filter is constant until the mains voltage and load is maintained constant. However, if either of the two is varied, D.C. voltage received at this point changes. Therefore, a regulator is applied at the output stage.

5.6 VOLTAGE REGULATOR:

As the name itself implies, it regulates the input applied to it. A voltage regulator is an electrical regulator designed to automatically maintain a constant voltage level.The voltage regulator monitors the current drawn by the load and increases or decreases the voltage accordingly to keep the voltage level constant. A voltage regulator may use a simple feed-forward design or may include negative feedback. It may use an electromechanical mechanism, or electronic components. Depending on the design, it may be used to regulate one or more AC or DC voltages. In this project, power supply

of 5V and 12V are required. In order to obtain these voltage levels, 7805 and 7812 voltage regulators are to be used. The first number 78 represents positive supply and the numbers 05, 12 represent the required output voltage levels. The most popular type of voltage regulator IC is the *78XX* series, sometimes called the *LM78XX* series.

Features:

• Output Current up to 1A.

• Output Voltages of 5, 6, 8, 9, 10, 12, 15, 18, 24V.

• Thermal Overload Protection.

• Short Circuit Protection.

• Output Transistor Safe Operating Area Protection.

5.7 DHT SENSOR:

Humidity is the measure of water vapour present in the air. The level of humidity in air affects various physical, chemical and biological processes. In industrial applications, humidity can affect the business cost of the products, health and safety of the employees. So, in semi conductors industries and control system industries measurement of humidity is very important. Humidity measurement determines the amount of moisture present in the gas that can be a mixture of water vapour, nitrogen, argon or pure gas etc… Humidity sensors are of two types based on their measurement units. They are a relative humidity sensor and Absolute humidity sensor. DHT11 is a digital temperature and humidity sensor.

HT11 is a low-cost digital sensor for sensing temperature and humidity. This sensor can be easily interfaced with any micro-controller such as Arduino, Raspberry Pi etc… to measure humidity and temperature instantaneously.

5.8 WORKING:

DHT11 sensor consists of a capacitive humidity sensing element and a thermistor for sensing temperature. The humidity sensing capacitor has two electrodes with a moisture holding substrate as a dielectric between them. Change in the capacitance value occurs with the change in humidity levels. The IC measure, process this changed resistance values and change them into digital form. For measuring temperature this sensor uses a Negative Temperature coefficient thermistor, which causes a decrease in its resistance value with increase in temperature. To get larger resistance value even for the smallest change in temperature, this sensor is usually made up of semiconductor

ceramics or polymers. The temperature range of DHT11 is from 0 to 50 degree Celsius with a 2-degree accuracy. Humidity range of this sensor is from 20 to 80% with 5% accuracy. The sampling rate of this sensor is 1Hz.i.e. it gives one reading for every second. DHT11 is small in size with operating voltage from 3 to 5 volts. The maximum current used while measuring is 2.5mA.

The Smart Safety Monitoring System for Sewage Workers is designed to enhance the safety of sewage workers by continuously monitoring their health and environmental conditions while providing real-time two-way communication with supervisors. The system uses IoT sensors, wearable devices, and a central monitoring unit to detect hazards and alert both the worker and control room in emergencies. Wearable Safety Device for Workers Gas Sensors (H2S, CH4, CO, O2 levels) Detects toxic gases and oxygen deficiency. Heart Rate & Body Temperature Sensor Monitors worker's health (fatigue, heat stress). Fall Detection Sensor (Accelerometer/Gyroscope) Alerts if a worker collapses. GPS Tracking Provides real-time location. Water proof & Shockproof Design Suitable for harsh sewage environments. Two-Way Communication Module Bluetooth/Wi-Fi/LoRa/4G Connectivity Ensures communication even in underground sewage. Push-to-Talk (PTT) Button Allows instant voice communication with the control room. Speaker & Microphone Enables clear audio transmission. Central Monitoring System (Control Room) Real-Time Dashboard Displays worker vitals, gas levels, and location. Alerts & Notifications Sends SMS/app alerts in case of emergencies. Cloud Storage Logs data for analysis and compliance. Emergency Protocols Automatic SOS Trigger. If gas levels exceed safety limits or a fall is detected.

Evacuation Alarm Alerts nearby workers in case of danger rescue Coordination. Directs rescue teams using GPS data.

How It Works?

Step 1: Continuous Monitoring

- Sensors on the wearable device track gas levels, heart rate, and movement.
- Data is transmitted to the control room via LoRa/4G for underground areas.

Step 2: Hazard Detection & Alerts

If toxic gas (H2S/CH4) is detected, the system triggers:

Vibration & Audio Alarm on the worker's device.

Alert to Control Room with worker's location.

if heart rate spikes or a fall is detected, an SOS is sent automatically.

Step 3: Two-Way Communication

- Worker presses PTT button to communicate with supervisors.
- Control room can broadcast warnings to all workers in the area.

Step 4: Emergency Response

- Supervisors dispatch rescue teams using real-time GPS tracking.
- Historical data helps in post-incident analysis.

DHT11 sensor consists of a capacitive humidity sensing element and a thermistor for sensing temperature. The humidity sensing capacitor has two electrodes with a moisture holding substrate as a dielectric between them. Change in the capacitance value occurs with the change in humidity levels. The IC measure, process this changed resistance values and change them into digital form. For measuring temperature this sensor uses a Negative Temperature coefficient thermistor, which causes a decrease in its resistance value with increase in temperature. To get larger resistance value even for the smallest change in temperature, this sensor is usually made up of semiconductor ceramics or polymers. The temperature range of DHT11 is from 0 to 50 degree Celsius with a 2-degree accuracy. Humidity range of this sensor is from 20 to 80% with 5% accuracy. The sampling rate of this sensor is 1Hz.i.e. it gives one reading for every second. DHT11 is small in size with operating voltage from 3 to 5 volts. The maximum current used while measuring is 2.5mA.

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software includes a serial monitor which allows simple textual data to be sent to and from the Arduino board. The RX and TX LEDs on the board will flash when data is being transmitted via the USB-to-serial chip and USB connection to the computer (but not for serial communication on pins 0 and 1). A Software Serial library allows for serial communication on any of the Uno's digital pins. The ATmega328 also supports I2C (TWI) and SPI communication.

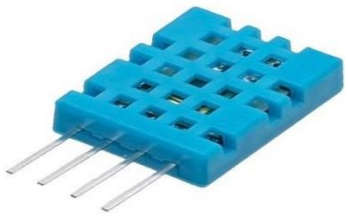

Fig 5.4: Capacitor

Applications

This sensor is used in various applications such as measuring humidity and temperature values in heating, ventilation and air conditioning systems. Weather stations also use these sensors to predict weather conditions. The humidity sensor is used as a preventive measure in homes where people are affected by humidity. Offices, cars, museums, greenhouses and industries use this sensor for measuring humidity values and as a safety measure.

5.9 GAS SENSOR:

A gas detector is a device that detects the presence of gases in an area, often as part of a safety system. A gas detector can sound an alarm to operators in the area where the leak is occurring, giving them the opportunity to leave. This type of device is important because there are many gases that can be harmful to organic life, such as humans or animals.

Gas leak detection is the process of identifying potentially hazardous gas by sensors. Additionally a visual identification can be done using a thermal camera These sensors usually employ an audible alarm to alert people when a dangerous gas has been detected. Exposure to toxic gases can also occur in operations such as painting, fumigation, fuel filling, construction, excavation of contaminated soils, landfill operations, entering confined spaces, etc. Common sensors include combustible gas sensors, photoionization detector sensors (MOS sensors). More recently, infrared

imaging sensors have come into use. All of these sensors are used for a wide range of applications and can be found in industrial plants, refineries, pharmaceutical manufacturing, fumigation facilities, paper pulp mills, aircraft and shipbuilding facilities, hazmat operations, waste-water treatment facilities, vehicles, indoor air quality testing and homes.

Fig 5.5: Gas Sensor

5.10 PULSE SENSOR

Heartbeat. Monitoring body temperature, heart rate and blood pressure are the basic things that we do in order to keep us healthy. n order to measure the body temperature, we use thermometers and a sphygmomanometer to monitor the Arterial Pressure or Blood Pressure. Heart Rate can be monitored in two ways: one way is to manually check the pulse either at wrists or neck and the other way is to use a Heartbeat Sensor. In this project, we have designed a Heart Rate Monitor System using Arduino and Heartbeat Sensor. You can find the Principle of Heartbeat Sensor, working of the Heartbeat Sensor and Arduino based Heart Rate Monitoring System using a practical heart beat Sensor.

5.11 INTRODUCTION TO HEARTBEAT SENSOR

Monitoring heart rate is very important for athletes, patients as it determines the condition of the heart (just heart rate). There are many ways to measure heart rate and the most precise one is using an Electro cardiography. But the more easy way to monitor the heart rate is to use a Heartbeat Sensor. It comes in different shapes and sizes and allows an instant way to measure the heartbeat.

