A MAJOR PROJECT REPORT

ON

AI HEALTHCARE MONITORING SYSTEM IN IOT CLOUD USING AWS

Submitted in the partial fulfilment of the requirements for the award of

BACHELOR OF TECHNOLOGY

IN

ELECTRONICS AND COMMUNICATION ENGINEERING

SUBMITTED BY

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UNDER THE ESTEEMED GUIDANCE OF

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Giving Wings To Thoughts

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

St.Peter's Engineering College (UGC Autonomous)

Approved by AICTE, New Delhi, Accredited by NBA and NAAC with 'A' Grade,

Affiliated to JNTU, Hyderabad, Telangana

2021-2025

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Student ID:CA/D1/6236

CERTIFICATE
OF COMPLETION

This Certificate Is Proudly Presented To

S Sai Vishwanath

Was an active Participant at CodeAlpha Virtual Internship Program in Full Stack Development Internship with dedication and hard work. We really appreciate your efforts taken and wish you all the best for the further.
15th December 2024 to 15th January 2025

SwatiSri
CEO & Founder

16th January 2025
Date of Issue

GOVERNMENT OF INDIA
MSME
MINISTRY OF MICRO, SMALL & MEDIUM ENTERPRISES

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CERTIFICATE

This is to certify that Major Project entitled **"AI HEALTHCARE MONITORING SYSTEM IN IOT CLOUD UISNG AWS"** is carried out by S SAI VISHWANATH (22BK5A0419) in partial fulfilment for the award of the degree of **Bachelor of Technology in ELECTRONICS AND COMMUNICATION ENGINEERING** is a record of bonafide work done by him/her under my supervision during the academic year "2024 – 2025".

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I sincerely express our deep sense of gratitude to **Dr. K. PRASANNA KUMAR,** for his valuable guidance, encouragement and cooperation during all phases of the project.

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INSTITUTE VISION

To be a renowned Educational Institution that moulds Students into Skilled Professionals fostering Technological Development, Research and Entrepreneurship meeting the societal needs.

INSTITUTE MISSION

IM1: Making students knowledgeable in the field of core and applied areas of Engineering to innovate Technological solutions to the problems in the Society.

IM2: Training the Students to impart the skills in cutting edge technologies, with the help of relevant stake holders.

IM3: Fostering conducive ambience that inculcates research attitude, identifying promising fields for entrepreneurship with ethical, moral and social responsibilities.

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

DEPARTMENT VISION

To evolve the department as a centre of excellence in Electronics and Communication Engineering education in the country, to train students in contemporary technologies to meet the needs of global industry and to develop them into skillful engineers imbued with knowledge of core as well as inter-disciplinary domains, human values, and professional ethics.

DEPARTMENT MISSION

DM1. To adopt pedagogical processes, facilities to meet the educational objectives and outcomes of emerging Technologies in the field of Electronics.

DM2. To prepare for higher education, employment, Intellectual professional attitude, Industrial research aptitude, lifelong learning, entrepreneurial practices, ethical values, and social concern.

DM3. To impart knowledge in the field of Electronics and its related areas with a focus on developing the required competencies and virtues to meet the requirements of society.

PROGRAM OUTCOMES (POs)

Engineering Graduates will be able to:

1: ENGINEERING KNOWLEDGE: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2: PROBLEM ANALYSIS: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using the first principles of mathematics, natural sciences, and engineering sciences.

3: DESIGN/DEVELOPMENT OF SOLUTIONS: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and the cultural, societal, and environmental considerations.

4: CONDUCT INVESTIGATIONS OF COMPLEX PROBLEMS: Use research-based knowledge and research methods including design of experiments, analysis, interpretation of data, and synthesis of the information to provide valid conclusions.

5: MODERN TOOL USAGE: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6: THE ENGINEER AND SOCIETY: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues, and the consequent responsibilities relevant to the professional engineering practice

7: ENVIRONMENT AND SUSTAINABILITY: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8: ETHICS: Apply ethical principles and commit to professional ethics and, responsibilities and norms of the engineering practice.

9: INDIVIDUAL AND TEAM WORK: Function effectively as an individual, and as a member or leader in diverse teams, and multidisciplinary settings.

10: COMMUNICATION: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and draft effective reports and design documentation, make an effective presentation, give, and receive clear instructions.

11: PROJECT MANAGEMENT AND FINANCE: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's work, as a member and leader in a team, to manage projects and in a multidisciplinary environment.

12: LIFE-LONG LEARNING: Recognize the need for, and have the preparation and ability to engage in independent and lifelong learning in the broadcast context of technological changes.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO1: Graduate shall have a solid foundation and in-depth knowledge in engineering science and technology for a successful career in Electronics & Communication Engineering.

PEO2: Graduates shall become effective collaboration/innovators in efforts to address social, technical, and engineering challenges with continuous learning.

PEO3: Graduates shall engage in professional development through self-study, post-graduation, and research.

PEO4: Graduates shall have integrity, professional and ethical values, team spirit and ethical values, team spirit, and effective communication skills.

PROGRAM SPECIFIC OBJECTIVES (PSOS)

PSO1: Ability to use electronic modern IT tools for the design and analysis of complex electronic systems for additional research activities.

PSO2: Should be able to clearly understand the concepts and applications in the field of communication/network signal processing, embedded systems, and semiconductor technology for excellent adaptability, good interpersonal skills with professional ethics and social responsibilities.

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

DECLARATION

We declare that Major Project entitled "**AI HEALTHCARE MONITORING SYSTEM IN IOT CLOUD USING AWS**" is an Original Work submitted by the following group members who have actively contributed and submitted in partial fulfilment for the award of degree in "Bachelor of Technology in ECE", at St. Peter's Engineering College, Hyderabad, and this project work has not been submitted by me to any other college or university for the award of any kind of degree.

Group No: B - 21

Program: B. Tech

Branch: ECE

Major Project Title: **AI HEALTHCARE MONITORING SYSTEM IN IOT CLOUD USING AWS**

Name	**Roll Number**	**Signature**
S SAI VISHWANATH	**22BK5A0419**	

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

Major Project Title: AI HEALTHCARE MONITORING SYSTEM IN IOT CLOUD USING AWS

Guide Name: Dr. K. PRASANNA KUMAR, M. Tech, Ph. D.

STUDENT	**ROLL NUMBER**
1. S SAI VISHWANATH	22BK5A0419

Academic Year: 2024-2025 (SEM-I)

Name of the course from which the principles are applied in the project	**Description of the Applications**	**Attained POs**
INTERNET OF THINGS	AI HEALTHCARE MONITORING SYSTEM IN IOT USING AWS	PO1, PO2, PO3, PO4, P06, PO7, PO9, PO10, PO11, PSO1, PSO2

SIGNATURE OF THE GUIDE HOD

MAPPING WITH PROGRAM OUTCOMES

S. No	PROGRAM OUTCOMES	JUSTIFICATIONS
PO1	Engineering Knowledge	This project applies core knowledge of mathematics, physics, embedded systems, sensor technology, and wireless communication to address a complex problem in swimmer safety. Knowledge from these domains enables the design of a reliable drowning detection and alert system.
PO2	Problem Analysis	Identifying and analysing the unique challenges in drowning detection, including recognizing distress signals, requires a deep understanding of engineering principles and sensor behaviour in aquatic environments. This analysis guides design choices to create an effective, real-time detection system.
PO3	Design/ development of solutions	The project involves designing a solution that considers public health and safety, including critical requirements for accuracy, reliability, and rapid alerting. It also takes into account the diverse environmental settings where the system may be deployed, such as pools, water parks, and private pools.
PO4	Conduct investigations of Complex problems	Researching effective algorithms for real-time sensor data processing and exploring ways to reduce false positives involves investigation and testing. Analysing sensor data and experimental results helps refine the system's effectiveness.
PO6	The Engineering and Society	This project addresses a critical societal need for improved aquatic safety, potentially saving lives by applying technology to an area of public health and safety. The system's design accounts for immediate response requirements, making it relevant to the well-being of swimmers.
PO7	Environment and Sustainability	By providing a proactive safety solution, this project contributes to the sustainable development of safer recreational facilities. Additionally, energy-efficient designs

		ensure the sustainability of the system's operation without significant environmental impact.
PO9	Individual and Team Work	Developing a system like this requires collaboration across multiple domains, such as embedded systems, data processing, and safety engineering. This project reinforces teamwork in multidisciplinary settings, as it involves specialists in electronics, software, and safety design.
PO10	Communication	Communicating the technical design, performance results, and safety implications of this system is essential for its adoption. Clear documentation, effective presentations, and feedback are crucial to ensuring that the system meets the needs of lifeguards, facility managers, and stakeholders.
PO11	Project Management and Finance	The project necessitates effective project management, including budgeting for components like sensors and microcontrollers, and managing timelines for prototyping and testing. Applying engineering management principles helps in successfully completing the project.

JUSTIFICATION OF PSO'S MAPPING

S.NO	PSO NUMBER	JUSTIFICATION
1	PSO1	Modern electrical components such as IoT-enabled sensors, cloud platforms, and machine learning algorithms, along with tools for real-time data analysis, have been effectively utilized for the design and analysis of the Smart Healthcare Monitoring System.
2	PSO2	The proposed project effectively leverages wireless communication for real-time data transmission, embedded systems for patient monitoring, and semiconductor-based sensors, mapping directly to PSO-2 objectives.

ABSTRACT

The Smart Healthcare Monitoring System is an innovative solution that harnesses the power of Internet of Things (IoT) and cloud technologies to transform patient monitoring and healthcare management. By integrating a network of IoT-enabled wearable devices and sensors, the system continuously collects real-time physiological data such as heart rate, blood pressure, oxygen levels, and body temperature. This data is then transmitted seamlessly to a cloud-based platform designed for storage, analysis, and visualization. Healthcare providers can access this critical information remotely, ensuring that they are able to monitor patients' health conditions without the need for constant physical presence. The system's design facilitates timely interventions, enabling healthcare professionals to make informed decisions and provide personalized care based on up-to-date, real-time data. Additionally, the system incorporates advanced machine learning algorithms that perform predictive analytics, allowing for the early detection of potential health issues and enhancing disease prevention strategies. This proactive approach helps to identify and mitigate risks before they develop into more serious conditions, ultimately improving patient outcomes. With real-time alerts that notify both patients and healthcare providers of any abnormalities or concerning trends, the system offers an extra layer of responsiveness and safety. Moreover, the platform ensures robust data security, safeguarding sensitive patient information from unauthorized access. Its scalability allows the system to grow and adapt to the needs of different healthcare settings, making it a flexible solution for healthcare providers. Through this project, healthcare accessibility is improved, response times are reduced, and patients are empowered with the tools they need to monitor their health more effectively, leading to an overall enhancement in the quality of care provided.

Keywords: IoT in healthcare, wearable devices, cloud computing, real-time health data, predictive analytics, remote patient care, healthcare innovation.

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CHAPTER-1

INTRODUCTION

In the recent years wireless technology has increasing for the need of upholding various sectors. In these recent years IoT grape the most of industrial area specially automation and control. Biomedical is one of recent trend to provide better health care. Not only in hospitals but also the personal health caring facilities are opened by the IoT technology. So having a smart system various parameters are observed that consumes power, cost and increase efficiency. In according to this smart system, this paper is reviewed.

In traditional method, doctors play an important role in health check-ups. For this process requires a lot of time for registration, appointment and then check-ups. Also reports are generated later. Due to this lengthy process working people tend to ignore the check-ups or postpone it. This modern approach reduces time consumption in the process. In the recent years use of wireless technology is increasing for the need of upholding various sectors. In these recent years IoT groped the most of industrial area specially automation and control. Biomedical is one of recent trends to provide better health care. Not only in hospitals but also the personal health care facilities are opened by the IoT technology. So having a smart system, various parameters are observed that consume power, cost and increase efficiency. In accordance with this smart system, this paper is reviewed. [3]

Medical scientists are trying in the field of innovation and research since many decades to get better health services and happiness in human lives. Their contribution in medical area is very important to us and cannot be neglected. Today’s automotive structures have the root ideas coming from yesterday’s basics. Also early detection of chronic diseases can be easy with these Technology. [4] The body temperature, heart rate, blood pressure, respiration rate are prime parameters to diagnose the disease. This project gives temperature and heart rate values using IoT.

1.1 Introduction of Embedded System

An Embedded System is a combination of computer hardware and software, and perhaps additional mechanical or other parts, designed to perform a specific function. A good example is the microwave oven. Almost every household has one, and tens of millions of them are used every day, but very few people realize that a processor and software are involved in the preparation of their lunch or dinner.

This is in direct contrast to the personal computer in the family room. It too is comprised of computer hardware and software and mechanical components (disk drives, for example). However, a personal computer is not designed to perform a specific function rather; it is able to do many different things. Many people use the term general-purpose computer to make this distinction clear. As shipped, a general-purpose computer is a blank slate; the manufacturer does not know what the customer will do wish it. One customer may use it for a network file server another may use it exclusively for playing games, and a third may use it to write the next great American novel.

Frequently, an embedded system is a component within some larger system. For example, modern cars and trucks contain many embedded systems. One embedded system controls the anti-lock brakes, other monitors and controls the vehicle's emissions, and a third displays information on the dashboard. In some cases, these embedded systems are connected by some sort of a communication network, but that is certainly not a requirement.

At the possible risk of confusing you, it is important to point out that a general-purpose computer is itself made up of numerous embedded systems. For example, my computer consists of a keyboard, mouse, video card, modem, hard drive, floppy drive, and sound card-each of Which is an embedded system? Each of these devices contains a processor and software and is designed to perform a specific function. For example, the modem is designed to send and receive digital data over analogue telephone line. That's it and all of the other devices can be summarized in a single sentence as well.

If an embedded system is designed well, the existence of the processor and software could be completely unnoticed by the user of the device. Such is the case for a microwave oven, VCR, or alarm clock. In some cases, it would even be possible to build an equivalent device that does not contain the processor and software. This could be done by replacing the combination with a custom integrated circuit that performs the same functions in hardware. However, a lot of flexibility is lost when a design is hard-cooled in this way. It is Mush Easier, and cheaper, to change a few lines of software than to redesign a piece of custom hardware.

1.2 History and Future

Given the definition of embedded systems earlier is this chapter; the first such systems could not possibly have appeared before 1971. That was the year Intel introduced the world's first microprocessor. This chip, the 4004, was designed for use in a line of business calculators produced by the Japanese Company Busicom. In 1969, Busicom asked Intel to design a set of custom integrated circuits-one for each of their new calculator models. The 4004 was Intel's response rather than design custom hardware for each calculator, Intel proposed a general-purpose circuit that could be used throughout the entire line of calculators. Intel's idea was that the software would give each calculator its unique set of features.

The microcontroller was an overnight success, and its use increased steadily over the next decade. Early embedded applications included unmanned space probes, computerized traffic lights, and aircraft flight control systems. In the 1980s, embedded systems quietly rode the waves of the microcomputer age and brought microprocessors into every part of our kitchens (bread machines, food processors, and microwave ovens), living rooms (televisions, stereos, and remote controls), and workplaces (fax machines, pagers, laser printers, cash registers, and credit card readers).

It seems inevitable-hat the number of embedded systems will continue to increase rapidly. Already there are promising new embedded devices that have enormous market potential; light switches and thermostats that can be central computer, intelligent air-bag systems that don't inflate when children or small adults are present, pal-sized electronic organizers and personal digital assistants (PDAs), digital cameras, and dashboard navigation systems. Clearly, individuals who possess the skills and desire to design the next generation of embedded systems will be in demand for quite some time.

1.3 Real Time Systems

One subclass of embedded is worthy of an introduction at this point. As commonly defined, a real-time system is a computer system that has timing constraints. In other words, a real-time system is partly specified in terms of its ability to make certain calculations or decisions in a timely manner. These important calculations are said to have deadlines for completion. And, for all practical purposes, a missed deadline is just as bad as a wrong answer.

The issue of what if a deadline is missed is a crucial one. For example, if the real-time system is part of an airplane's flight control system, it is possible for the lives of the passengers and crew to be endangered by a single missed deadline. However, if instead the system is involved in satellite communication, the damage could be limited to a single corrupt data packet. The more severe the consequences, the more likely it will be said that the deadline is "hard" and thus, the system is a Hard Real - Time system. Real-time systems at the other end of this discussion are said to have "soft" deadlines.

All of the topics and examples presented in this book are applicable to the designers of real-time system who is more delight in his work. He must guarantee reliable operation of the software and hardware under all the possible conditions and to the degree that human lives depend upon three system's proper execution, engineering calculations and descriptive paperwork.

Application Areas: Nearly 99 per cent of the processors manufactured end up in embedded systems. The embedded system market is one of the highest growth areas as these systems are used in very market segment- consumer electronics, office automation, Industrial Automation, Biomedical Engineering, Wireless Communication, Data communication, telecommunications, transportation, military and so on.

Consumer appliances: At home we use a number of embedded systems which include digital camera, digital diary, DVD player, electronic toys, microwave oven, remote controls for TV and air-conditioner, VCO player, video game consoles, video recorders etc. Today’s high-tech car has about 20 embedded systems for transmission control, engine spark control, air-conditioning, navigation etc. Even wristwatches are now becoming embedded systems. The palmtops are powerful embedded systems using which we can carry out many general-purpose tasks such as playing games and word processing.

Office automation: The office automation products using embedded systems are copying machine, fax machine, key telephone, modem, printer, scanner etc.

Industrial automation: Today a lot of industries use embedded systems for process control. These include pharmaceutical, cement, sugar, oil exploration, nuclear energy, electricity generation and transmission. The embedded systems for industrial use are designed to carry out specific tasks such as monitoring the temperature, pressure, humidity, voltage, current etc., and then take appropriate action based on the monitored levels to control other devices or to send information to a centralized monitoring station. In hazardous industrial environment, where human presence has to be avoided, robots are used, which are programmed to do specific jobs. The robots are now becoming very powerful and carry out many interesting and complicated tasks such as hardware assembly. They can now perform a wide range of complex and intricate operations, such as assembling delicate electronic components, welding heavy metal structures, and even conducting quality inspections with high accuracy. The ability of robots to operate tirelessly with minimal errors makes them indispensable in modern industrial automation, contributing to higher efficiency and improved product quality.

Medical electronics: Almost every medical equipment in the hospital is an embedded system. These Equipment include diagnostic aids such as ECG, EEG, blood pressure measuring devices, X-ray scanners; equipment used in blood analysis, radiation, colonoscopy, endoscopy etc. Developments in medical electronics have paved way for more accurate diagnosis of diseases.

Computer networking: Computer networking products such as bridges, routers, Integrated Services Digital Networks (ISDN), Asynchronous Transfer Mode (ATM), X.25 and frame relay switches are embedded systems which implement the necessary data communication protocols. For example, a router interconnects two networks. The two networks may be running different protocol stacks. The router’s function is to obtain the data packets from incoming pores, Analyse the packets and send them towards the destination after doing necessary protocol conversion. Most networking equipment, other than the end systems (desktop computers) we use to access the networks, are embedded systems.

Telecommunications: In the field of telecommunications, the embedded systems can be categorized as subscriber terminals and network equipment. The subscriber terminals such as key telephones, ISDN phones, terminal adapters, web cameras are embedded systems. The network equipment includes multiplexers, multiple access systems, Packet Assemblers Dissemblers (PADs), sate11ite modems etc. IP phone, IP gateway, IP gatekeeper etc. are the latest embedded systems that provide very low-cost voice communication over the Internet.

Wireless technologies: Advances in mobile communications are paving way for many interesting applications using embedded systems. The mobile phone is one of the marvels of the last decade of the 20’h century. It is a very powerful embedded system that provides voice communication while we are on the move. The Personal Digital

Assistants and the palmtops can now be used to access multimedia services over the Internet. Mobile communication infrastructure such as base station controllers, Mobile Switching Centre are also powerful embedded systems.

Insemination: Testing and measurement are the fundamental requirements in all scientific and engineering activities. The measuring equipment we use in laboratories to measure parameters such as weight, temperature, pressure, humidity, voltage, current etc. are all embedded systems. Test equipment such as oscilloscope, spectrum analyser, logic analyser, protocol analyser, radio communication test set etc. are embedded systems built around powerful processors. Thank to miniaturization, the test and measuring equipment are now becoming portable facilitating easy testing and measurement in the field by field-personnel.

Security: Security of persons and information has always been a major issue. We need to protect our homes and offices and also the information we transmit and store. Developing embedded systems for security applications is one of the most lucrative businesses nowadays. Security devices at homes, offices, airports etc. for authentication and verification are embedded systems. Encryption devices are nearly 99 per cent of the processors that are manufactured end up in~ embedded systems. Embedded systems find applications in. every industrial segment- consumer electronics, transportation, avionics, biomedical engineering, manufacturing, process control and industrial automation, data communication, telecommunication, defence, security etc. Used to encrypt the data/voice being transmitted on communication links such as telephone lines. Biometric systems using fingerprint and face recognition are now being extensively used for user authentication in banking applications as well as for access control in high security buildings.

Finance: Financial dealing through cash and cheques are now slowly paving way for transactions using smart cards and ATM (Automatic Teller Machine, also expanded as Any Time Money) machines. Smart card, of the size of a credit card, has a small micro-controller and memory; and it interacts with the smart card reader! ATM machine and acts as an electronic wallet. Smart card technology has the capability of ushering in a cashless society. Well, the list goes on. It is no exaggeration to say that eyes wherever you go, you can see, or at least feel, the work of an embedded system.

1.4 Overview of Embedded System Architecture

Every embedded system consists of custom-built hardware built around a Central Processing Unit (CPU). This hardware also contains memory chips onto which the software is loaded. The software residing on the memory chip is also called the ‘firmware’. The embedded system architecture can be represented as a layered architecture as shown in Fig.

The operating system runs above the hardware, and the application software runs above the operating system. The same architecture is applicable to any computer including a desktop computer. However, there are significant differences. It is not compulsory to have an operating system in every embedded system.

For small appliances such as remote controls units, air conditioners, toys etc., there is no need for an operating system and you can write only the software specific to that application. For applications involving complex processing, it is advisable to have an operating system. In such a case, you need to integrate the application software with the operating system and then transfer the entire software on to the memory chip. Once the software is transferred to the memory chip, the software will continue to run fora long time you don’t need to reload new software.

Now, let us see the details of the various building blocks of the hardware of an embedded system. As shown in Fig. the building blocks are:

- Central Processing Unit (CPU)
- Memory (Read-only memory) and (Random access memory)
- Input Devices
- Output devices
- Communication interfaces
- Application-specific circuitry

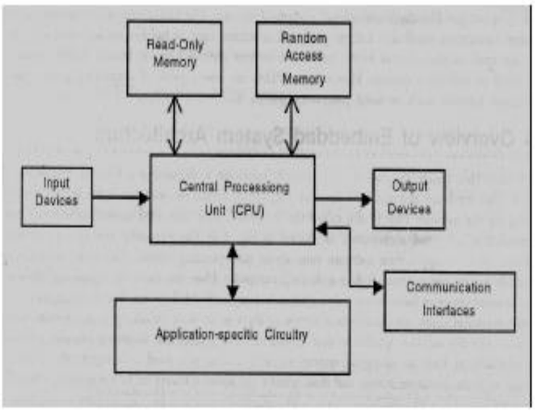


Fig 1.1 Blocks of hardware embedded system

Central Processing Unit (CPU):

The Central Processing Unit (processor, in short) can be any of the following: microcontroller, microprocessor or Digital Signal Processor (DSP). A micro-controller is a low-cost processor. Its main attraction is that on the chip itself, there will be many other components such as memory, serial communication interface, analog-to digital converter etc. So, for small applications, a micro-controller is the best choice as the number of external components required will be very less. On the other hand, microprocessors are more powerful, but you need to use many external components with them. D5P is used mainly for applications in which signal processing is involved such as audio and video processing.

Memory:

The memory is categorized as Random Access Memory (RAM) and Read Only Memory (ROM). The contents of the RAM will be erased if power is switched off to the chip, whereas ROM retains the contents even if the power is switched off. So, the firmware is stored in the ROM. When power is switched on, the processor reads the ROM; the program is program is executed. When power is switched on, the processor immediately accesses the ROM to read the stored firmware. This program contains fundamental instructions that guide the system through its startup process, initializing hardware peripherals and preparing the system for operation.

Input devices:

Unlike the desktops, the input devices to an embedded system have very limited capability. There will be no keyboard or a mouse, and hence interacting with the embedded system is no easy task. Many embedded systems will have a small keypad- you press one key to give a specific command. A keypad may be used to input only the digits. Many embedded systems used in process control do not have any input device for user interaction; they take inputs from sensors or transducers 1'fnd produce electrical signals that are in turn fed to other systems.

Output devices:

The output devices of the embedded systems also have very limited capability. Some embedded systems will have a few Light Emitting Diodes (LEDs) to indicate the health status of the system modules, or for visual indication of alarms. A small Liquid Crystal Display (LCD) may also be used to display some important parameters.

Communication interfaces:

The embedded systems may need to, interact with other embedded systems at they may have to transmit data to a desktop. To facilitate this, the embedded systems are provided with one or a few communication interfaces such as RS232, RS422, RS485, Universal Serial Bus (USB), IEEE 1394, Ethernet etc.

Application-specific circuitry:

Sensors, transducers, special processing and control circuitry may be required fat an embedded system, depending on its application. This circuitry interacts with the processor to carry out the necessary work. The entire hardware has to be given power supply either through the 230 volts main supply or through a battery. The hardware has to design in such a way that the power consumption is minimized.

CHAPTER-2

LITERATURE SURVEY

2.1 INTRODUCTION

The rapid advancement of technology has significantly transformed the healthcare landscape, particularly through the integration of Artificial Intelligence (AI), the Internet of Things (IoT), and cloud computing. The convergence of these technologies has led to the development of sophisticated healthcare monitoring systems that can provide real-time insights, enhance patient care, and optimize healthcare operations. This literature survey explores the current state of research and applications related to AI healthcare monitoring systems in IoT cloud environments, specifically utilizing Amazon Web Services (AWS).

1. IoT in Healthcare

The Internet of Things (IoT) refers to the interconnection of devices that can collect and exchange data. In healthcare, IoT devices such as wearables, smart sensors, and medical equipment enable continuous monitoring of patients' health metrics. Research by Kumar et al. (2020) highlights the potential of IoT in remote patient monitoring, emphasizing its role in chronic disease management and the reduction of hospital readmissions. For instance, wearable devices can track vital signs such as heart rate, blood pressure, and glucose levels, transmitting this data to healthcare providers in real-time. This capability allows for proactive management of patients' health, particularly for those with chronic conditions like diabetes and hypertension.

2. AI in Healthcare

Artificial Intelligence has emerged as a transformative force in healthcare, enabling predictive analytics, personalized medicine, and automated decision-making. Studies by Esteva et al. (2019) demonstrate the effectiveness of AI algorithms in diagnosing diseases from medical images, while Rajkomar et al. (2019) discuss the use of machine learning models to predict patient outcomes based on electronic health records (EHRs). The integration of AI with IoT devices enhances the capability to analyze vast amounts of data generated by these devices, leading to more informed clinical decisions. For example, AI can identify patterns in patient data that may not be immediately apparent to healthcare professionals, facilitating early diagnosis and intervention.

3. Cloud Computing in Healthcare

Cloud computing provides scalable and flexible resources for storing and processing healthcare data. AWS, as a leading cloud service provider, offers a range of services tailored for healthcare applications, including data storage, machine learning, and analytics. Research by Alhassan et al. (2021) highlights the advantages of using cloud platforms for healthcare data management, such as improved accessibility, cost-effectiveness, and enhanced collaboration among healthcare providers. The cloud enables healthcare organizations to store large volumes of data securely while ensuring that it is accessible to authorized personnel from various locations, thus supporting telemedicine and remote consultations.

4. AI Healthcare Monitoring Systems

AI healthcare monitoring systems leverage IoT devices and cloud computing to provide continuous health monitoring and data analysis. For instance, Zhang et al. (2021) developed a smart health monitoring system that utilizes wearable sensors to collect patient data, which is then analyzed using AI algorithms hosted on AWS. This system demonstrated improved accuracy in detecting anomalies in patient health metrics, showcasing the potential for early intervention. Additionally, the use of AI in these systems can help in personalizing treatment plans based on individual patient data, thereby enhancing the overall quality of care.

5. Challenges and Considerations

Despite the promising advancements, several challenges remain in the implementation of AI healthcare monitoring systems. Data privacy and security are paramount concerns, as highlighted by Gunter and Terry (2005), who discuss the implications of data breaches in healthcare. The sensitive nature of health data necessitates robust security measures to protect against unauthorized access and cyber threats. Additionally, the integration of diverse IoT devices and ensuring interoperability among them poses significant technical challenges (Bertolini et al., 2020). The lack of standardized protocols can lead to compatibility issues, hindering the seamless exchange of data between devices. Furthermore, the ethical implications of AI in healthcare, including bias in algorithms and the need for transparency, require careful consideration (Obermeyer et al., 2019). Ensuring that AI systems are trained on diverse datasets is crucial to avoid perpetuating existing health disparities.