Heartbeat Sensors are available in Wrist Watches (Smart Watches), Smart Phones, chest straps, etc. The heartbeat is measured in beats per minute or bpm, which indicates the number of times the heart is contracting or expanding in a minute. Monitoring heart rate is very important for athletes, patients as it determines the condition of the heart (just heart rate). There are many ways to measure heart rate and the most precise one is using

an Electro cardiography. But the more easy way to monitor the heart rate is to use a Heartbeat Sensor. It comes in different shapes and sizes and allows an instant way to measure the heartbeat.

Fig 5.6: Principle of Heartbeat Sensor

The principle behind the working of the Heartbeat Sensor is Photplethysmo graph. According to this principle, the changes in the volume of blood in an organ is measured by the changes in the intensity of the light passing through that organ. Usually, the source of light in a heartbeat sensor would be an IR LED and the detector would be any Photo Detector like a Photo Diode, an LDR (Light Dependent Resistor) or a Photo Transistor. With these two i.e. a light source and a detector, we can arrange them in two ways: A Transmissive Sensor and a Reflective Sensor. In a Transmissive Sensor, the light source and the detector are place facing each other and the finger of the person must be placed in between the transmitter and receiver. Reflective Sensor, on the other hand, has the light source and the detector adjacent to each other and the finger of the person must be placed in front of the sensor. Monitoring heart rate is very important for athletes, patients as it determines the condition of the heart (just heart rate). There are many ways to measure heart rate and the most precise one is using an Electro cardiography. But the more easy way to monitor the heart rate is to use a Heartbeat Sensor. It comes in different shapes and sizes and allows an instant way to measure the heartbeat.

5.12 Working Of Heartbeat Sensor

A simple Heartbeat Sensor consists of a sensor and a control circuit. The sensor part of the Heartbeat Sensor consists of an IR LED and a Photo Diode placed in a clip. The Control Circuit consists of an Op-Amp IC and few other components that help in

connecting the signal to a Microcontroller. The working of the Heartbeat Sensor can be understood better if we take a look at its circuit diagram.

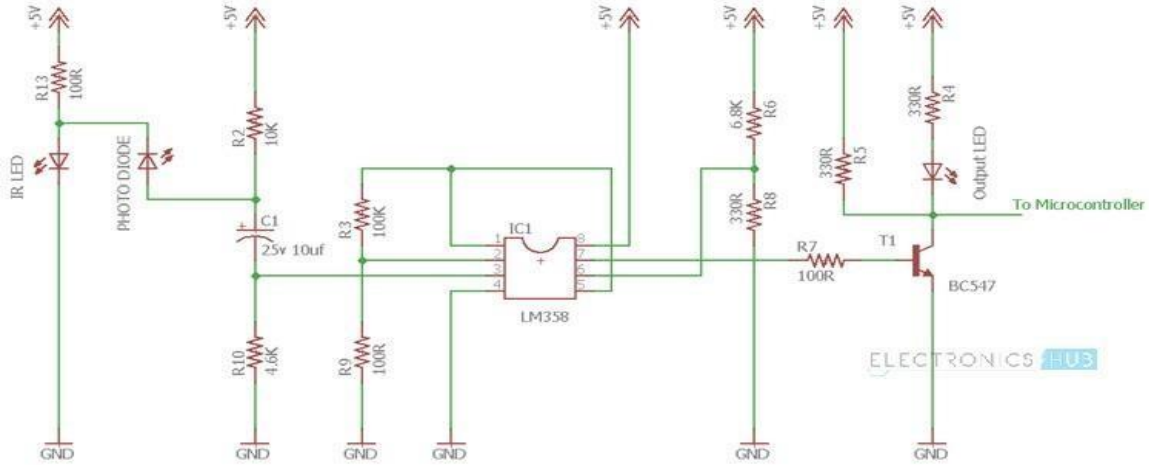

Fig 5.7: Working Of Heat Beat

The above circuit shows the finger type heartbeat sensor, which works by detecting the pulses. Every heartbeat will alter the amount of blood in the finger and the light from the IR LED passing through the finger and thus detected by the Photo Diode will also vary. The output of the photo diode is given to the non inverting input of the first op amp through a capacitor, which blocks the DC Components of the signal. The first op amp cats as a non -inverting amplifier with an amplification factor of 1001. The output of the first op amp is given as one of the inputs to the second op amp, which acts as a comparator. The output of the second op amp triggers a transistor, from which, the signal is given to a Microcontroller like Arduino. The Op amp used in this circuit is LM358. It has two op amps on the same chip. Also, the transistor used is a BC547. An LED, which is connected to transistor, will blink when the pulse is detected.

5.13 WIFI

A wireless network uses radio waves, just like cell phones, televisions and radios do. In fact, communication across a wireless network is a lot like two-way radio communication.

Here's what happens:

A computer's wireless adapter translates data into a radio signal and transmits it using an antenna. A wireless router receives the signal and decodes it. The router sends the information to the Internet using a physical, wired Ethernet connection.

The process also works in reverse, with the router receiving information from the Internet, translating it into a radio signal and sending it to the computer's wireless adapter. The radios used for Wi-Fi communication are very similar to the radios used for walkie-talkies, cell phones and other devices. They can transmit and receive radio waves, and they can convert 1s and 0s into radio waves and convert the radio waves back into 1s and 0s. But Wi-Fi radios have a few notable differences from other radios: They transmit at frequencies of 2.4 GHz or 5 GHz. This frequency is considerably higher than the frequencies used for cell phones, walkie-talkies and televisions. The higher frequency allows the signal to carry more data.They use 802.11 networking standards

How does it work?

A small device known as a wireless transmitter, or hub, is required; this device receives information from the internet via your home broadband connection. This transmitter (often referred to as a Wireless Access Point, or WAP) then converts this information into radio waves and emits it, effectively creating a small, local area around itself, within which your devices can receive these radio signals if they are fitted with the correct kind of wireless adapter. This area is often termed a Wireless Local Area Network, or WLAN for short. The radio signals aren’t very strong, which is why the Wi-Fi signal doesn’t travel very far; it will travel far enough to cover throughout the average home and to the street directly outside, for example, but not much further.

802.11 systems and bands:

There are several different 802.11 variants in use. Different 802.11 variants use different bands. A summary of the bands used by the 802.11 systems is given below:

IEEE 802.11 VARIANT	FREQUENCY BANDS USED	COMMENTS
802.11a	**5GHz**	**Read more about** 802.11a
802.11b	**2.4GHz**	**Read more about** 802.11b
802.11g	**2.4GHz**	**Read more about** 802.11g
802.11n	**2.4 & 5 GHz**	**Read more about** 802.11n
802.11ac	**Below 6GHz**	**Read more about** 802.11ac
802.11ad	**Up to 60 GHz**	**Read more about** 802.11ad
802.11af	**TV white space (below 1 GHz)**	**Read more about** 802.11af
802.11ah	**700 MHz, 860MHz, 902 MHz, etc. ISM bands dependent upon country and allocations**	**Read more about** 802.11ah

Table 1: Frequency Bands

How Wi-Fi Networks Works

Wi-Fi networks have no physical wired connection between sender and receiver by using radio frequency (RF) technology -- a frequency within the electromagnetic spectrum associated with radio wave propagation. When an RF current is supplied to an antenna, an electromagnetic field is created that then is able to propagate through space.

Fig 5.8: wifi

The cornerstone of any wireless network is an access point (AP). The primary job of an access point is to broadcast a wireless signal that computers can detect and "tune" into. In order to connect to an access point and join a wireless network, computers and devices must be equipped with wireless network adapters.

The Wi-Fi Alliance

The Wi-Fi Alliance, the organization that owns the Wi-Fi registered trademark term specifically defines Wi-Fi as any "wireless local area network (WLAN) products that are based on the Institute of Electrical and Electronics Engineers' (IEEE) 802.11 standards."

Initially, Wi-Fi was used in place of only the 2.4GHz 802.11b standard; however the Wi-Fi Alliance has expanded the generic use of the Wi-Fi term to include any type of network or wlan product based on any of the 802.11 standards, including 802.11b, 802.11a, dual-band and so on, in an attempt to stop confusion about wireless LAN interoperability.

Wi-Fi Support in Applications and Devices

Wi-Fi is supported by many applications and devices including video game consoles, home networks, PDAs, mobile phones, major operating systems, and other types

of consumer electronics. Any products that are tested and approved as "Wi-Fi Certified" (a registered trademark) by the Wi-Fi Alliance are certified as interoperable with each other, even if they are from different manufacturers. For example, a user with a Wi-Fi Certified product can use any brand of Acees point with any other brand of client hardware that also is also "Wi-Fi Certified".

5.14 SWITCHES

A switch is an electrical that can disconnect or connect the conducting path in an electrical current, interrupting the electrical or diverting it from one conductor to another. The most common type of switch is an electromechanical device consisting of one or more sets of movable electrical connected to external circuits. When a pair of contacts is touching current can pass between them, while when the contacts are separated no current can flow.

Switches are made in many different configurations; they may have multiple sets of contacts controlled by the same knob or actuator, and the contacts may operate simultaneously, sequentially, or alternately. A switch may be operated manually, for example, a light switching or a keyboard button, or may function as a sensing element to sense the position of a machine part, liquid level, pressure, or temperature, such as a Many specialized forms exist, such as the switch, and . A common use is control of lighting, where multiple switches may be wired into one circuit to allow convenient control of light fixtures. Switches in high-powered circuits must have special construction to prevent destructive arcing when they are opened.