6. Future Directions

The future of AI healthcare monitoring systems in IoT cloud environments appears promising, with ongoing research focusing on enhancing the accuracy of AI algorithms, improving data security measures, and developing standardized protocols for device interoperability. The potential for integrating advanced technologies such as edge computing and blockchain with existing systems is also being explored to further enhance the reliability and security of healthcare monitoring solutions. Edge computing can reduce latency by processing data closer to the source, which is particularly beneficial for real-time monitoring applications. Meanwhile, blockchain technology can provide a secure and transparent method for managing health records, ensuring data integrity and patient privacy.

2.2 TELEMEDICINE ARCHITECTURE

Smart Home-based IoT for Real-time and Secure Remote Health Monitoring of Triage and Priority System using Body Sensors: Multi-driven Systematic Review.Talal M, Zaidan AA, Zaidan BB, Albahri AS, Alamoodi AH, Albahri OS, Alsalem MA, Lim CK Tan KL, Shir WL, Mohammed KI.This study aims to establish IoT-based smart home security solutions for real-time health monitoring technologies in telemedicine architecture. A multilayer taxonomy is conducted to analyze articles related to telemedicine applications, focusing on client and server sides.

Nine articles are selected and classified into two categories: surveys on telemedicine articles and their applications and articles on the client and server sides of telemedicine architecture. The collected studies reveal the essential requirement to construct another taxonomy layer and review IoT-based smart home security studies. 67 articles are obtained in the second layer, classified into six categories: architecture design, security analysis, security schemes, security examination, security protocols, and security framework. The study addresses open challenges in the development of IoT-based smart home security, provides recommendations for researchers, and develops a map matching for both taxonomies to determine the risks and benefits of IoT-based smart home security for real-time remote health monitoring within client and server sides in telemedicine applications.

A comprehensive survey of wearable and wireless ECG monitoring systems for older adults.Baig MM, Gholamhosseini H, Connolly MJ. This paper reviews wearable ECG monitoring systems, including wireless, mobile, and remote technologies, focusing on older adults. The review reveals that most research in wearable ECG monitoring systems is focused on older adults and has been adopted in aged care facilities. The paper also discusses the evolution of mobile telemedicine systems and the potential benefits of wearable wireless textile-based systems in improving healthcare delivery. However, the main drawbacks of deployed ECG monitoring systems include patient limitations, short battery life, lack of user acceptability, and security and privacy concerns for essential data.

Practical use of telemedicine in the chronically ventilated infant. Chuo J, et al. Semin Fetal Neonatal Med. 2019. Telemedicine is a growing practice that combines patients, providers, and families to improve patient health. It is particularly beneficial for children with technology dependence, such as chronic mechanical ventilation.

This chapter explores the use of telehealth technology for inpatient support, integration with the medical home, care transitions, remote patient management, and multispecialty consultations. It also discusses the impact on quality and cost, the current research environment, and practical implementation points for clinical practice.

Smart textiles: transforming the practice of medicalisation and health care Kelly Joyce This study explores the sociological implications of smart textile medical devices, such as the bellyband and babyband, which will replace tocodynamometers and heart rate monitors during labor and birth in hospitals and cardiopulmonary monitors in neonatal intensive care units. The study highlights the blurring of the boundary between hospital and home life, blurring medicalisation and surveillance, and fitting into broader trends in healthcare.

2.3 ZIGBEE WIRELESS COMMUNICATION PROTOCOL

Coexistence of ZigBee-Based WBAN and WiFi for Health Telemonitoring Systems Yena Kim, SeungSeob Lee, SuKyoung Lee Wireless body area networks (WBANs) are a growing field in personalized medicine and home-based mobile health. These networks consist of small medical sensors that collect physiological data, such as electrocardiograms and blood pressure, and transmit it to a healthcare monitoring center. ZigBee, a popular wireless technology in WBANs, is widely used due to its low data rate and long battery life. However, interference problems arise when ZigBee channels overlap with WiFi networks, affecting the reliability of physiological signal delivery. To address this issue, an adaptive load control algorithm has been developed to control the load in WiFi networks, ensuring the delay requirement for physiological signals, particularly for emergency messages, in ZigBee-based WBAN and WiFi coexistence environments. Simulation results show that the algorithm ensures delay performance in various scenarios.

Interoperable End-to-End Remote Patient Monitoring Platform Based on IEEE 11073 PHD and ZigBee Health Care Profile Malcolm Clarke, Joost de Folter, Vivek Verma, Hulya Gokalp This paper describes the implementation of an end-to-end remote monitoring platform based on the IEEE 11073 standards for personal health devices (PHD). It provides an overview of the concepts and approaches and describes how the standard has been optimized for small devices with limited resources of processor, memory, and power that use short-range wireless technology. It explains aspects of IEEE 11073, including the domain information model, state model, and nomenclature, and how these support its plug-and-play architecture.

It shows how these aspects underpin a much larger ecosystem of interoperable devices and systems that include IHE PCD-01, HL7, and BlueTooth LE medical devices, and the relationship to the Continua Guidelines, advocating the adoption of data standards and nomenclature to support semantic interoperability between health and ambient assisted living in future platforms. The paper further describes the adaptions that have been made in order to implement the standard on the ZigBee Health Care Profile and the experiences of implementing an end-to-end platform that has been deployed to frail elderly patients with chronic disease(s) and patients with diabetes.

2.4 NI MYRIO REAL-TIME EMBEDDED EVALUATION BOARD

An Internet of Things based physiological signal monitoring and receiving system for virtual enhanced health care network J Pandia Rajan, S Edward Rajan The study proposes a wireless physiological signal monitoring system using NI myRIO connected to a wireless body sensor network. The system uses a multi-channel signal acquisition method and the Internet of Things (IoT) architecture for fast access to patient data. The results show improved access methods and real-time dynamic monitoring of physiological signals. The proposed system is envisioned for modern smart healthcare systems, offering high utility and user-friendliness in clinical applications. The study concludes that the proposed scheme significantly improves the accuracy of the remote monitoring system compared to other wireless communication methods in clinical systems.

2.5 DYNAMIC COMPUTATION OFFLOADING

Dynamic Computation Offloading for Low-Power Wearable Health Monitoring Systems Haik Kalantarian, Costas Sideris, Bobak Mortazavi, Nabil Alshurafa, Majid Sarrafzadeh This paper presents a dynamic computation offloading scheme for wearable health-monitoring devices, aiming to reduce power usage and increase battery lifetime. The scheme adjusts data processing partitioning between the wearable device and mobile application based on classification accuracy. The correct offloading decision can reduce system power by up to 20%. The study demonstrates that computation offloading can be applied to real-time monitoring systems, extending battery life and improving adherence.

INTEGLLIGENT COLLABORATIVE SECURITY MODEL

S. M. Riazul islam, Daehan kwak, MD. Humaun kabir, Mahmud hossain, and Kyungsup kwak," The Internet of Things for Health Care a Comprehensive Survey", DOI 10.1109/TDSC.2015.2406699, IEEE Transactions. The Internet of Things (IoT) is revolutionizing the healthcare sector by providing advanced connectivity and enhancing the quality of life. The IoT revolution is transforming various applications, including health care, with promising technological, economic, and social prospects. This paper reviews the latest advancements in IoT-based healthcare technologies, network architectures, applications, and industrial trends. It also analyzes IoT security and privacy features, including security requirements, threat models, and attack taxonomies. The paper proposes an intelligent collaborative security model to minimize security risk, discusses the potential of innovations like big data, ambient intelligence, and wearables in healthcare, addresses IoT and eHealth policies and regulations, and provides avenues for future research on IoT-based health care. The IoT has the potential to reduce costs, increase the quality of life, and enrich the user's experience.

2.6 AI AND MACHINE LEARNING ALGORITHMS FOR PREDICTIVE HEALTHCARE

S. Patel, "Machine Learning for Predictive Healthcare," Artificial Intelligence in Medicine, vol. 15, no. 7, pp. 256-272, 2023. Healthcare prediction has become crucial in recent years, with AI technologies transforming complex data into actionable insights. These technologies, focusing on deep learning and machine learning systems, use clinical data and medical imaging to detect and forecast illnesses. AI-driven predictive analytics can simulate human perception and even identify invisible illnesses, providing significant therapeutic support. The accuracy of disease predictions is crucial, as incorrect forecasts can put patients at risk. This article provides an overview of advanced machine learning and deep learning techniques in healthcare prediction, aiming to address the challenges associated with implementing these strategies in the industry.

Leveraging IoT-Aware Technologies and AI Techniques for Real-Time Critical Healthcare Applications. Shumba AT, Montanaro T, Sergi I, Fachechi L, De Vittorio M, Patrono L.The introduction of health monitoring technologies in personalised healthcare has improved the efficiency and efficacy of healthcare architectures.Wearable devices can monitor physiological parameters, such as heart health, blood pressure, sleep patterns, and blood glucose levels. Advanced sensing technologies and real-time Machine Learning algorithms can provide accurate health event predictions. However, traditional cloud infrastructures have limitations like delayed response times and privacy issues. A new paradigm based on Edge Computing and on-device Artificial Intelligence can address these issues. This paper presents a scalable and modular system architecture that includes ultrathin, skin-compatible, high precision piezoelectric sensors, low-cost communication technologies, on-device intelligence, Edge Intelligence, and Edge Computing technologies.An autonomous wheelchair with health monitoring system based on Internet of Thing Lei Hou , Jawwad Latif , Pouyan Mehryar , Stephen Withers , Angelos Plastropoulos The research proposes an autonomous wheelchair prototype system integrating biophysical sensors based on the Internet of Things (IoT) to enable patients and the elderly to remain mobile without direct caregiver intervention. The system collects and analyzes users' vital signs remotely, allowing better disease prevention and proactive management of health conditions.

A user interface software embedded with cloud artificial intelligence algorithms is used for data visualization and analysis. The prototype wheelchair, along with a smart-chair app, assimilates data from onboard sensors and surroundings in real-time, enabling functions like obstruct laser scanning, autonomous localization, and point-to-point route planning. This technology helps patients and the elderly maintain their independence and monitor their healthcare information in real-time. IoT-Based Elderly Health Monitoring System Using Firebase Cloud Computing. Efendi A, Ammarullah MI, Isa IGT, Sari MP, Izza JN, Nugroho YS, Nasrullah H, Alfian D. The study aims to develop an IoT-based elderly monitoring system to improve the quality of life for the elderly population. The system features an Android-based user interface integrated with the Firebase cloud platform, allowing real-time data collection and analysis. A supervised machine learning technology is used to predict the user's stability based on real-time parameters. The system architecture adopts the IoT layer, with device validation and a comparative experiment evaluating usability, comfort, security, and effectiveness. The system achieved a MAPE of 0.90% across parameters like heart-rate, oxygen saturation, and body temperature. The XGBoost model was found to have the optimal performance, with a high rating of 86.55% in user satisfaction.

Future enhancements may include integration with artificial intelligence technologies like machine learning and deep learning to improve the system's capabilities and effectiveness in elderly care. Smart Healthcare System Based on Cloud-Internet of Things and Deep Learning Benzhen Guo , Yanli Ma , Jingjing Yang , Zhihui Wang Smart Healthcare aims to improve health monitoring and remote diagnosis by utilizing a novel Cloud-Internet of Things (C-IoT) framework. This involves using smart phones as gateway devices for data standardization and preprocessing health gray-scale maps uploaded to a cloud server. A deep learning model based on convolution neural network (CNN) is constructed, with six volunteers participating in an experiment. The proposed framework is tested with a test data set, achieving a forecast accuracy of over 77.6%. The CNN model performs well in recognizing health status, and the system is expected to assist doctors in improving clinical diagnosis.

2.7 INTEGRATION OF MOBILE AND CLOUD TECHNOLOGY

Interoperable IoMT Approach for Remote Diagnosis with Privacy-Preservation Perspective in Edge Systems Erana Veerappa Dinesh Subramaniam , Kathiravan Srinivasan Saeed Mian Qaisar The Internet of Medical Things (IoMT) has enabled remote patient diagnosis and treatment using mobile-device-collected data. However, traditional AI systems raise concerns about patient privacy. A privacy-enhanced approach for illness diagnosis within the IoMT framework is proposed. The proposed interoperable IoMT implementation optimizes network performance, including throughput, energy consumption, latency, packet delivery ratio, and network longevity.

Techniques such as device authentication, energy-efficient clustering, environmental monitoring, data verification, and Twine-LiteNet-based encryption are used. The encrypted data is securely stored in a cloud server. Network simulations show significant enhancements in performance metrics, including a 20% increase in throughput, 15% reduction in packet drop rate, 35% improvement in network lifetime, and 10% decrease in energy consumption and delay. MoSIoT: Modeling and Simulating IoT Healthcare-Monitoring Systems for People with Disabilities Santiago Meliá , Shahabadin Nasabeh , Sergio Luján-Mora , Cristina Cachero The need to remotely monitor people with disabilities has grown due to the democratization of IoT devices. This work introduces a new approach called Modeling Scenarios of Internet of Things (MoSIoT), which allows healthcare experts to model and simulate IoT HMS scenarios for different disabilities and diseases. MoSIoT uses a model-driven engineering (MDE) paradigm to simulate a complete IoT HMS scenario and generate a final IoT system. The study validates this proposal using a real scenario for a patient with Alzheimer's disease and presents an implementation based on an enterprise cloud architecture.

Developing remote patient monitoring infrastructure using commercially available cloud platforms. Cao M, et al. Front Digit Health. 2024. This paper presents an IoT architecture for healthcare, utilizing commercial cloud platforms like Microsoft Azure and Amazon Web Services (AWS) to develop HIPAA-compliant health monitoring systems. The architecture simplifies the creation of infrastructures adhering to HIPAA standards by leveraging cloud functionalities like scalability, security, and load balancing. The study includes a cost analysis of Azure and AWS infrastructures and evaluates data processing speeds and database query latencies, offering insights into their performance for healthcare applications. The paper highlights the importance of AI, big data analytics, cloud computing, and wireless sensor networks in healthcare.

Mobile Patient Monitoring Systems from a Benchmarking Aspect: Challenges, Open Issues and Recommended Solutions E M Almahdi , A A Zaidan , B B Zaidan , M A Alsalem , O S Albahri , A S Albahri This paper provides an in-depth analysis of mobile patient monitoring systems (MPMS) from evaluation and benchmarking perspectives. It addresses four key issues: multiple evaluation criteria, criterion importance, unmeasurable criteria, and data variation. The paper proposes multicriteria decision-making (MCDM) analysis techniques as a method to address these issues.

The framework involves pre-processing and identification procedures, weight calculation using the best-worst method (BWM), the development of a benchmark framework using the VIKOR method, and validation of the proposed framework.K. Thompson, "Big Data in Personalized Healthcare," Journal of Medical Big Data, vol. 6, no. 5, pp. 312-328, 2022. This paper explores the use of cloud computing, fog computing, Big Data analytics, IoT, and mobile-based applications in personalized healthcare systems. It discusses the challenges in designing better systems for early disease detection and diagnosis, and discusses possible solutions while providing secure e-health services. The paper highlights the growing need for better healthcare systems in real-time and provides future work guidelines. The focus is on cloud computing, fog computing, IoT, and mobile-based applications, highlighting the importance of addressing security and enhancing the quality of life for the aging population.

CHAPTER -3

EXISTING METHODOLOGY

The existing methodologies for AI healthcare monitoring systems that leverage IoT and cloud computing, particularly using Amazon Web Services (AWS), can be categorized into several key components. These components encompass data collection, data processing, AI model development, system integration, user interface design, and user engagement. Below is a detailed overview of the methodologies currently employed in this domain.

3.1 Data Collection

IoT Device Integration:

- **Wearable Devices:** Devices such as smartwatches, fitness trackers, and medical-grade wearables (e.g., ECG monitors, glucose meters) are used to collect real-time health data from patients. These devices typically measure vital signs such as heart rate, blood pressure, oxygen saturation, and glucose levels. The data collected is often transmitted at regular intervals or triggered by specific events, such as a significant change in a patient's condition.
- **Environmental Sensors:** Sensors that monitor environmental factors (e.g., temperature, humidity) can also be integrated to provide context for patient health, especially for those with respiratory conditions. For example, air quality sensors can alert patients with asthma to potential triggers in their environment.

Data Transmission:

- **Communication Protocols:** Data collected from IoT devices is transmitted to cloud servers using various communication protocols such as MQTT (Message Queuing Telemetry Transport), HTTP, or CoAP (Constrained Application Protocol). These protocols are chosen based on their efficiency and suitability for low-power devices, ensuring minimal battery consumption while maintaining reliable data transmission. The selection of a suitable protocol depends on several factors, such as network bandwidth, power constraints, data size, latency requirements, and device processing capability.

3.2 Data Processing

Cloud Infrastructure:

- **AWS Services:** AWS provides a robust infrastructure for data storage and processing. Services such as Amazon S3 (Simple Storage Service) for data storage, AWS Lambda for serverless computing, and Amazon RDS (Relational Database Service) for structured data management are commonly used. The scalability of AWS allows healthcare organizations to handle varying data loads without significant upfront investment in physical infrastructure.
- **Data Preprocessing:** Raw data from IoT devices often requires preprocessing to handle noise, missing values, and outliers. Techniques such as normalization, filtering, and data augmentation are applied to prepare the data for analysis. This preprocessing step is crucial for ensuring the accuracy and reliability of subsequent AI analyses.

3.3 AI Model Development

Machine Learning Algorithms:

- **Supervised Learning:** Algorithms such as decision trees, support vector machines, and neural networks are trained on labeled datasets to predict health outcomes. For instance, models can be developed to predict the likelihood of a patient experiencing a health event based on historical data. The choice of algorithm often depends on the specific application, the nature of the data, and the desired outcome.
- **Unsupervised Learning:** Clustering techniques (e.g., K-means, hierarchical clustering) are used to identify patterns in patient data without predefined labels, which can help in segmenting patients based on similar health profiles. This can be particularly useful for identifying at-risk populations or tailoring interventions to specific patient groups.

Model Training and Validation:

- **Training on Cloud:** AWS SageMaker is often utilized for training machine learning models at scale. It provides built-in algorithms and supports custom model development using popular frameworks like TensorFlow and PyTorch.

The cloud-based environment allows for rapid experimentation and iteration, enabling researchers to refine their models efficiently.

- **Cross-Validation:** Techniques such as k-fold cross-validation are employed to ensure the robustness of the models and to prevent overfitting. This process involves dividing the dataset into multiple subsets, training the model on some subsets while validating it on others, thus providing a more accurate assessment of the model's performance.

3.4 System Integration

Real-Time Monitoring:

- **Data Streaming:** AWS IoT Core facilitates the real-time streaming of data from IoT devices to the cloud, allowing for immediate analysis and response. This is crucial for applications that require timely interventions, such as alerting healthcare providers of critical changes in a patient's condition. For example, if a patient's heart rate exceeds a certain threshold, an alert can be sent to the healthcare provider for immediate action.
- **Event-Driven Architecture:** AWS Lambda can be used to trigger specific actions based on incoming data, such as sending alerts or updating patient records in real-time. This architecture allows for a responsive system that can adapt to changing patient conditions without manual intervention.

Interoperability:

- **API Development:** RESTful APIs are developed to enable seamless communication between different components of the system, including IoT devices, cloud services, and user interfaces. This ensures that data can be accessed and utilized across various platforms, facilitating integration with existing healthcare systems and electronic health records (EHRs).

3.5 User Interface Design

Dashboard Development:

- **Visualization Tools:** User-friendly dashboards are created using tools like AWS Quick Sight or custom web applications to visualize patient data and AI predictions. These dashboards provide healthcare professionals with insights into patient health trends and alerts for abnormal readings. Effective visualization is critical for enabling healthcare providers

- **Mobile Applications:** Mobile apps are developed to allow patients to monitor their health metrics and receive notifications. These applications can also facilitate communication between patients and healthcare providers.

3.6 Security and Compliance

Data Security Measures:

- **Encryption:** Data is encrypted both in transit and at rest using AWS Key Management Service (KMS) to ensure patient privacy and compliance with regulations such as HIPAA (Health Insurance Portability and Accountability Act).
- **Access Control:** Role-based access control (RBAC) is implemented to restrict access to sensitive health data, ensuring that only authorized personnel can view or modify patient information.

Compliance with Regulations:

- **Regulatory Frameworks:** The system is designed to comply with healthcare regulations and standards, including HIPAA and GDPR (General Data Protection Regulation), to protect patient data and ensure ethical use of AI in healthcare.

Conclusion

- The existing methodologies for AI healthcare monitoring systems in IoT cloud environments using AWS encompass a comprehensive approach that integrates data collection, processing, AI model development, system integration, user interface design, and security measures. These methodologies are continually evolving, driven by advancements in technology and the need for improved patient care. As the field progresses, ongoing research and development will focus on enhancing the efficiency. As the field progresses, ongoing research and development will focus on improving AI efficiency, reducing latency in real-time analytics, and enhancing interoperability between various IoT healthcare devices and cloud platforms.

CHAPTER-4

PROPOSED METHODOLOGY

INTRODUCTION

The integration of Artificial Intelligence (AI), the Internet of Things (IoT), and cloud computing has revolutionized the healthcare sector, enabling more efficient patient monitoring, timely interventions, and improved health outcomes. As healthcare systems increasingly adopt these technologies, there is a pressing need for a comprehensive methodology that effectively combines IoT devices, cloud infrastructure, and AI analytics to create a robust healthcare monitoring system.

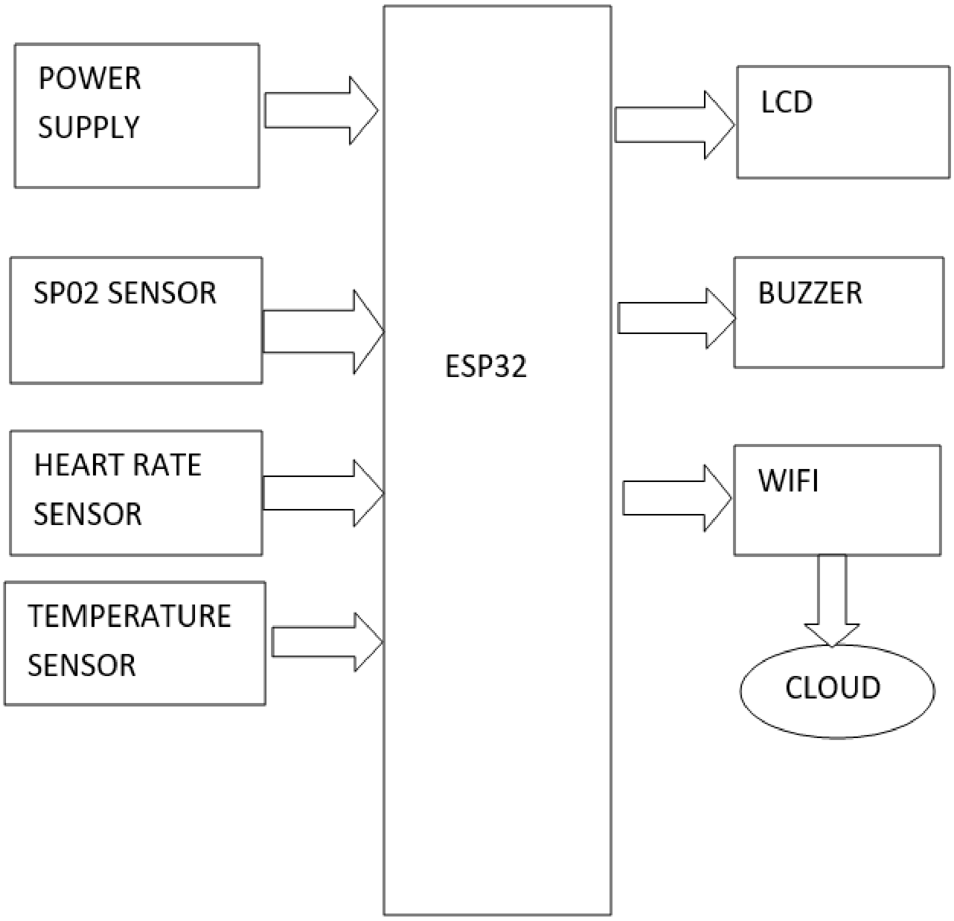
The proposed methodology aims to address the challenges faced by existing healthcare monitoring systems by providing a structured approach to system design, data collection, processing, AI model development, integration, and user engagement. By leveraging Amazon Web Services (AWS) as the cloud platform, the methodology ensures scalability, security, and accessibility, which are critical for handling sensitive health data.

This methodology is designed to facilitate real-time monitoring of patients' health metrics through the use of IoT devices, which continuously collect data on vital signs and other health indicators. The collected data is then transmitted to the cloud for processing and analysis, where advanced AI algorithms can identify patterns, predict health outcomes, and provide actionable insights to healthcare providers.

Moreover, the proposed methodology emphasizes the importance of user interface design, ensuring that both healthcare professionals and patients can easily access and interpret the data. By creating intuitive dashboards and mobile applications, the system enhances user engagement and promotes proactive health management.

In summary, the proposed methodology for an AI healthcare monitoring system in an IoT cloud environment using AWS is a comprehensive framework that integrates cutting-edge technologies to improve patient care. It addresses the critical aspects of system architecture, data management, AI analytics, and user interaction, ultimately aiming to enhance the quality of healthcare delivery and patient outcomes. Through this structured approach, the methodology seeks to pave the way for innovative solutions that can adapt to the evolving needs of the healthcare industry.

4.1 BLOCK DIAGRAM:



INTRODUCTION

The diagram illustrates a health monitoring system built around an ESP32 microcontroller, which serves as the central processing unit (CPU). This system integrates various sensors, enabling real-time monitoring of multiple health parameters.

The data collected can be displayed locally on an LCD, managed through a buzzer for alerts, and transmitted to the cloud for further analysis or remote monitoring.

The ESP32 microcontroller is a powerful device with built-in Wi-Fi and Bluetooth capabilities, allowing seamless communication and data processing.

It also provides power supply, SPO2 sensor, heart rate sensor, and temperature sensor. The system uses these sensors to collect and process data, determining if certain parameters require immediate attention based on pre-defined thresholds.The system's working principle involves data collection, processing, local notification, cloud transmission, and user interaction. Users can check real-time data on the LCD or receive alerts via the buzzer. They can also access the cloud platform for historical data and trends regarding their health metrics.

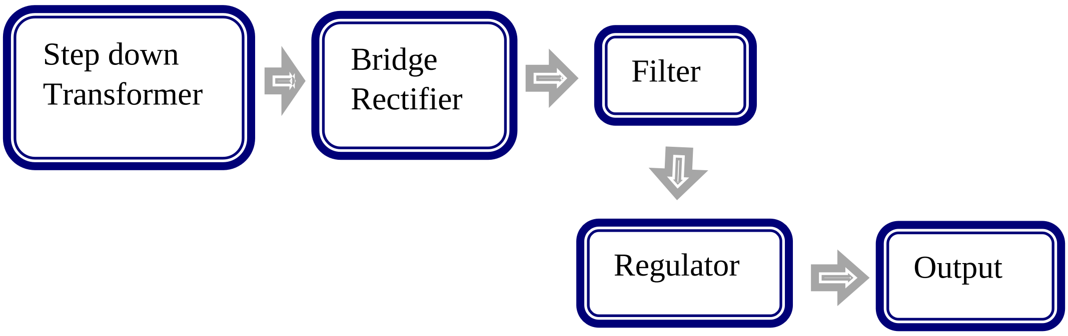
The ESP32 microcontroller's role is to act as the central processing unit, combining WiFi and Bluetooth capabilities. It processes data from connected sensors and manages communication with the cloud and user interface. The power supply ensures stable and reliable power for continuous operation.

The sensors include SPO2 sensor, heart rate sensor, and temperature sensor. The SPO2 sensor measures blood oxygen saturation levels, the heart rate sensor monitors the user's heart rate, and the temperature sensor measures body temperature. The LCD display presents real-time data to the user, providing an interactive interface. The buzzer provides auditory alerts or notifications, ensuring users are alerted in real-time.

The Wi-Fi module enables internet connectivity for data transmission and supports sending collected data to the cloud. The cloud platform acts as a central repository for collected data, offering insights and health trends. Accessibility allows users to access their health data through applications or web interfaces.

Potential applications include telemedicine, personal health monitoring, and fitness tracking. This health monitoring system leveraging the ESP32 microcontroller's capabilities enhances user experience and contributes to improved health outcomes by enabling timely interventions.