The most familiar form of switch is a manually operated electromechanical device with one or more sets of which are connected to external circuits. Each set of contacts can be in one of two states: either "closed" meaning the contacts are touching and electricity can flow between them, or "open", meaning the contacts are separated and the switch is nonconducting. The mechanism actuating the transition between these two states (open or closed) are usually (there are other types of actions) either an "alternate action" (flip the switch for continuous "on" or "off") or "momentary" (push for "on" and release for "off") type.

A switch may be directly manipulated by a human as a control signal to a system, such as a computer keyboard button, or to control power flow in a circuit, such as

a light. Automatically operated switches can be used to control the motions of machines, for example, to indicate that a garage door has reached its full open position or that a machine tool is in a position to accept another workpiece. Switches may be operated by process variables such as pressure, temperature, flow, current, voltage, and force, acting as sensor in a process and used to automatically control a system. For example, a thermostat is a temperature-operated switch used to control a heating process. A switch that is operated by another electrical circuit is called a relay. Large switches may be remotely operated by a motor drive mechanism. Some switches are used to isolate electric power from a system, providing a visible point of isolation that can be padlocked if necessary to prevent accidental operation of a machine during maintenance, or to prevent electric shock.

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An ideal switch would have no voltage drop when closed, and would have no limits on voltage or current rating. It would have zero rise time and fall time during state changes, and would change state without "bouncing" between on and off positions. Practical switches fall short of this ideal; as the result of roughness and oxide films, they exhibit contact resistance, limits on the current and voltage they can handle, finite switching time, etc. The ideal switch is often used in circuit analysis as it greatly simplifies the system of equations to be solved, but this can lead to a less accurate solution. Theoretical treatment of the effects of non-ideal properties is required in the design of large networks of switches, as for example used in telephone exchanges.

CHAPTER 6

IOT

6.1 INTERNET OF THINGS-IOT:

The IOT concept was coined by a member of the Radio Frequency Identification (RFID) development community in 1999, and it has recently become more relevant to the practical world largely because of the growth of mobile devices, embedded and ubiquitous communication, cloud computing and data analytics. Imagine a world where billions of objects can sense, communicate and share information, all interconnected over public or private Internet Protocol (IP) networks. These interconnected objects have data regularly collected, analysed and used to initiate action, providing a wealth of intelligence for planning, management and decision making.

This is the world of the Internet of Things (IOT). Internet of things common definition is defining as: Internet of things (IOT) is a network of physical objects. The internet is not only a network of computers, but it has evolved into a network of device of all type and sizes , vehicles, smart phones, home appliances, toys, cameras, medical instruments and industrial systems, animals, people, buildings, all connected ,all communicating & sharing information based on stipulated protocols in order to achieve smart reorganizations, positioning, tracing, safe & control & even personal real time online monitoring , online upgrade, process control & administration We define IOT into three categories as below.

Fig 6.1: IOT

Internet of things is an internet of three things People to people, People to machine things, machine to things machine, Interacting through internet. Internet of Things Vision: Internet of Things (IoT) is a concept and a paradigm that considers pervasive

presence in the environment of a variety of things/objects that through wireless and wired connections and unique addressing schemes are able to interact with each other and cooperate with other things/objects to create new applications/services and reach common goals. In this context the research and development challenges to create a smart world are enormous. A world where the real, digital and the virtual are converging to create smart environments that make energy, transport, cities and many other areas more intelligent.

Internet of Things is refer to the general idea of things, especially everyday objects, that are readable, recognisable, locatable, addressable through information sensing device and/or controllable via the Internet, irrespective of the communication means (whether via RFID, wireless LAN, wide area networks, or other means). Everyday objects include not only the electronic devices we encounter or the products of higher technological development such as vehicles and equipment but things that we do not ordinarily think of as electronic at all - such as food , clothing ,chair, animal, tree, water etc.

Internet of Things is a new revolution of the Internet. Objects make themselves recognizable and they obtain intelligence by making or enabling context related decisions thanks to the fact that they can communicate information about themselves. They can access information that has been aggregated by other things, or they can be components of complex services. This transformation is concomitant with the emergence of cloud computing capabilities and the transition of the Internet towards IPv6 with an almost unlimited addressing capacity. The goal of the Internet of Things is to enable things to be connected anytime, anyplace, with anything and anyone ideally using any path/network and any service.

Many technological advancements have accelerated IoT. A few key advancements include the following: Sensors and actuators. Environmental changes such as temperature, humidity, light, motion or pressure is detected by sensors, while actuators cause physical changes such as opening a valve or turning on a motor. Connectivity and network protocols. The availability of a host of network protocols for the internet has made it easy to connect sensors to the cloud and to other devices, facilitating efficient data transfer. IoT employs a range of connectivity technologies, including WiFi, Bluetooth, cellular, Zigbee and LoRa WAN. Low cost and low power

sensor technology. More manufacturers now have access to IoT technology due to the availability of dependable and reasonably priced sensors. These sensors make it possible to gather data from the real world, which is then transferred to and analyzed in the digital domain. AI and NLP. Due to the developments in neural networks, IoT devices now feature natural language processing, which makes them appealing and useful for a wide range of uses, such as conversational AI assistants and digital personal assistants. IoT has evolved from the convergence of wireless technologies, microelectromechanical systems and microservices.

All these advancements have facilitated seamless connectivity and data exchange between devices and the cloud. What is the history and future outlook of IoT? Kevin Ashton, co-founder of the Auto-ID Center at the Massachusetts Institute of Technology (MIT), first mentioned the internet of things in a presentation he made in 1999 to Procter & Gamble (P&G). Wanting to bring radio frequency ID to the attention of P&G's senior management, Ashton called his presentation "Internet of Things" to incorporate the cool new trend of 1999: the internet. MIT professor Neil Gershenfeld's book, When Things Start to Think, also appeared in 1999. Although the book didn't use the exact term, it provided a clear vision of where IoT was headed. IoT has evolved from the convergence of wireless technologies, microelectromechanical systems, microservices and the internet. This convergence helped tear down the silos between operational technology and information technology, enabling unstructured machine-generated data to be analyzed for insights to drive improvements.

Although Ashton was the first to mention IoT, the idea of connected devices has been around since the 1970s, under the monikers embedded internet and pervasive computing. The first internet appliance, for example, was a Coke machine at Carnegie Mellon University in the early 1980s. This is the world of the Internet of Things (IOT). Internet of things common definition is defining as: Internet of things (IOT) is a network of physical objects. The internet is not only a network of computers, but it has evolved into a network of device of all type and sizes vehicles, smart phones, home appliances, toys, cameras, medical instruments and industrial systems, animals, people, buildings, all connected ,all communicating & sharing information based on stipulated protocols in order to achieve smart reorganizations, positioning, tracing, safe & control & even personal real time online monitoring , online upgrade, process control & administration We define IOT into three categories as below. Easy accessibility. IoT provides easy

access to information from anywhere at any time on any device. For example, IoT enhances the accessibility of information by providing real-time data and insights, intuitive interfaces and proactive alerts. Improves communication. IoT improves communication between connected electronic devices. It achieves this by enabling efficient data exchange, extending network reach, conserving energy and prioritizing critical communications. For example, if a motion sensor in a smart home ecosystem detects activity at the front door, it triggers a communication alert with the smart lighting system to turn on the outdoor lights. Saves time and money.

IoT enables the transfer of data packets over a connected network, which can save time and money. Predictive maintenance in industrial settings is another good example of this. IoT sensors installed on machinery continuously monitor parameters such as temperature, vibration and operating conditions in real-time. Data gathered from these sensors is analyzed using machine learning algorithms to detect patterns that show potential flaws or degradation in performance which helps in saving both time and money. Optimizes supply chain. IoT data can be used to optimize supply chain and inventory management processes, enabling manufacturers to reduce costs and enhance customer satisfaction. By tracking goods and materials in real-time, manufacturers can keep track of low stock, reduce excess inventory and streamline logistics operations. Improves efficiency.

IoT analyzes data at the edge, reducing the amount of data that needs to be sent to the cloud. Edge computing enables physical devices to communicate more efficiently by processing data locally and exchanging only relevant information with other devices or cloud services. Provides automation. IoT automates tasks to improve the quality of a business's services and reduces the need for human intervention. For example, in agriculture, IoT-enabled irrigation systems can automatically adjust watering schedules based on soil moisture levels, weather forecasts and crop requirements. Improves customer experience. IoT enables the development of personalized products and services tailored to individual preferences and needs. Smart home devices, wearable technology and personalized recommendations in retail are examples of how IoT enhances the customer experience. Provides flexibility. IoT options can be scaled according to changing needs of a business. Whether it's adding new devices, expanding operations or integrating with existing systems, IoT provides the flexibility to scale and evolve with business requirements. Enables better business decisions. IoT generates

vast amounts of data that can be analyzed to gain valuable insights into operations, consumer behavior and market trends. By harnessing and analyzing big data, businesses can make data-driven decisions, optimize processes and identify new revenue opportunities.