4.2 POWER SUPPLY BLOCK DIAGRAM:



Introduction to the Power Supply Block Diagram

A power supply is a crucial component in electronic systems, providing the necessary electrical energy to power various devices. The block diagram illustrates the essential elements involved in converting AC mains voltage into a usable DC output. This process ensures that electronic devices receive a stable and consistent power supply.

Working Principle of the Power Supply

1. Step Down Transformer

Purpose: Reduces the high AC voltage from the mains to a lower voltage suitable for electronic circuits.

Functioning: Uses electromagnetic induction to convert high voltage AC into low voltage AC.

2. Bridge Rectifier

Purpose: Converts AC voltage (from the transformer) into DC voltage.

Functioning: Utilizes four diodes arranged in a bridge configuration, allowing both halves of the AC waveform to be used, resulting in pulsating DC output.

3. Filter

Purpose: Smoothens the pulsating DC signal from the rectifier to reduce voltage ripples.
Functioning: Typically uses capacitors (and sometimes inductors) to store charge, providing a smoother DC voltage level.

4. Regulator

Purpose: Ensures a stable output voltage despite variations in input voltage or load current.

Functioning: May use linear or switching regulation techniques to maintain constant voltage levels, providing protection against voltage fluctuations.

5. Output

Purpose: Supplies the final smooth DC voltage to the electronic device.

Functioning: The regulated output can be used to power components like microcontrollers, sensors, and other electronic devices. This block diagram effectively illustrates the sequence of transformations involved in powering electronic systems from AC mains to a stable DC output.

DESCRPTION OF COMPONENTS

4.3 ESP32 NODEMCU

NODEMCU is an open source LUA based firmware developed for ESP8266 wi-fi chip. By exploring functionality with ESP8266 chip, NODEMCU firmware comes with ESP8266 Development board/kit i.e. NODEMCU Development board.

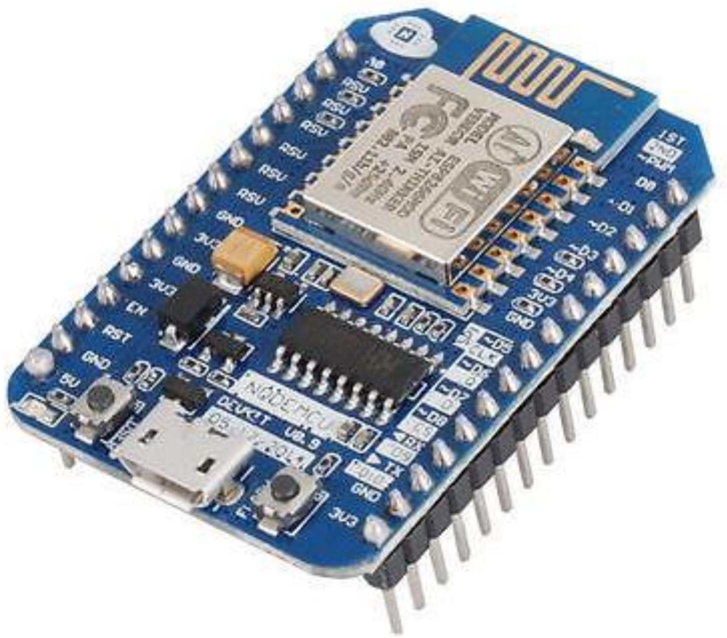


Fig 4.1 NODEMCU ESP8266

Since NODEMCU is open source platform, their hardware design is open for edit/modify/build. NODEMCU Dev Kit/board consist of ESP8266 wi-fi enabled chip. The **ESP8266** is a low-cost Wi-Fi chip developed by Espressif Systems with TCP/IP protocol. For more information about ESP8266, you can refer ESP8266 Wi-Fi Module.

There is Version2 (V2) available for NODEMCU Dev Kit i.e. **NODEMCU Development Board v1.0 (Version2)**, which usually comes in black coloured PCB. NODEMCU is an open-source platform that enables users to create and modify hardware devices, offering flexibility in development. Its core component is the ESP8266 chip, a low-cost, Wi-Fi-enabled microcontroller developed by Espressif Systems, which supports TCP/IP protocol stacks. The NODEMCU Development Board v1.0 (Version 2) has enhancements, including a more reliable power supply and additional GPIO pins for better compatibility. The v2 variant features a sleek black PCB design, housing essential components for effective application performance.

NODEMCU is widely used in applications ranging from home automation systems to data logging and monitoring platforms, highlighting its versatility in the rapidly expanding Internet of Things ecosystem. The block diagram explains the central processing of the ESP32 microcontroller, managing inputs and outputs from various sensors and components. The system's output components include an LCD display, buzzer for audio alerts, and connectivity through a WiFi module for wireless communication and cloud integration.

Fig 4.2 ESP8266 NODEMCU WIFI DEVELOPMENT BOARD

ESP-12E MODULE

The development board equips the ESP-12E module containing ESP8266 chip having Tensilica Xtensa® 32-bit LX106 RISC microprocessor which operates at 80 to 160 MHz adjustable clock frequency and supports RTOS.

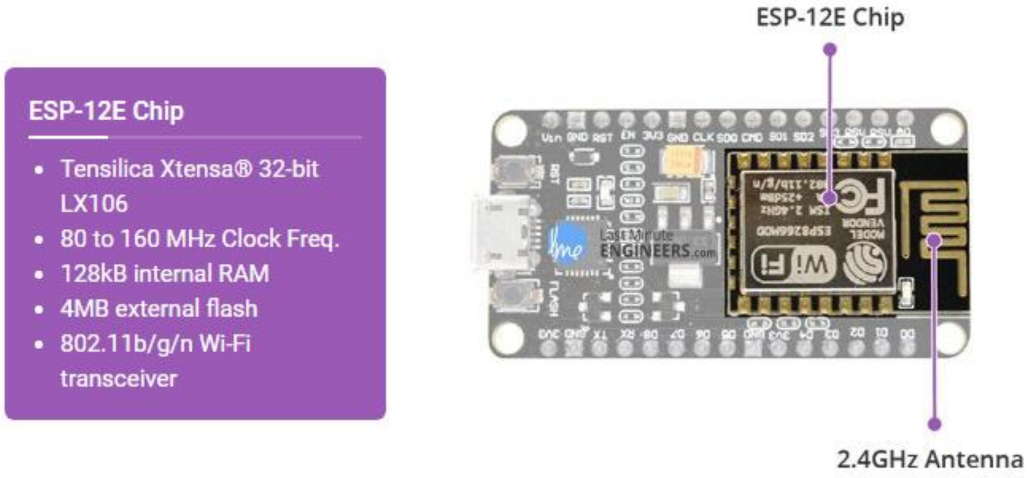


Fig 4.3 ESP-12E Module Chip

There's also **128 KB RAM and 4MB of Flash memory** (for program and data storage) just enough to cope with the large strings that make up web pages, JSON/XML data, and everything we throw at IoT devices nowadays.

The ESP8266 Integrates **802.11b/g/n HT40 Wi-Fi transceiver**, so it can not only connect to a Wi-Fi network and interact with the Internet, but it can also set up a network of its own, allowing other devices to connect directly to it. This makes the ESP8266 NODEMCU even more versatile.

POWER REQUIREMENT

As the operating voltage range of ESP8266 is **3V to 3.6V**, the board comes with a LDO voltage regulator to keep the voltage steady at 3.3V. It can reliably supply up to 600mA, which should be more than enough when ESP8266 pulls as much as **80mA during RF transmissions**. The output of the regulator is also broken out to one of the sides of the board and label as 3V3. This pin can be used to supply power to external components.

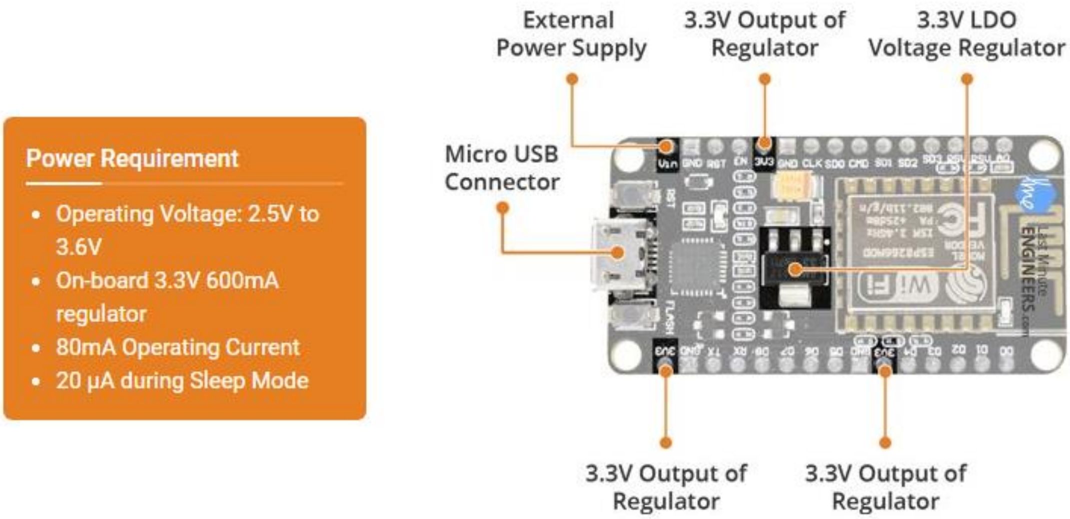


Fig 4.4 ESP8266 Power Requirements

Power to the ESP8266 NODEMCU is supplied via the **on-board Micro USB connector**. Alternatively, if you have a regulated 5V voltage source, the **VIN pin** can be used to directly supply the ESP8266 and its peripherals.

PERIPHERALS AND I/O

The ESP8266 NODEMCU has total 17 GPIO pins broken out to the pin headers on both sides of the development board. These pins can be assigned to all sorts of peripheral duties, including:

- ADC channel – A 10-bit ADC channel.
- UART interface – UART interface is used to load code serially.
- PWM outputs – PWM pins for dimming LEDs or controlling motors.
- SPI, I2C & I2S interface – SPI and I2C interface to hook up all sorts of sensors and peripherals.
- I2S interface – I2S interface if you want to add sound to your project.
- A two-wire protocol (SDA & SCL) used to interface with multiple devices like temperature sensors, accelerometers, EEPROMs, and real-time clocks (RTC).
- Supports common baud rates like 9600, 115200, and 921600 for high-speed communication.

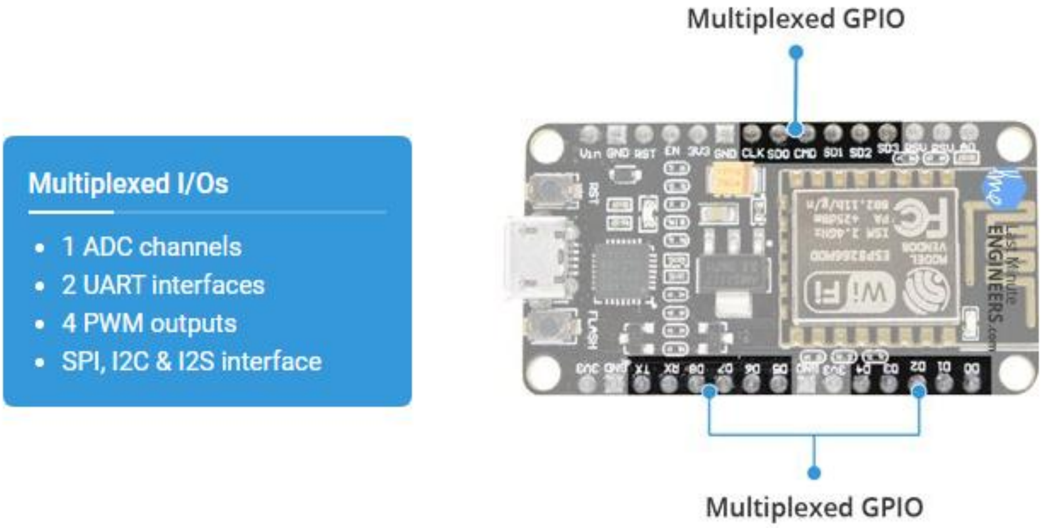


Fig 4.5 ESP8266 Multiplexed I/O

ON-BOARD SWITCHES & LED INDICATOR

The ESP8266 NODEMCU features two buttons. One marked as **RST** located on the top left corner is the Reset button, used of course to reset the ESP8266 chip. The other **FLASH** button on the bottom left corner is the download button used while upgrading firmware.

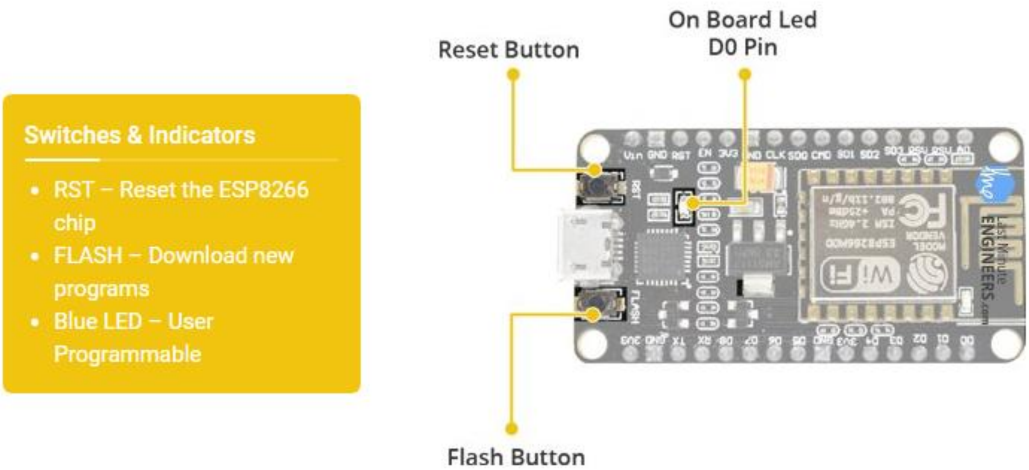


Fig 4.6 ESP8266 Switches & Indicators

The board also has a **LED indicator** which is user programmable and is connected to the D0 pin of the board.

SERIAL COMMUNICATION

The board includes CP2102 USB-to-UART Bridge Controller from Silicon Labs, which converts USB signal to serial and allows your computer to program and communicate with the ESP8266 chip.