Internet of Things is refer to the general idea of things, especially everyday objects, that are readable, recognisable, locatable, addressable through information sensing device and/or controllable via the Internet, irrespective of the communication means (whether via RFID, wireless LAN, wide area networks, or other means). Everyday objects include not only the electronic devices we encounter or the products of higher technological development such as vehicles and equipment but things that we do not ordinarily think of as electronic at all - such as food , clothing ,chair, animal, tree, water etc.

The Internet of Things is not a single technology, but it is a mixture of different hardware & software technology. The Internet of Things provides solutions based on the integration of information technology, which refers to hardware and software used to store, retrieve, and process data and communications technology which includes electronic systems used for communication between individuals or groups. There is a heterogeneous mix of communication technologies, which need to be adapted in order to address the needs of IoT applications such as energy efficiency, speed, security, and reliability.

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6.2 ENABLING TECHNOLOGIES FOR IOT

Internet of things (IoT) is a global infrastructure for the information society, enabling advanced services by interconnecting (physical and virtual) things based on existing and evolving interoperable information and communication technologies. With the Internet of Things the communication is extended via Internet to all the things that surround us. These are considered as being the enabling technologies that make "Internet of Things" applications possible. Enabling technologies for the Internet of Things are considered in and can be grouped into three categories: technologies that enable "things" to acquire contextual information, technologies that enable "things" to process contextual information, and technologies to improve security and privacy. The first two categories can be jointly understood as functional building blocks required building "intelligence" into "things", which are indeed the features that differentiate the IoT from the usual Internet. The third category is not a functional but rather a de facto requirement, without which the penetration of the IoT would be severely reduced.

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6.3 CHARACTERISTICS

The fundamental characteristics of the IoT are as follows

Interconnectivity:

With regard to the IoT, anything can be interconnected with the global information and communication infrastructure.

Things-related services: The IoT is capable of providing thing-related services within the constraints of things, such as privacy protection and semantic consistency between physical things and their associated virtual things. In order to provide thing-related services within the constraints of things, both the technologies in physical world and information world will change.

Heterogeneity: The devices in the IoT are heterogeneous as based on different hardware platforms and networks. They can interact with other devices or service platforms through different networks.

Dynamic changes: The state of devices change dynamically, e.g., sleeping and waking up, connected and/or disconnected as well as the context of devices including location and speed. Moreover, the number of devices can change dynamically.

Enormous scale: The number of devices that need to be managed and that communicate with each other will be at least an order of magnitude larger than the devices connected to the current Internet. Even more critical will be the management of the data generated and their interpretation for application purposes. This relates to semantics of data, as well as efficient data handling.

Safety: As we gain benefits from the IoT, we must not forget about safety. As both the creators and recipients of the IoT, we must design for safety. This includes the safety of our personal data and the safety of our physical well-being. Securing the endpoints, the networks, and the data moving across all of it means creating a security paradigm that will scale.

Connectivity: Connectivity enables network accessibility and compatibility. Accessibility is getting on a network while compatibility provides the common ability to consume and produce data.

6.4 IOT ARCHITECTURE

IOT architecture consists of different layers of technologies supporting IOT. It serves to illustrate how various technologies relate to each other and to communicate the scalability, modularity and configuration of IOT deployments in different scenarios. Figure shows detailed architecture of IOT. The functionality of each layer is described below**.** smart device / sensor layer: The lowest layer is made up of smart objects integrated with sensors. The sensors enable the interconnection of the physical and digital worlds allowing real-time information to be collected and processed. There are various types of sensors for different purposes. The sensors have the capacity to take measurements such as temperature, air quality, speed, humidity, pressure, flow, movement and electricity etc. In some cases, they may also have a degree of memory, enabling them to record a certain number of measurements. A sensor can measure the physical property and convert it into signal that can be understood by an instrument. IOT architecture consists of different layers of technologies supporting IOT. It serves to illustrate how various technologies relate to each other and to communicate the scalability, modularity and configuration of IOT deployments in different scenarios. Figure shows detailed architecture of IOT.

Fig 6.2 IOT Architecture

Sensors are grouped according to their unique purpose such as environmental sensors, body sensors, home appliance sensors and vehicle telematics sensors, etc. Most sensors

require connectivity to the sensor gateways. This can be in the form of a Local Area Network (LAN) such as Ethernet and Wi-Fi connections or Personal Area Network (PAN) such as ZigBee, Bluetooth and Ultra Wideband (UWB). For sensors that do not require connectivity to sensor aggregators, their connectivity to backend servers/applications can be provided using Wide Area Network (WAN) such as GSM, GPRS and LTE. Sensors that use low power and low data rate connectivity, they typically form networks commonly known as wireless sensor networks (WSNs). WSNs are gaining popularity as they can accommodate far more sensor nodes while retaining adequate battery life and covering large areas. IOT architecture consists of different layers of technologies supporting IOT.

It serves to illustrate how various technologies relate to each other and to communicate the scalability, modularity and configuration of IOT deployments in different scenarios. Figure shows detailed architecture of IOT. The functionality of each layer is described below**.** smart device / sensor layer: The lowest layer is made up of smart objects integrated with sensors. The sensors enable the interconnection of the physical and digital worlds allowing real-time information to be collected and processed. There are various types of sensors for different purposes. The sensors have the capacity to take measurements such as temperature, air quality, speed, humidity, pressure, flow, movement and electricity etc. In some cases, they may also have a degree of memory, enabling them to record a certain number of measurements. A sensor can measure the physical property and convert it into signal that can be understood by an instrument. IOT architecture consists of different layers of technologies supporting IOT. It serves to illustrate how various technologies relate to each other and to communicate the scalability, modularity and configuration of IOT deployments in different scenarios. Figure shows detailed architecture of IOT. The Internet of Things concept refers to uniquely identifiable things with their virtual representations in an Internet-like structure and IoT solutions comprising a number of components such as : Module for interaction with local IoT devices. This module is responsible for acquisition of observations and their forwarding to remote servers for analysis and permanent storage. Module for local analysis and processing of observations acquired by IoT devices. Module for interaction with remote IoT devices, directly over the Internet. This module is responsible for acquisition of observations and their forwarding to remote servers for analysis and permanent storage. Module for application specific

data analysis and processing. This module is running on an application server serving all clients.

Gateways and Networks

Massive volume of data will be produced by these tiny sensors and this requires a robust and high performance wired or wireless network infrastructure as a transport medium. Current networks, often tied with very different protocols, have been used to support machine-to-machine (M2M) networks and their applications. With demand needed to serve a wider range of IOT services and applications such as high speed transactional services, context-aware applications, etc., multiple networks with various technologies and access protocols are needed to work with each other in a heterogeneous configuration. These networks can be in the form of a private, public or hybrid models and are built to support the communication requirements for latency, bandwidth or security. Various gateways (microcontroller, microprocessor...) & gateway networks (WI-FI, GSM, GPRS…) are shown in figure.

Management Service Layer

The management service renders the processing of information possible through analytics, security controls, process modelling and management of devices.

One of the important features of the management service layer is the business and process rule engines. IOT brings connection and interaction of objects and systems together providing information in the form of events or contextual data such as temperature of goods, current location and traffic data. Some of these events require filtering or routing to post processing systems such as capturing of periodic sensory data, while others require response to the immediate situations such as reacting to emergencies on patient's health conditions. The rule engines support the formulation of decision logics and trigger interactive and automated processes to enable a more responsive IOT system.

In the area of analytics, various analytics tools are used to extract relevant information from massive amount of raw data and to be processed at a much faster rate. Analytics such as in memory analytics allows large volumes of data to be cached in random access memory (RAM) rather than stored in physical disks. In-memory analytics reduces data query time and augments the speed of decision making. Streaming analytics is another form of analytics where analysis of data, considered as

data-in-motion, is required to be carried out in real time so that decisions can be made in a matter of seconds.

Data management is the ability to manage data information flow. With data management in the management service layer, information can be accessed, integrated and controlled. Higher layer applications can be shielded from the need to process unnecessary data and reduce the risk of privacy disclosure of the data source. Data filtering techniques such as data anonymisation, data integration and data synchronization, are used to hide the details of the information while providing only essential information that is usable for the relevant applications. With the use of data abstraction, information can be extracted to provide a common business view of data to gain greater agility and reuse across domains. Security must be enforced across the whole dimension of the IOT architecture right from the smart object layer all the way to the application layer. Security of the system prevents system hacking and compromises by unauthorized personnel, thus reducing the possibility of risks.

Application Layer

The IoT application covers "smart" environments/spaces in domains such as: Transportation, Building, City, Lifestyle, Retail, Agriculture, Factory, Supply chain, Emergency, Healthcare, User interaction, Culture and tourism, Environment and Energy.

6.5 IOT FUNCTIONAL VIEW

The Internet of Things concept refers to uniquely identifiable things with their virtual representations in an Internet-like structure and IoT solutions comprising a number of components such as : Module for interaction with local IoT devices. This module is responsible for acquisition of observations and their forwarding to remote servers for analysis and permanent storage. Module for local analysis and processing of observations acquired by IoT devices. Module for interaction with remote IoT devices, directly over the Internet. This module is responsible for acquisition of observations and their forwarding to remote servers for analysis and permanent storage. Module for application specific data analysis and processing. This module is running on an application server serving all clients.