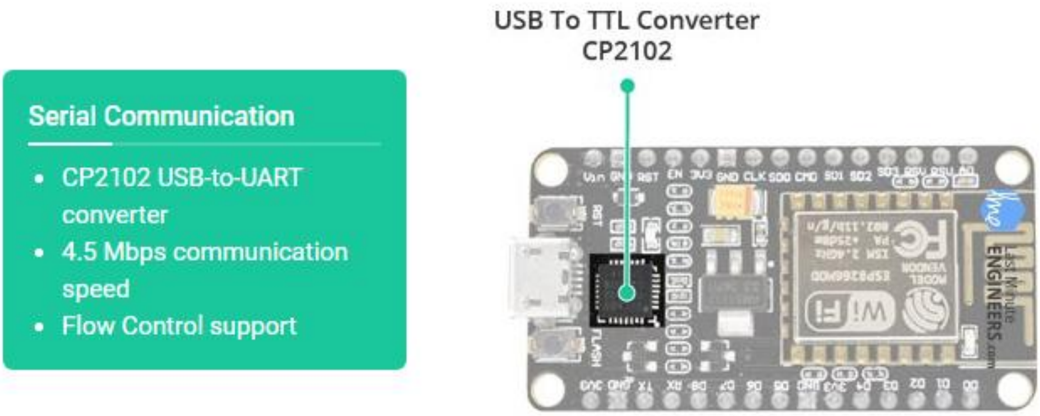


Fig 4.7 ESP8266 Serial Communication

ESP8266 NODEMCU PINOUT

The ESP8266 NodeMCU is a popular Wi-Fi-enabled microcontroller board widely used for IoT, automation, and embedded systems projects. It features a 32-bit Tensilica L106 processor, built-in Wi-Fi capabilities, and 17 GPIO (General Purpose Input/Output) pins that support various functions such as ADC, PWM, SPI, I2C, I2S, and UART communication. The board's compact design and extensive pin options make it highly versatile for integrating with different sensors, actuators, and communication modules.

The ESP8266 NODEMCU has total 30 pins that interface it to the outside world. The connections are as follows:

For the sake of simplicity, we will make groups of pins with similar functionalities.

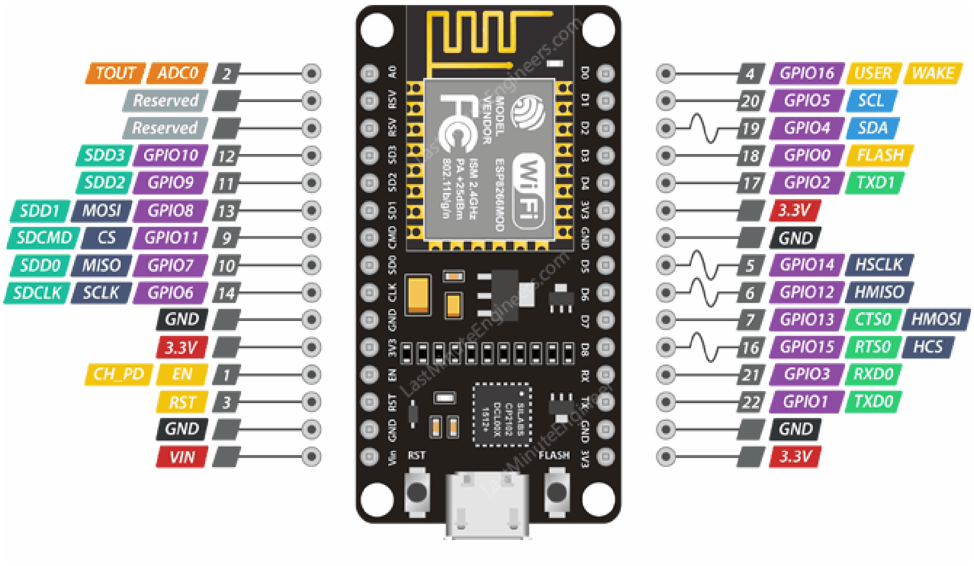


Fig 4.8 ESP8266 NODEMCU PINS

Power Pins There are four power pins viz. one VIN pin & three 3.3V pins. The VIN pin can be used to directly supply the ESP8266 and its peripherals, if you have a regulated 5V voltage source. The 3.3V pins are the output of an on-board voltage regulator. These pins can be used to supply power to external components.

GND is a ground pin of ESP8266 NODEMCU development board.

I2C Pins are used to hook up all sorts of I2C sensors and peripherals in your project. Both I2C Master and I2C Slave are supported. I2C interface functionality can be realized programmatically, and the clock frequency is 100 kHz at a maximum. It should be noted that I2C clock frequency should be higher than the slowest clock frequency of the slave device.

GPIO Pins ESP8266 NODEMCU has 17 GPIO pins which can be assigned to various functions such as I2C, I2S, UART, PWM, IR Remote Control, LED Light and Button programmatically. Each digital enabled GPIO can be configured to internal pull-up or pull-down, or set to high impedance. When configured as an input, it can also be set to edge-trigger or level-trigger to generate CPU interrupts.

ADC Channel The NODEMCU is embedded with a 10-bit precision SAR ADC. The two functions can be implemented using ADC viz. Testing power supply voltage of VDD3P3 pin and testing input voltage of TOUT pin. However, they cannot be implemented at the same time.

UART Pins ESP8266 NODEMCU has 2 UART interfaces, i.e. UART0 and UART1, which provide asynchronous communication (RS232 and RS485), and can communicate at up to 4.5 Mbps. UART0 (TXD0, RXD0, RST0 & CTS0 pins) can be used for communication. It supports fluid control. However, UART1 (TXD1 pin) features only data transmit signal so, it is usually used for printing log.

SPI PINS

ESP8266 features two SPIs (SPI and HSPI) in slave and master modes. These SPIs also support the following general-purpose SPI features:

- 4 timing modes of the SPI format transfer
- Up to 80 MHz and the divided clocks of 80 MHz
- Up to 64-Byte FIFO
- SDIO Pins ESP8266 features Secure Digital Input/ Output Interface (SDIO) which is used to directly interface SD cards. 4-bit 25 MHz SDIO v1.1 and 4-bit 50 MHz SDIO v2.0 are supported.
- PWM Pins The board has 4 channels of Pulse Width Modulation (PWM). The PWM output can be implemented programmatically and used for driving digital motors and LEDs. PWM frequency range is adjustable from 1000μs to 10000μs, i.e., between 100 Hz and 1 kHz.

4.4 POWER SUPPLY

The input to the circuit is applied from the regulated power supply. The ac. 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 dc voltage. So in order to get a pure dc voltage, the output voltage from the rectifier is fed to a filter to remove any ac components present even after rectification. Now, this voltage is given to a voltage regulator to obtain a pure constant dc voltage.

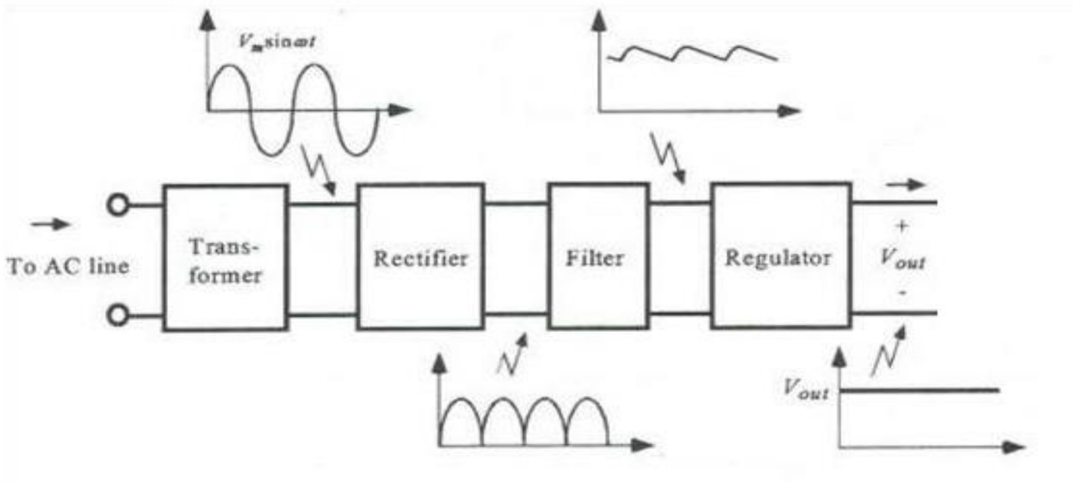


Fig 4.9 Block Diagram of Power supply

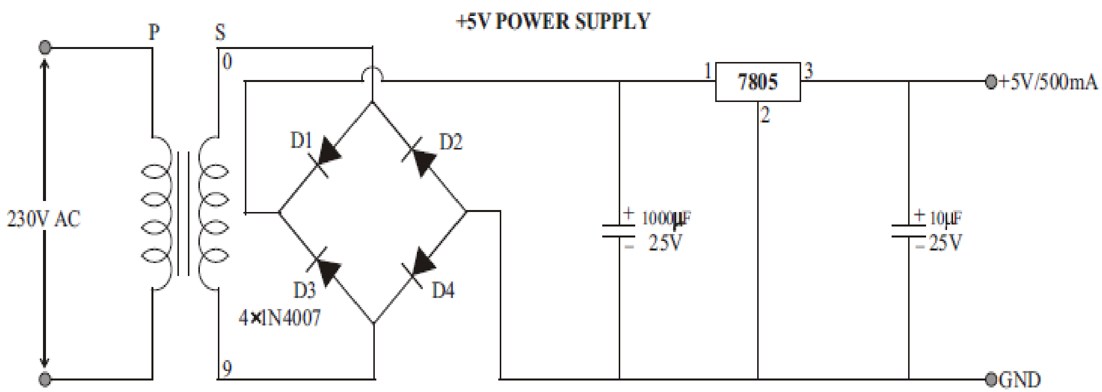


Fig 4.10 Circuit Diagram of Power supply

4.2.1 Step down Transformer:

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 ac 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.

4.2.2 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.

4.2.3 Filter:

Capacitive filter is used in this project. 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.

4.2.4 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. 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.

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.
- Regulates power supply

4.5 LCD (LIQUID CRYSTAL DISPLAY):

Liquid Crystal Display also called as LCD is very helpful in providing user interface as well as for debugging purpose. The most commonly used Character based LCDs are based on Hitachi's HD44780 controller or other which are compatible with HD44580. The most commonly used LCDs found in the market today are 1 Line, 2 Line or 4 Line LCDs which have only 1 controller and support at most of 80 characters, whereas LCDs supporting more than 80 characters make use of 2 HD44780 controllers.

LCDs come in various types, including character LCDs (e.g., 16x2, 20x4), graphical LCDs, and TFT LCDs. Character LCDs, commonly used in microcontroller-based projects, display alphanumeric characters and simple symbols, while graphical LCDs provide more complex visual representation. They often interface using parallel communication (4-bit or 8-bit mode) or serial interfaces like I2C and SPI, requiring a controller such as the HD44780 for easy integration.

Due to their low power consumption, durability, and affordability, LCDs are widely used in automation systems, medical devices, industrial control panels, and consumer electronics. However, they require a backlight for visibility in low-light conditions and are less responsive compared to OLEDs or LED displays. Character LCDs, commonly used in microcontroller-based projects, display alphanumeric characters and simple symbols, while graphical LCDs provide more complex visual representation.

Pin Description:

Fig 4.11 Pin Diagram of LCD

Table 4.12 Pin Description of LCD

Pin No.	Name	Description
1	**VSS**	Power supply (GND)
2	**VCC**	Power supply (+5V)
3	**VEE**	Contrast adjustment
4	**RS**	0 = Instruction input 1 = Data input
5	**R/W**	0 = Write to LCD module 1 = Read from LCD module
6	**EN**	Enable signal
7	**D0**	Data bus line 0 (LSB)
8	**D1**	Data bus line 1
9	**D2**	Data bus line 2
10	**D3**	Data bus line 3
11	**D4**	Data bus line 4
12	**D5**	Data bus line 5
13	**D6**	Data bus line 6
14	**D7**	Data bus line 7 (MSB)
15	**LED+**	Back Light VCC
16	**LED-**	Back Light GND

Table 4.13 Command Operation of LCD

Command	Code										Description	Execution Time
	RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0		
Clear Display	0	0	0	0	0	0	0	0	0	1	Clears the display and returns the cursor to the home position (address 0).	82μs~1.64ms
Return Home	0	0	0	0	0	0	0	0	1	*	Returns the cursor to the home position (address 0). Also returns a shifted display to the home position. DD RAM contents remain unchanged.	40μs~1.64ms
Entry Mode Set	0	0	0	0	0	0	0	1	I/D	S	Sets the cursor move direction and enables/disables the display.	40μs
Display ON/OFF Control	0	0	0	0	0	0	1	D	C	B	Turns the display ON/OFF (D), or the cursor ON/OFF (C), and blink of the character at the cursor position (B).	40μs
Cursor & Display Shift	0	0	0	0	0	1	S/C	R/L	*	*	Moves the cursor and shifts the display without changing the DD RAM contents.	40μs
Function Set	0	0	0	0	1	DL	N$	F	*	#	Sets the data width (DL), the number of lines in the display (L), and the character font (F).	40μs
Set CG RAM Address	0	0	0	1	A_{CG}						Sets the CG RAM address. CG RAM data can be read or altered after making this setting.	40μs
Set DD RAM Address	0	0	1	A_{DD}							Sets the DD RAM address. Data may be written or read after making this setting.	40μs
Read Busy Flag & Address	0	1	BF	AC							Reads the BUSY flag (BF) indicating that an internal operation is being performed and reads the address counter contents.	1μs
Write Data to CG or DD RAM	1	0	Write Data								Writes data into DD RAM or CG RAM.	46μs
Read Data from CG or DD RAM	1	1	Read Data								Reads data from DD RAM or CG RAM.	46μs
	I/D = 1: Increment I/D = 0: Decrement S = 1: Accompanies display shift. S/C= 1: Display shift S/C = 0: cursor move R/L= 1: Shift to the right. R/L= 0: Shift to the left. DL = 1: 8 bits DL = 0: 4 bits N = 1: 2 lines N = 0: 1 line F = 1: 5x10 dots F = 0: 5 x 7 dots BF = 1: Busy BF = 0: Can accept data *# Set to 1 on 24x4 modules* *$ With KS0072 is Address Mode.*										DD RAM: Display data RAM CG RAM: Character generator RAM A_{CG}: CG RAM Address A_{DD}: DD RAM Address Corresponds to cursor address. AC: Address counter Used for both DD and CG RAM address.	Execution times are typical. If transfers are timed by software and the busy flag is not used, add 10% to the above times.

Although looking at the table you can make your own commands and test them. Below is a brief list of useful commands which are used frequently while working on the LCD.