It is taking requests from mobile and web clients and relevant IoT observations as input, executes appropriate data processing algorithms and generates output in terms of knowledge that is later presented to users. User interface (web or mobile): visual

representation of measurements in a given context (for example on a map) and interaction with the user, i.e. definition of user queries. The Internet of Things concept refers to uniquely identifiable things with their virtual representations in an Internet-like structure and IoT solutions comprising a number of components such as : Module for interaction with local IoT devices. This module is responsible for acquisition of observations and their forwarding to remote servers for analysis and permanent storage. Module for local analysis and processing of observations acquired by IoT devices. Module for interaction with remote IoT devices, directly over the Internet. This module is responsible for acquisition of observations and their forwarding to remote servers for analysis and permanent storage. Module for application specific data analysis and processing.

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6.6 FUTURE TECHNOLOGICAL DEVELOPMENTS FOR IOT.

The development of enabling technologies such as semiconductor electronics, communications, sensors, smart phones, embedded systems, cloud networking, network virtualization and software will be essential to allow physical devices to operate in changing environments & to be connected all the time everywhere.

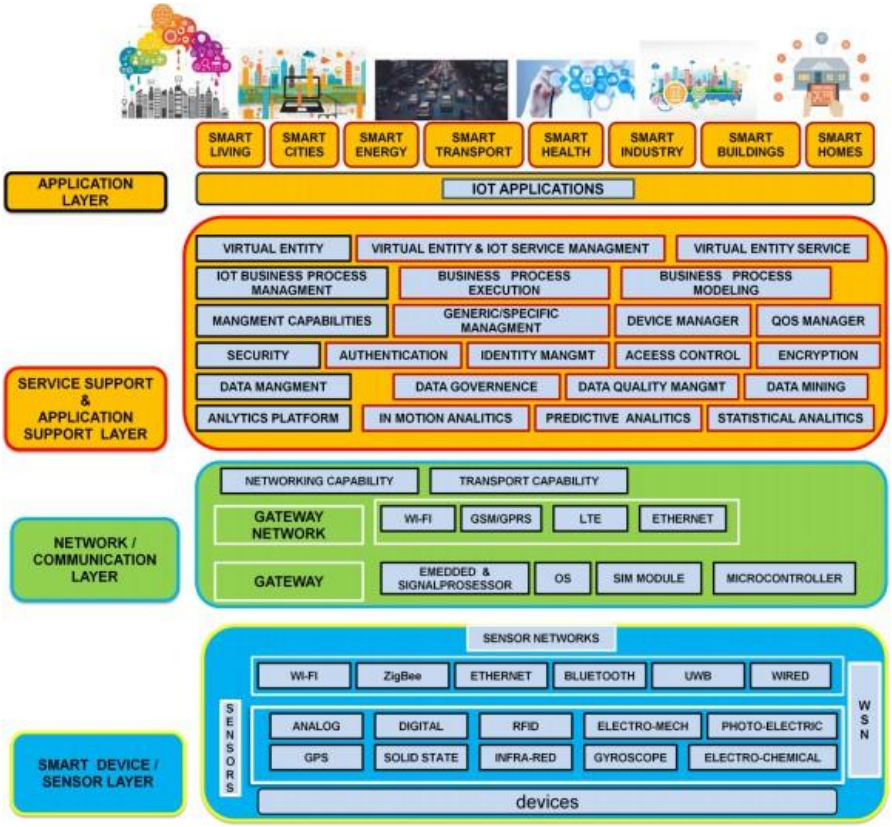

Fig 6.3: Technological Development IOT

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CHAPTER 7

SOFTWARE USED

7.1 PROGRAMMING ARDUINO

Once arduino IDE is installed on the computer, connect the board with computer using USB cable. Now open the arduino IDE and choose the correct board by selecting Tools>Boards>Arduino/Genuino Uno, and choose the correct Port by selecting Tools>Port. Arduino Uno is programmed using Arduino programming language based on Wiring. To get it started with Arduino Uno board and blink the built-in LED, load the example code by selecting Files>Examples>Basics>Blink. Once the example code (also shown below) is loaded into your IDE, click on the 'upload' button given on the top bar. Once the upload is finished, you should see the Arduino's built-in LED blinking. Below is the example code for blinking: Tools>Boards>Arduino/Genuino Uno, and choose the correct Port by selecting Tools>Port. Arduino Uno is programmed using Arduino programming language based on Wiring.

7.2 ARDUINO – INSTALLATION

After learning about the main parts of the Arduino UNO board, we are ready to learn how to set up the Arduino IDE. Once we learn this, we will be ready to upload our program on the Arduino board.

In this section, we will learn in easy steps, how to set up the Arduino IDE on our computer and prepare the board to receive the program via USB cable.

Step 1: First you must have your Arduino board (you can choose your favorite board) and a USB cable. In case you use Arduino UNO, Arduino Duemilanove, Nano, Arduino Mega 2560, or Diecimila, you will need a standard USB cable (A plug to B plug), the kind you would connect to a USB printer as shown in the following image.

Fig 7.1: USB Printer

In case you use Arduino Nano, you will need an A to Mini-B cable instead as shown in the following image

Fig 7.2: Mini Cable

Step 2: Download Arduino IDE Software.

You can get different versions of Arduino IDE from the Download page on the Arduino Official website. You must select your software, which is compatible with your operating system (Windows, IOS, or Linux). After your file download is complete, unzip the file.

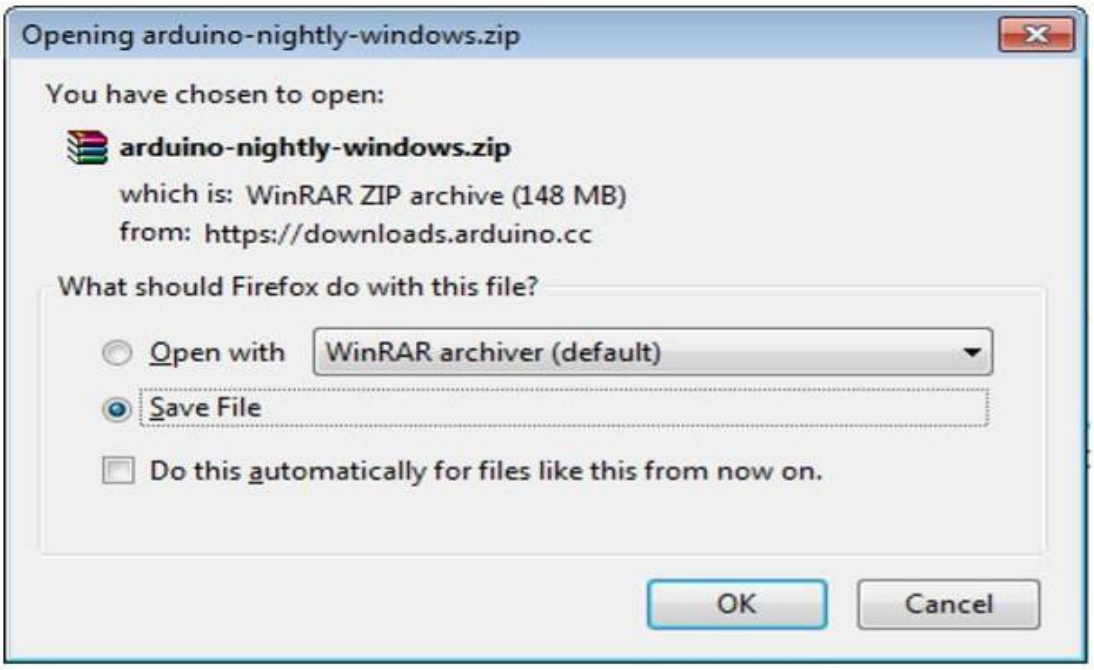


Fig 7.3 : Arduino Ide Software

Step 3: Power up your board.

The Arduino Uno, Mega, Duemilanove and Arduino Nano automatically draw power from either, the USB connection to the computer or an external power supply. If you are using an Arduino Diecimila, you have to make sure that the board is configured to draw power from the USB connection. The power source is selected with a jumper,

a small piece of plastic that fits onto two of the three pins between the USB and power jacks. Check that it is on the two pins closest to the USB port.

Connect the Arduino board to your computer using the USB cable. The green power LED (labeled PWR) should glow.

Step 4: Launch Arduino IDE.

After your Arduino IDE software is downloaded, you need to unzip the folder. Inside the folder, you can find the application icon with an infinity label (application.exe). Double click the icon to start the IDE

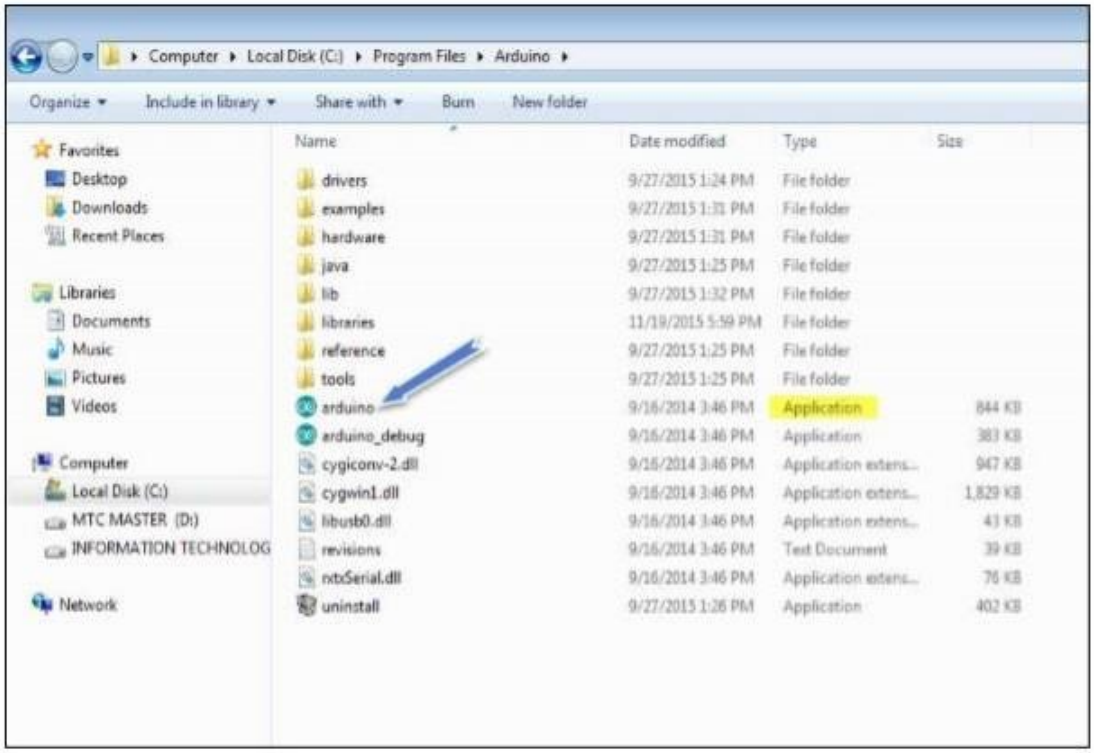


Fig 7.4: Arduino Folder

Step 5: Open your first project.

Once the software starts, you have two options:

- Create a new project.
- Open an existing project example.

To create a new project, select File --> New

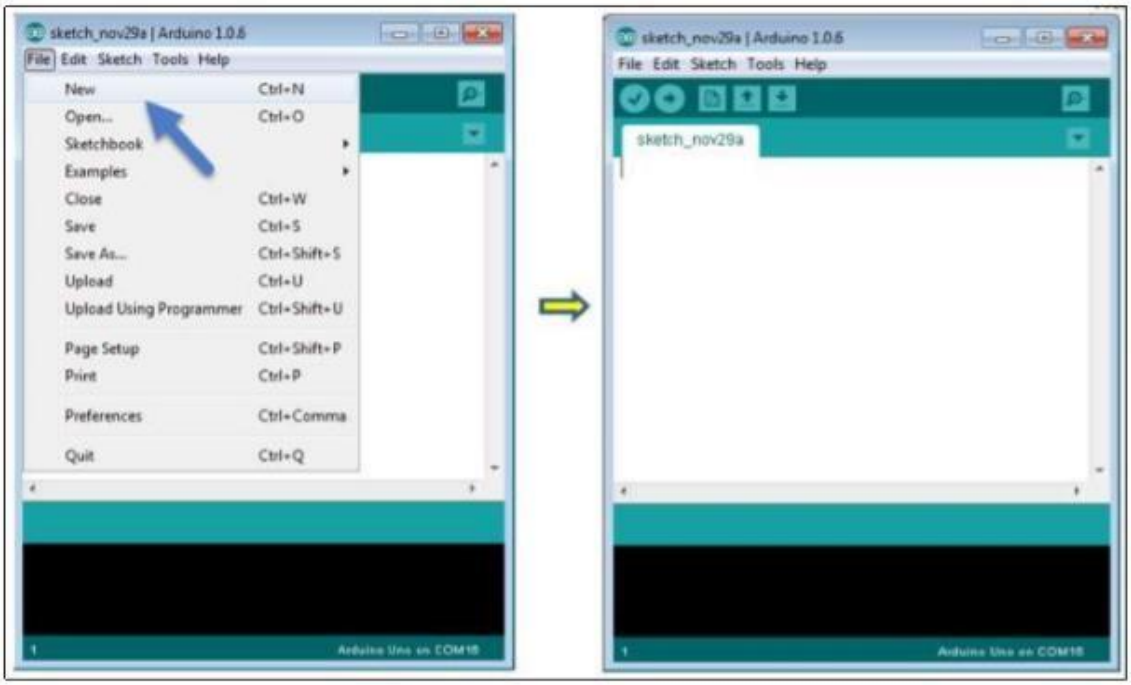


Fig 7.5: Open Your Project

To open an existing project example, select File -> Example -> Basics -> Blink**.**

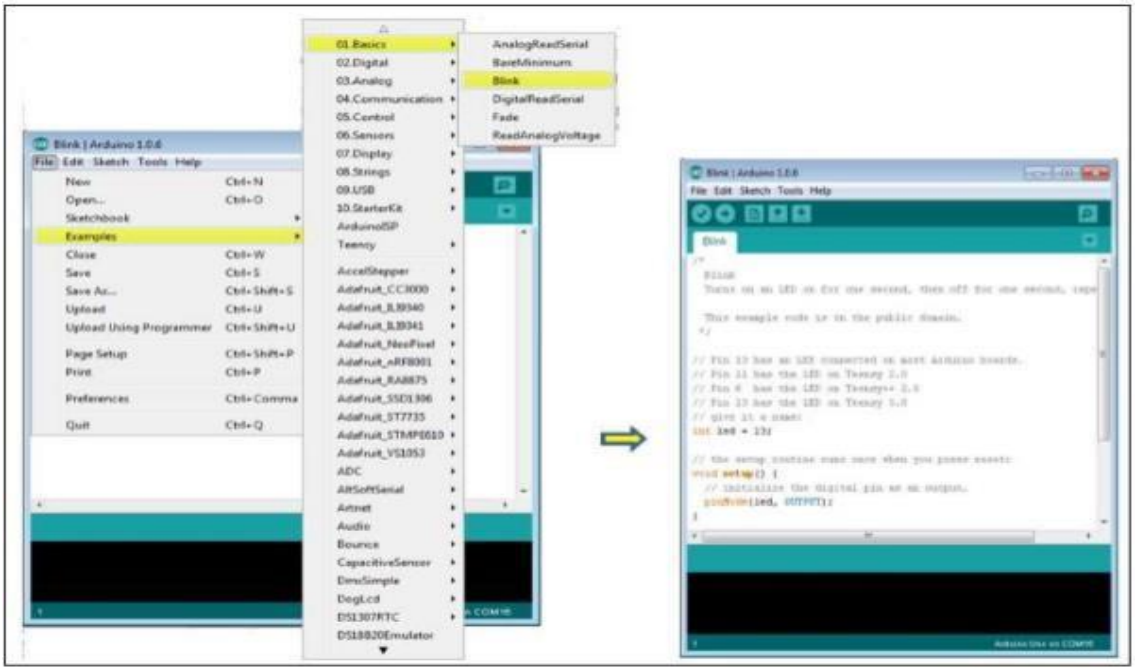


Fig 7.6 Basic File Open

Here, we are selecting just one of the examples with the name Blink. It turns the LED on and off with some time delay. You can select any other example from the list.

Step 6: Select your Arduino board.

To avoid any error while uploading your program to the board, you must select the correct Arduino board name, which matches with the board connected to your computer.

Go to Tools -> Board and select your board.