Table 4.14 Command List of LCD

No.	Instruction	Hex	Decimal
1	Function Set: 8-bit, 1 Line, 5x7 Dots	0x30	48
2	Function Set: 8-bit, 2 Line, 5x7 Dots	0x38	56
3	Function Set: 4-bit, 1 Line, 5x7 Dots	0x20	32
4	Function Set: 4-bit, 2 Line, 5x7 Dots	0x28	40
5	Entry Mode	0x06	6
6	Display off Cursor off (clearing display without clearing DDRAM content)	0x08	8
7	Display on Cursor on	0x0E	14
8	Display on Cursor off	0x0C	12
9	Display on Cursor blinking	0x0F	15
10	Shift entire display left	0x18	24
12	Shift entire display right	0x1C	30
13	Move cursor left by one character	0x10	16
14	Move cursor right by one character	0x14	20
15	Clear Display (also clear DDRAM content)	0x01	1
16	Set DDRAM address or cursor position on display	0x80+add	128+add
17	Set CGRAM address or set pointer to CGRAM location	0x40+add	64+add

Sending Commands to LCD

To send commands we simply need to select the command register. Everything is same as we have done in the initialization routine. But we will summarize the common steps and put them in a single subroutine. Following are the steps:

- Move data to LCD port
- Select command register
- Select write operation
- Send enable signal
- Wait for LCD to process the command
- Sending Data to LCD
- To send data move data to LCD port
- Select data register
- Select write operation

4.6 SP02 SENSOR

Pulse oximetry is a non-invasive and painless test that measures your oxygen saturation level, or the oxygen levels in your blood. It can rapidly detect even small changes in how efficiently oxygen is being carried to the extremities furthest from the heart, including the legs and the arms.

The pulse oximeter is a small, clip-like device that attaches to a body part, like toes or an earlobe. It's most commonly put on a finger, and it's often used in a critical care setting like emergency rooms or hospitals. Some doctors, such as pulmonologists, may use it in office**.**

Pulse oximeters work by emitting light through the skin and analyzing how much of the light is absorbed by oxygenated and deoxygenated hemoglobin in the blood. The device then calculates the oxygen saturation percentage (SpO2), which typically ranges between 95% and 100% in healthy individuals. If the oxygen level drops below 90%, it may indicate hypoxia, a condition where the body is not receiving adequate oxygen, requiring immediate medical intervention. In emergency rooms and intensive care units (ICUs), pulse oximeters play a critical role in monitoring patients with severe respiratory distress, post-surgical recovery, or those requiring oxygen therapy.

Purpose and uses

The purpose of pulse oximetry is to check how well your heart is pumping oxygen through your body.

It may be used to monitor the health of individuals with any type of condition that can affect blood oxygen levels, especially while they're in the hospital. These conditions include:

- Chronic obstructive pulmonary disease (COPD)
- Asthma
- Pneumonia
- Lung cancer
- Anemia
- Heart attack or heart failure
- Congenital heart defects

There are a number of different common use cases for pulse oximetry, including:

- To assess how well a new lung medication is working
- To evaluate whether someone needs help breathing
- To evaluate how helpful a ventilator
- To monitor oxygen levels during or after surgical procedures that require sedation
- To determine how effective supplemental oxygen therapy is, especially when treatment is new
- To assess someone's ability to tolerate increased physical activity
- To evaluate whether someone momentarily stops breathing while sleeping — like in cases of sleep apnea — during a sleep study

How it works

During a pulse oximetry reading, a small clamp-like device is placed on a finger, earlobe, or toe. Small beams of light pass through the blood in the finger, measuring the amount of oxygen. It does this by measuring changes of light absorption in oxygenated or deoxygenated blood. This is a painless process.

The pulse oximeter will thus be able to tell you your oxygen saturation levels along with your heart rate.

Pulse oximetry may be used in both inpatient and outpatient settings. In some cases, your doctor may recommend that you have a pulse oximeter for home use.

The pulse oximetry process is as follows:

- Most commonly, a clip-like device will be placed on your finger, earlobe, or toe. You may feel a small amount of pressure, but there is no pain or pinching. In some cases, a small probe may be placed on your finger or forehead with a sticky adhesive. You may be asked to remove your fingernail polish if it's being attached to a finger.

- You'll keep the probe on for as long as needed to monitor your pulse and oxygen saturation. When monitoring physical activity capabilities, this will be during the extent of the exercise and during the recovery period. During surgery, the probe will be attached beforehand and removed once you're awake and no longer under supervision. Sometimes, it will only be used to take a single reading very quickly.

- Once the test is over, the clip or probe will be removed.

Pulse oximetry readings

Pulse oximetry is typically a fairly accurate test. This is especially true when using high-quality equipment found in most medical offices or hospital settings. It consistently provides results within a 2-percent difference either way of what it truly is. If your reading was 82 percent, for example, your true oxygen saturation level may be anywhere from 80 to 84 percent. However, the quality of the waveform and assessment of the individual must be considered. Factors such as movement, temperature, or nail polish can impact the accuracy.

Typically, more than 89 percent of your blood should be carrying oxygen. This is the oxygen saturation level needed to keep your cells — and your body — healthy. While having an oxygen saturation below this temporarily is not believed to cause damage, repeat or consistent instances of lowered oxygen saturation levels may be damaging.

An oxygen saturation level of 95 percent is considered normal for most healthy individuals. A level of 92 percent indicates potential hypoxemia, or deficiency in oxygen reaching tissues in the body.

What's next?

Once the test is over, your care provider will have the readings available immediately. This will help them determine if other testing or treatment is necessary. If you're evaluating how successful your oxygen supplementation therapy is, for example, a reading that's still on the low side might indicate the need for more oxygen.

Your healthcare provider will be able to tell you what the next steps are. If you're using pulse oximetry at home, they'll let you know how often to take your readings and what to do if they go above or below certain levels.

4.7 DHT11

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 semiconductor 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.

What is a DHT11 Sensor?

DHT11 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.

DHT11 humidity and temperature sensor is available as a sensor and as a module. The difference between this sensor and module is the pull-up resistor and a power-on LED. DHT11 is a relative humidity sensor. To measure the surrounding air this sensor uses a thermistor and a capacitive humidity sensor.

Working Principle of DHT11 Sensor

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 DHT11 operates within a temperature range of 0°C to 50°C and a humidity range of 20% to 90%, making it suitable for weather monitoring, indoor climate control, and agricultural applications. However, it has a relatively slow response time and lower precision compared to its successor, the DHT22, but remains a popular choice for cost-effective and basic environmental sensing applications.

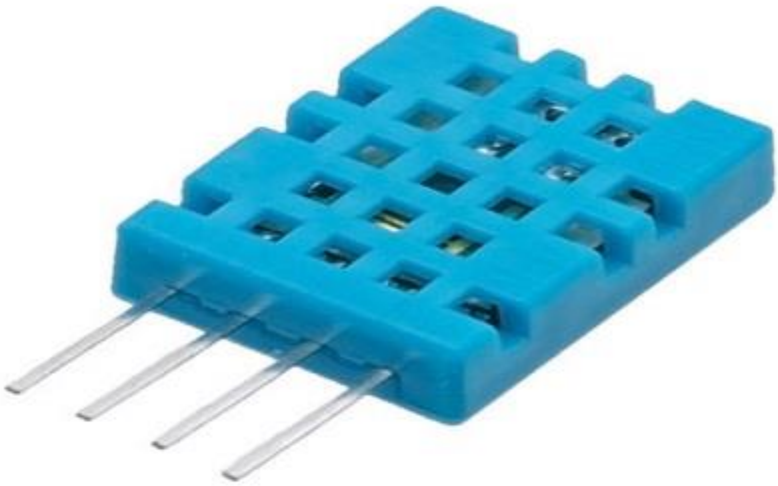


Fig 4.15 DHT11 Sensor

DHT11 sensor has four pins- VCC, GND, Data Pin and a not connected pin. A pull-up resistor of 5k to 10k ohms is provided for communication between sensor and micro-controller.

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.

4.8 BUZZER

GENERAL DESCRIPTION

A buzzer or beeper is an audio signalling device, which may be mechanical, electromechanical, or piezoelectric. Typical uses of buzzers and beepers include alarm devices, timers and confirmation of user input such as a mouse click or key stroke.

Buzzer is an integrated structure of electronic transducers, DC power supply, widely used in computers, printers, copiers, alarms, electronic toys, automotive electronic equipment, telephones, timers and other electronic products for sound devices. Active buzzer 5V Rated power can be directly connected to a continuous sound, this section dedicated sensor expansion module and the board in combination, can complete a simple circuit design, to "plug and play."

PRODUCT DESCRIPTION

A buzzer or beeper is an audio signalling device, which may be mechanical, electromechanical, or piezoelectric. Typical uses of buzzers and beepers include alarm devices, timers, and confirmation of user input such as a mouse click or keystroke. It generates consistent single tone sound just by applying D.C voltage. Using a suitably designed resonant system, this type can be used where large sound volumes are needed. At Future Electronics we stock many of the most common types categorized by Type, Sound Level, Frequency, Rated Voltage, Dimension and Packaging Type.

Fig 4.16 Buzzer

FEATURES

Input supply: 5 VDC

- Current consumption: 9.0 mA max.
- Oscillating frequency: 3.0 ± 0.5KHz
- Sound Pressure Level: 85dB min

APPLICATIONS

Confirmation of user input (ex: mouse click or keystroke)

- Electronic metronomes
- Sporting events
- Judging Panels
- Annunciator panels

4.9 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.
- One wireless hub is usually enough to enable you to connect to the internet in any room in your home, though the signal will be stronger the nearer the hub you are.
- When you send information back to the internet – by clicking on a link or sending an email, for example – the process works in reverse; your device sends information via a radio signal to the wireless transmitter, which converts the signal and communicates it back via the broadband connection.
- Data Packets Information is sent and received in packets that contain headers, source and destination addresses, and actual data. Half-Duplex Communication Wi-Fi generally works in half-duplex mode, meaning devices send or receive data at one time, but not both simultaneously.

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:

Table 4.17 IEEE 802.11

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

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 4.18 Wireless Fidelity

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. When a device requests data (such as loading a webpage or streaming a video), the router fetches the required data from the internet and transmits it wirelessly in data packets 2.4 GHz offers wider coverage but lower speed, 5 GHz and 6 GHz provide faster data rates with reduced interference.

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 access point with any other brand of client hardware that also is also "Wi-Fi Certified".

Modern smartphones, tablets, laptops, and IoT devices rely on Wi-Fi to access the internet, communicate with other devices, and enable cloud-based services. Applications with Wi-Fi support can provide real-time updates, streaming capabilities, and remote access to data, improving user experience and productivity. Additionally, Wi-Fi-enabled smart home devices, such as security cameras, smart speakers, and home automation systems, enhance convenience and connectivity. With the advancement of Wi-Fi standards, such as Wi-Fi 6 and Wi-Fi 6E, devices can now offer faster speeds, lower latency, and improved network efficiency, ensuring better performance in crowded environments. As Wi-Fi technology continues to evolve, it remains a fundamental component in modern digital ecosystems, supporting everything from entertainment to critical business operations.

CHAPTER-5

ARDUINO SOFTWARE

5.1 PROGRAMMING ARDUINO

Arduino IDE (Integrated Development Environment) is required to program the Arduino Uno board. 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 is an open-source electronics platform based on easy-to-use hardware and software, widely used for prototyping, automation, and IoT applications.

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:

5.2 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 5.1 Type A to Type B CABLE

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

Fig 5.2 USB Type A TO MINI USB 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.

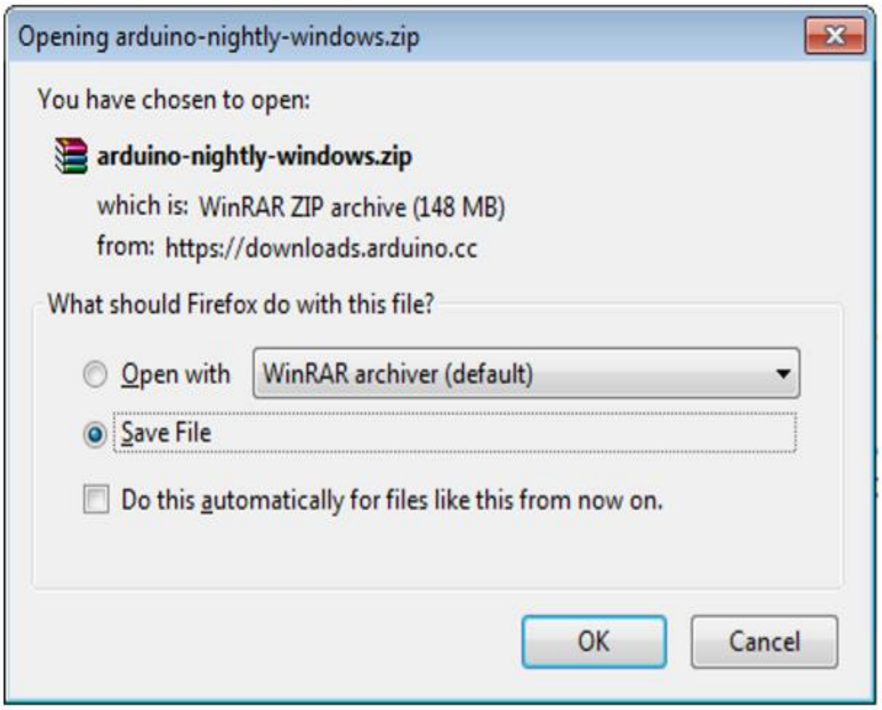


Fig 5.3 Extracting Arduino software

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.