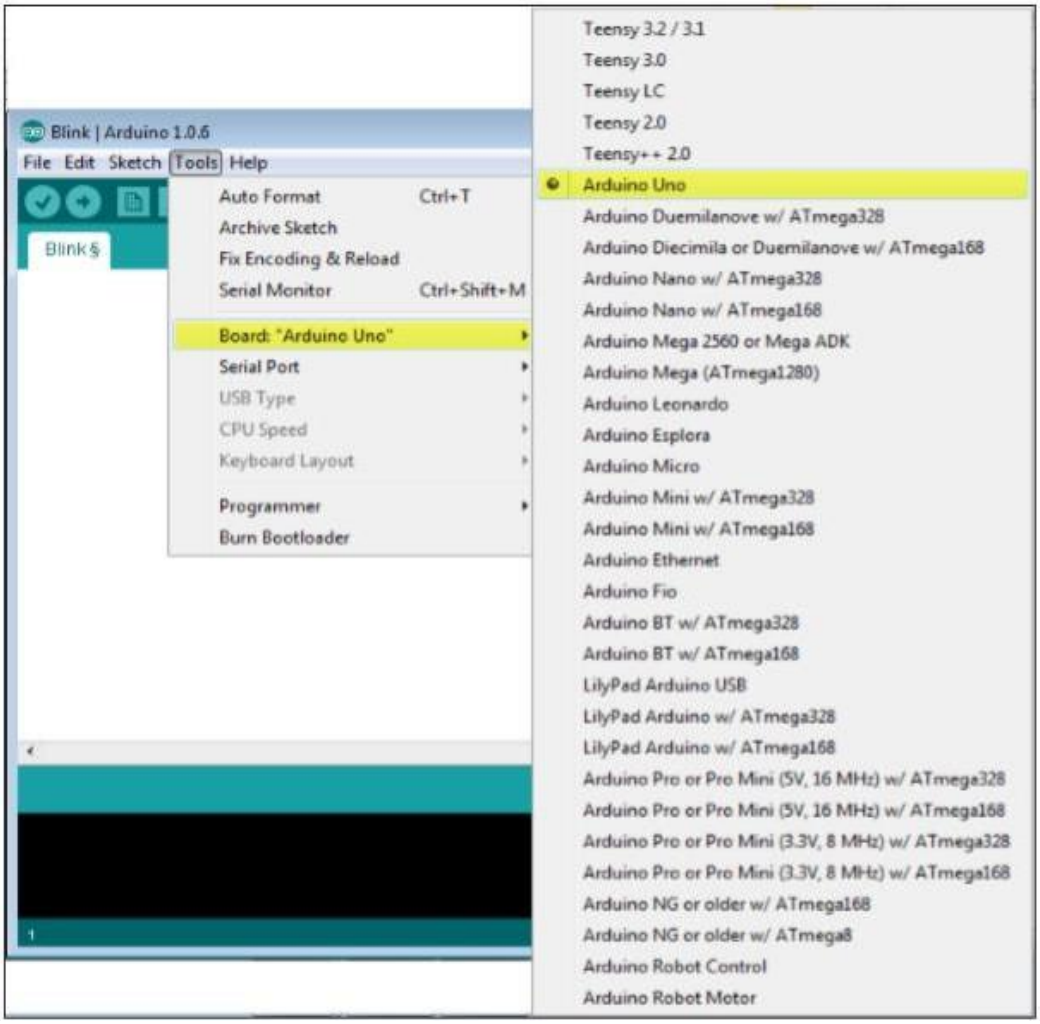


Fig 7.7: Arduino Board

Here, we have selected Arduino Uno board according to our tutorial, but you must select the name matching the board that you are using.

Step 7: Select your serial port.

Select the serial device of the Arduino board. Go to Tools -> Serial Port menu. This is likely to be COM3 or higher (COM1 and COM2 are usually reserved for hardware serial ports). To find out, you can disconnect your Arduino board and re-open the menu, the entry that disappears should be of the Arduino board. Reconnect the board and select that serial port.

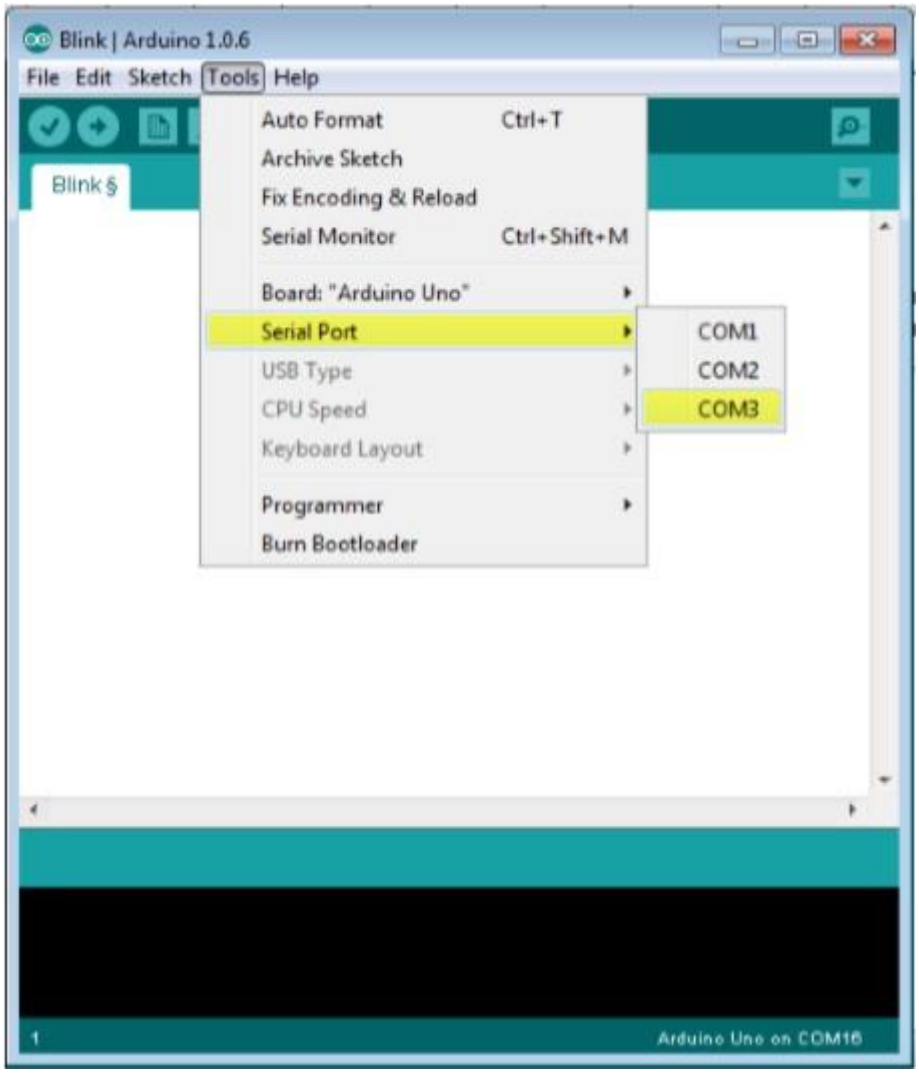


Fig 7.8: Serial Port

Step 8: Upload the program to your board.

Before explaining how we can upload our program to the board, we must demonstrate the function of each symbol appearing in the Arduino IDE toolbar

A- Used to check if there is any compilation error.

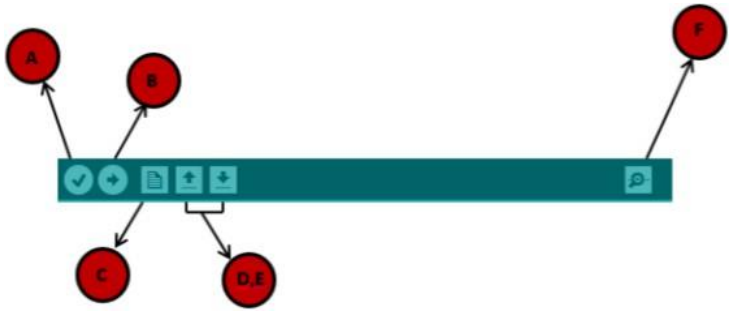
B- Used to upload a program to the Arduino board.

C- Shortcut used to create a new sketch.

D- Used to directly open one of the example sketch.

E- Used to save your sketch.

F- Serial monitor used to receive serial data from the board and send the serial data to the board.



Now, simply click the "Upload" button in the environment. Wait a few seconds; you will see the RX and TX LEDs on the board, flashing. If the upload is successful, the message "Done uploading" will appear in the status bar.

Note: If you have an Arduino Mini, NG, or other board, you need to press the reset button physically on the board, immediately before clicking the upload button on the Arduino Software.

7.3 ARDUINO – PROGRAM STRUCTURE

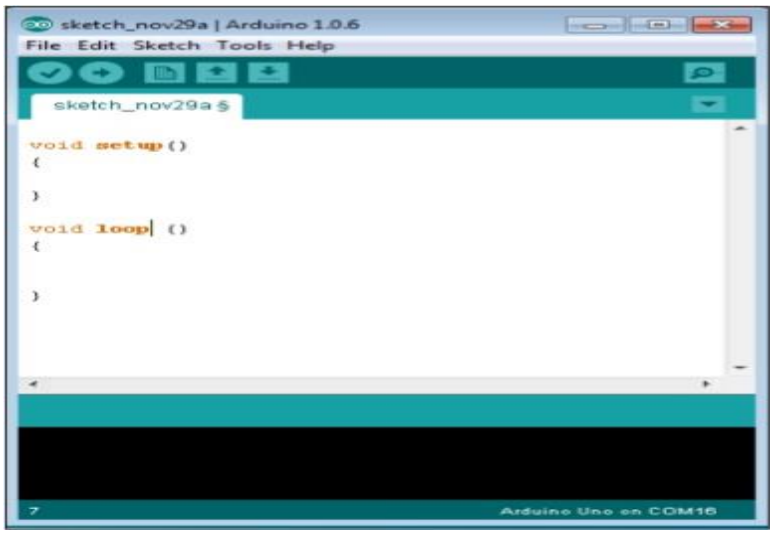
we will study in depth, the Arduino program structure and we will learn more new terminologies used in the Arduino world. The Arduino software is open-source. The source code for the Java environment is released under the GPL and the C/C++ microcontroller libraries are under the LGPL.

Sketch: The first new terminology is the Arduino program called “sketch”.

Structure Arduino programs can be divided in three main parts: Structure, Values (variables and constants), and Functions. In this tutorial, we will learn about the Arduino software program, step by step, and how we can write the program without any syntax or compilation error. Let us start with the Structure. Software structure consist of two main functions:

Setup( ) function

Loop( ) function




```
Void setup ( )
{

}
```

PURPOSE: The setup() function is called when a sketch starts. Use it to initialize the variables, pin modes, start using libraries, etc. The setup function will only run once, after each power up or reset of the Arduino board.

INPUT: -

OUTPUT: -

RETURN:

```
Void Loop ( )
{

}
```

PURPOSE: After creating a setup() function, which initializes and sets the initial values, the loop() function does precisely what its name suggests, and loops consecutively, allowing your program to change and respond. Use it to actively control the Arduino board.

INPUT:

OUTPUT:

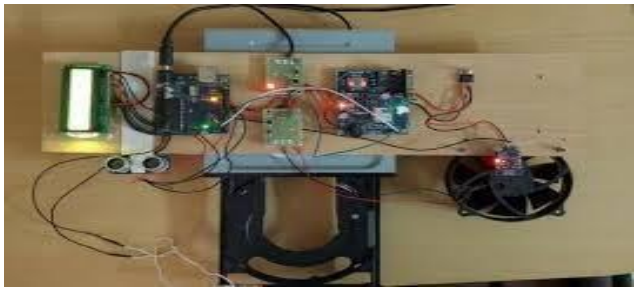
RETURN:

CHAPTER - 8

RESULTS

Internet of Things has gained its wide popularity in recent days due to its various streams of applications which has paved way for smooth, safe and easier mode of living style for human beings. Though, several techniques is existing for the same, yet sewage cleaning is one major concern and a challenge always. This paper thus put forth a new proposed system which is micro controller based application of sewage workers health monitoring systems using IOT. This device is designed keeping in mind, the measurement of necessary parameters, which needs to be monitored for unhindered safety of the workers. The device finds major application in household sewage systems, municipal manholes and sewage, sewer, deep well, gutters and drains etc.

However, the places where toxic gases or fumes are present should never be handled by human workers directly. In country like India where sewage is mostly cleaned by humans, which make this device useful around India. The proposed methodology helps to prevent the sudden accident of workers and also helps to keep the society clean. The smart safety device is cost wise less and fast in accessing the WSN and transfer the information to both the concerned department and emergency department. The proposed device helps the worker at a basic level of knowledge to understand the gas level and his pulse rate. The smart device can be implemented and used across the world and also helps to monitor the overflow of the sewage water.



CONCLUSION

A Smart Safety Monitoring System for Sewage Workers with Two-Way Communication is an innovative approach designed to enhance safety and productivity in hazardous work environments like sewage systems. The system involves multiple components that track real-time data, such as environmental

conditions, worker status, and safety equipment, with the added capability for workers to communicate with supervisors or emergency responders. The Smart Safety Monitoring System for Sewage Workers with Two-Way Communication offers several advantages, making it a highly beneficial solution for enhancing safety and efficiency in hazardous environments. Here are the key advantages:

1. Enhanced Worker Safety

Real-time Hazard Detection: Continuous monitoring for hazardous gases (like methane or hydrogen sulfide temperature extremes, and low oxygen levels provides early warnings, reducing the risk of exposure to dangerous conditions.

Health Monitoring: Wearable devices track vital signs like heart rate, body temperature, and fatigue levels, alerting supervisors if a worker shows signs of distress or health risks. Immediate Emergency Alerts: The system can trigger alarms and notify emergency responders instantly in case of a safety breach, ensuring a fast and effective response to incidents.

2. Improved Communication

Two-Way Communication: Workers can directly communicate with supervisors or emergency teams in real-time, enabling them to report issues or request assistance without delay.

Remote Supervision: Supervisors can monitor workers remotely, ensuring that safety protocols are followed, and can provide immediate instructions or guidance if necessary. Multiple Channels: Communication can happen via voice, text, or video, providing flexibility depending on the situation or urgency.

APPLICATIONS

1. Sewage and Wastewater Treatment Plants

Hazardous Gas Detection: Sewage workers are at risk of exposure to toxic gases like methane, hydrogen sulfide, and ammonia. The system continuously monitors these gases and alerts workers to potential dangers, enabling quick evacuation if necessary.

Confined Space Monitoring: Sewage systems often involve working in confined spaces, where oxygen levels and air quality may fluctuate. The system tracks these environmental parameters and sends alerts if conditions become unsafe.

Real-Time Communication: Workers can communicate directly with supervisors in real-time, ensuring immediate help in emergencies or when advice is needed about a specific task or situation.

2. Construction and Underground Utilities

Underground Safety Monitoring: In construction sites or utility work, workers often operate in tunnels, trenches, and underground settings where environmental conditions can change rapidly. The system ensures air quality is monitored, and workers' health is checked, reducing the risks of asphyxiation, accidents, or health problems.

Worker Location Tracking: In vast and complex underground networks, real-time tracking ensures that workers' locations are always known, which is critical in case of an emergency or a need for evacuation.

FUTURE SCOPE

Integration with Artificial Intelligence (AI) and Machine Learning (ML) Predictive Analytics: Future systems will leverage AI and machine learning to analyze the vast amounts of data collected from sensors, wearables, and environmental monitors. This data can be used to predict potential safety hazards before they occur, based on trends and patterns.

AI-Based Decision Making: AI algorithms can help supervisors make real-time decisions, such as identifying when a worker may be at risk of health problems (e.g., fatigue, dehydration) and suggesting preventive measures automatically.

Risk Assessment: Machine learning can assess risk factors based on historical data, weather conditions, and other variables, allowing the system to predict and mitigate dangers more effectively. Integration with Augmented Reality (AR) and Virtual Reality (VR) AR for On-Site Assistance: AR glasses or helmets could provide real-time visual instructions to workers, guiding them through complex procedures and offering real-time.

REFERENCES

1. Chang A.Y, Chang-Sung Yu, Sheng-ZhiXin Lin-Yih Chang, Pei-Chi Ho, 'Search, Identification and Positioning of the Underground Manhole with RFID Ground Tag' INC, IMS and IDC, 2009. NCM '09. Fifth International Joint Conference on vol no. pp.1899, 1903 25-27 Aug.2009.

2. M. Maroti, B. Kusy, G. Simon, and A. Ledeczi, "The flooding time synchronization protocol," in Proc. ACM SenSys'04, Baltimore, MD, November 2004.

3. Wemer Allen, G., Johnson, J., Ruize, M., Less, J., and Welsh, Matt 'Monitoring Volcanic Eruptions with a Wireless sensor Network'. Proceedings of 2nd European Workshop on Wireless Sensor Network, 2005.

4. ZigBee Alliance, "Understanding ZigBee gateway", ZigBee Document 095465r13, September 2010.

5. Yuwat, C. and Kilaso, S. A Wireless Sensor Network for Weather and Disaster Alarm System" ,Proceedings of International Conference on Information and Electronics Engineering, Vol. 6, Singapore. Pp 1 – 5, 2011.

6. Morias, R., Valente, A., Serodo, C. "A Wireless Sensor Network for Smart Irrigation and Environmental Monitoring. EFTA/WCCA Joint Congress on IT in Agriculture, Portugal, pp 845 – 850.

7. Windarto, J, Flood Early Warning System develop at Garang River Semarang using Information Technologybase on SMS and Web'. International Journal of Geomatics and Geosciences Vol. 1 No. 1, 2010.

8. Geoffrey Werner-Allen , Jeff Johnson , Mario Ruiz , Jonathan Lees , and Matt Welsh, 'Monitoring Volcanic Eruptions with a Wireless Sensor Network,' in Published in Proceedings of the Second European Workshop on 2005.

9. Ganeriwal, S., Kumar, R. and Srivastava, M. B. Timing-Sync Protocol for Sensor Networks. Proceedings of the 1st international conference on Embedded networked sensor systems, November 2003.

10. Hill, J., and Culler, D. Mica: A Wireless Platform for Deeply Embedded Networks. IEEE Micro archive, Volume 22, Issue 6, p. 12–24, November 2002.

11. Horauer, M, PSynUTC.' Evaluation of a High Precision Time Synchronization Prototype System for Ethernet LANs. 34th Annual Precise Time and Time Interval Meeting (PTTI), December 2002.

APPENDIX

Appendix-1: Introduction

1. Overview of the Smart Safety Monitoring System for sewage workers.
2. Importance of ensuring worker safety in hazardous environments.

Appendix-2: System Components

1. List of hardware and software components.
2. Sensors (Gas, Temperature, Humidity, etc.).
3. Microcontrollers and Communication Modules (GSM, Wi-Fi, Bluetooth).
4. Protective Gear Integration.

Appendix-3: Working Principle

1. Explanation of the system's working mechanism.
2. Detection of hazardous gases, temperature variations, and humidity.
3. Communication and alert mechanisms.

Appendix-4: Circuit Diagram & Block Diagram

1. Detailed circuit diagram representation.
2. Block diagram explaining the system’s connectivity and flow of information.

Appendix-5: Two-Way Communication Feature

1. Use of GSM/Wi-Fi/Bluetooth for worker communication.
2. Features enabling distress calls and emergency responses.