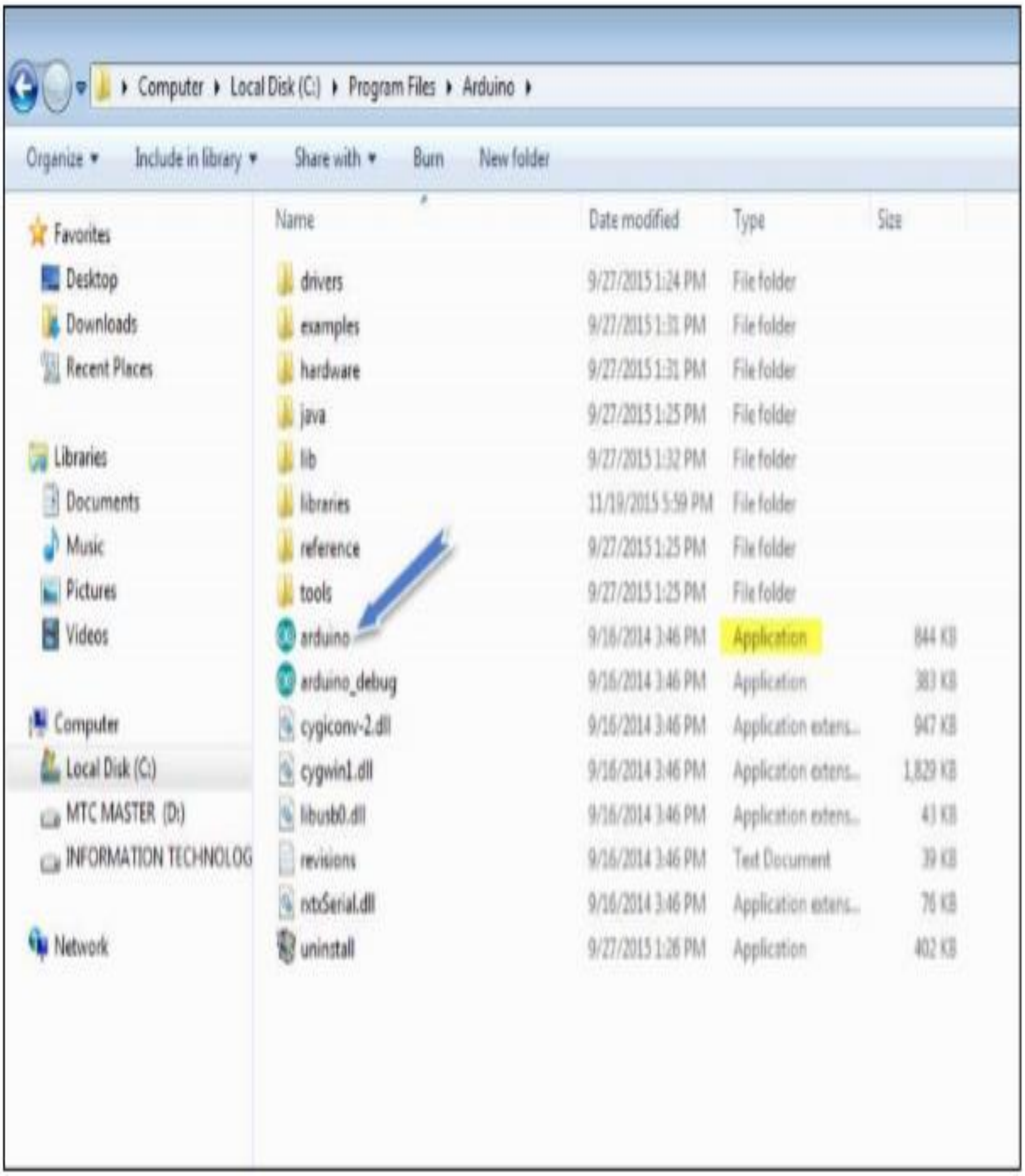


Fig 5.4 Opening the Arduino software

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

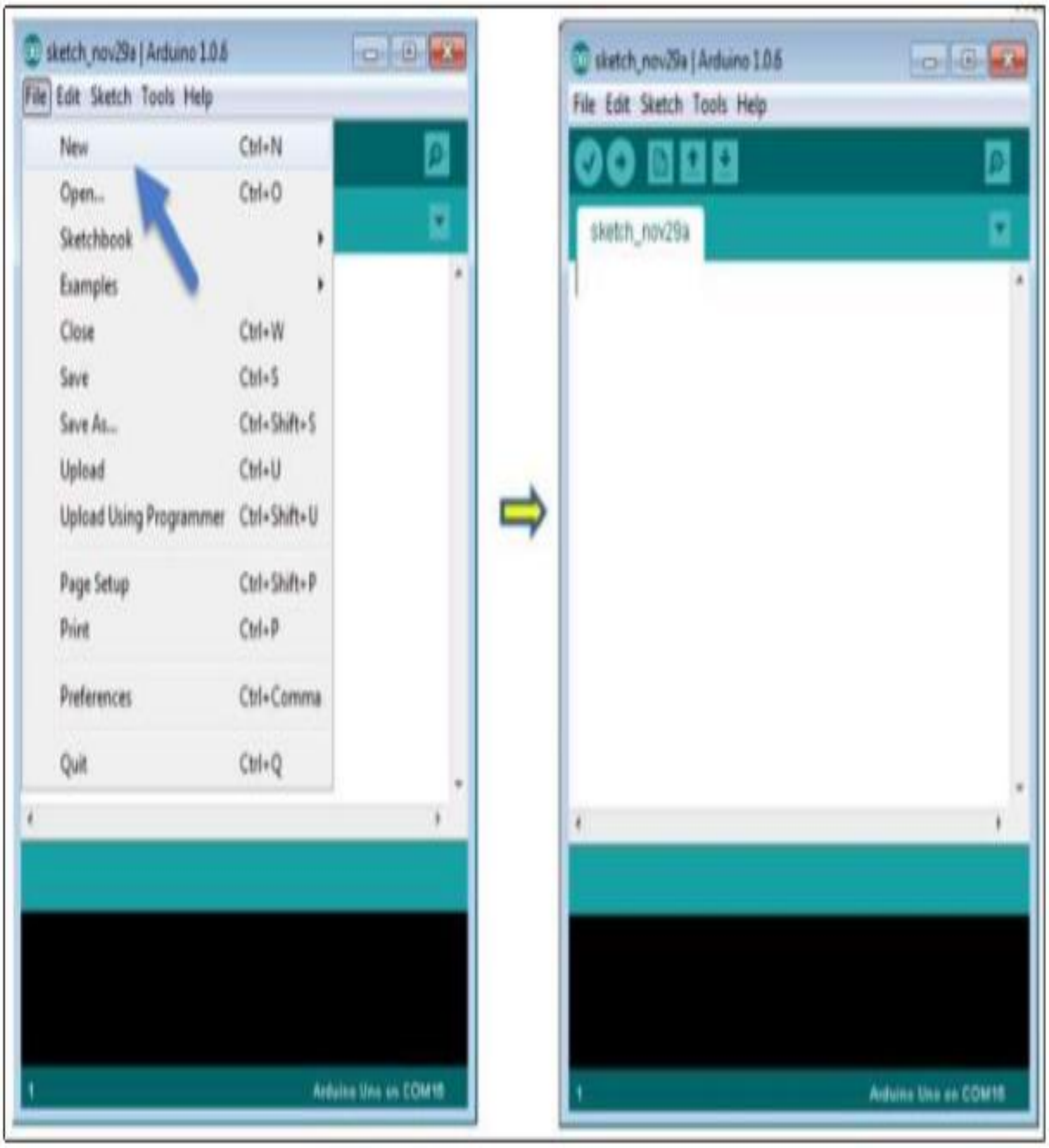


Fig 5.5 To open an existing project example, select File -> Example -> Basics -> Blink

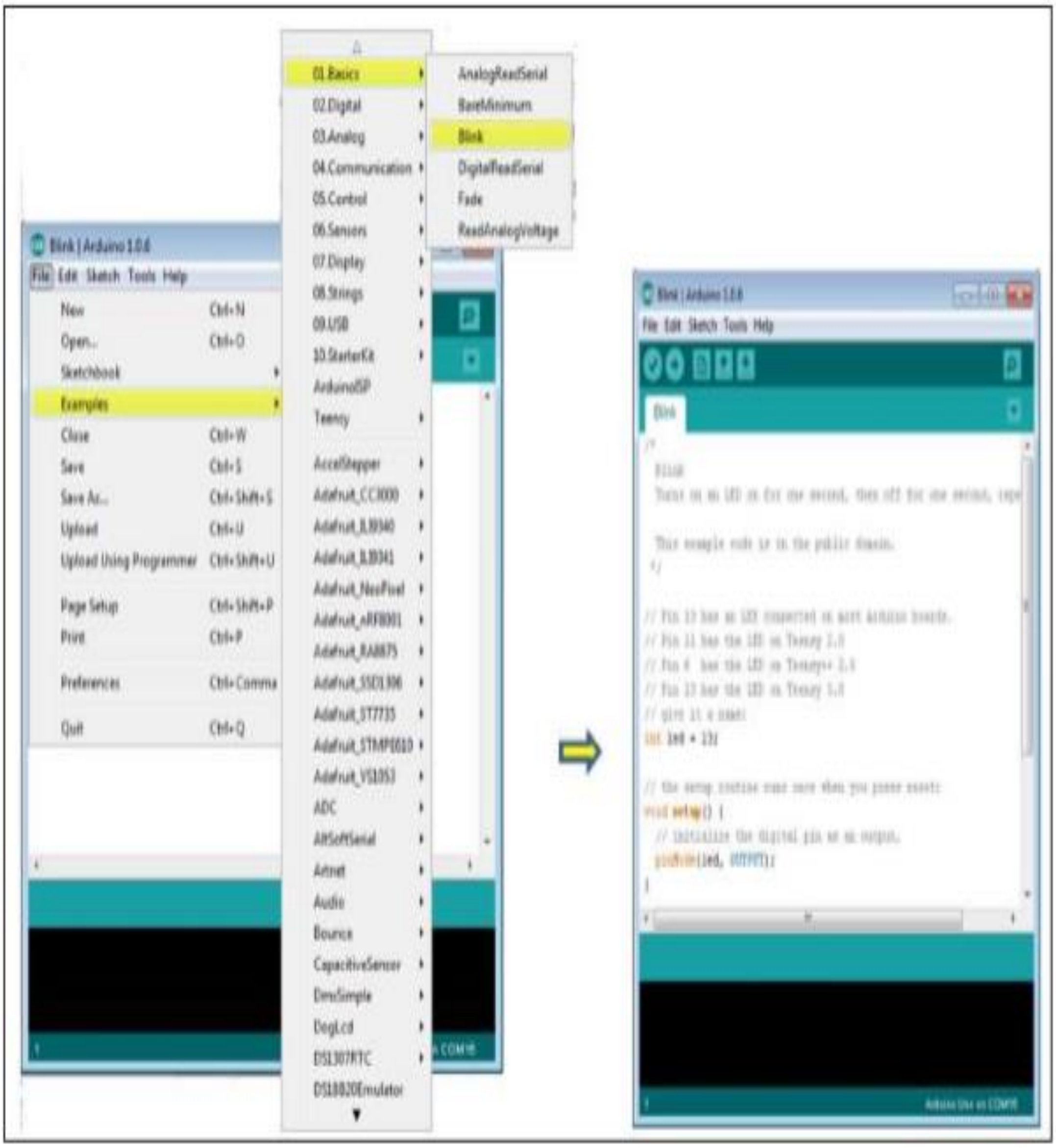


Fig 5.6 Here, we are selecting just one of the examples with the name Blink. It turns the LED on and off with some time delay. You can select any other example from the list.

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.

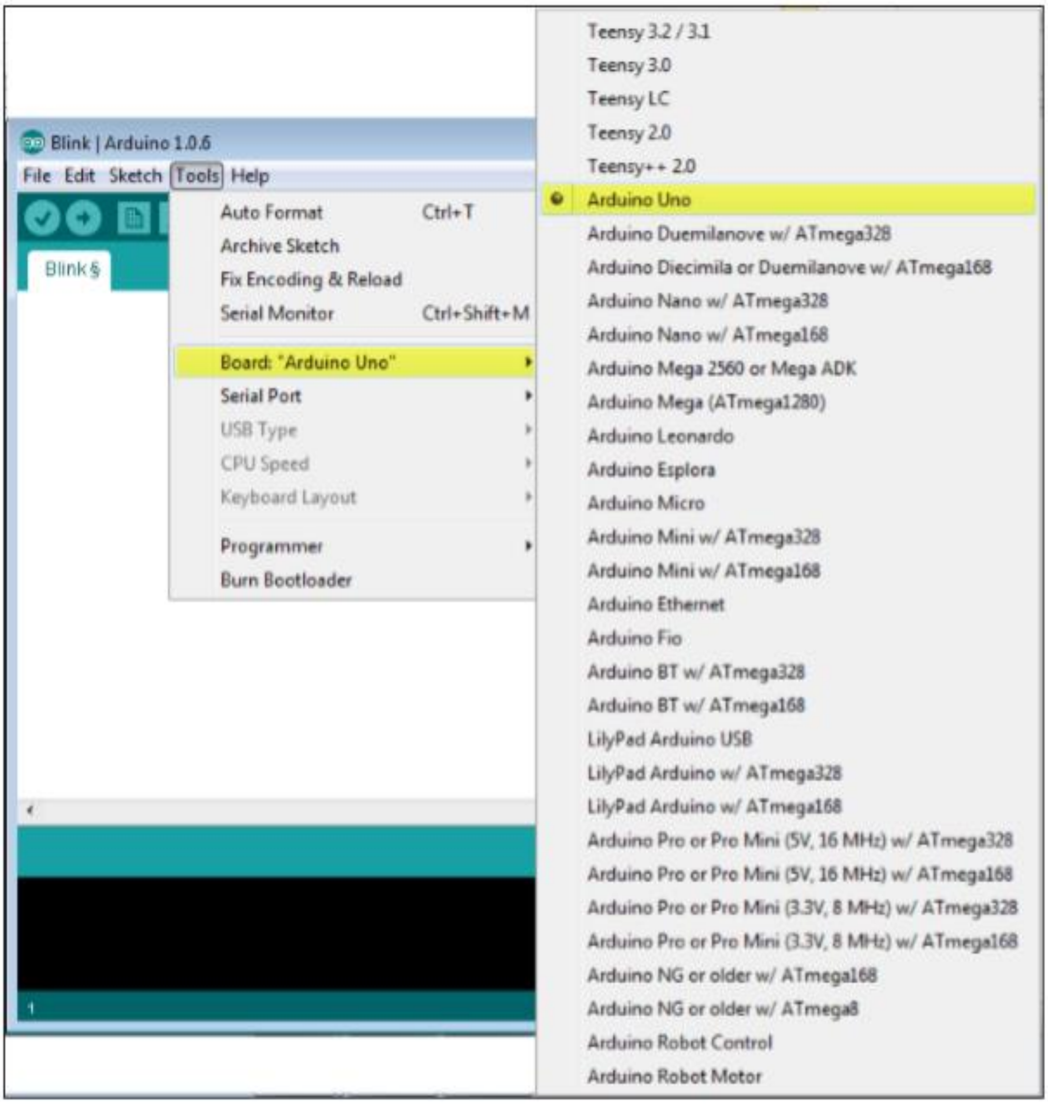


Fig 5.7 Here, we have selected Arduino Uno board according to our tutorial, but you must select the name matching the board that you are using.

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.

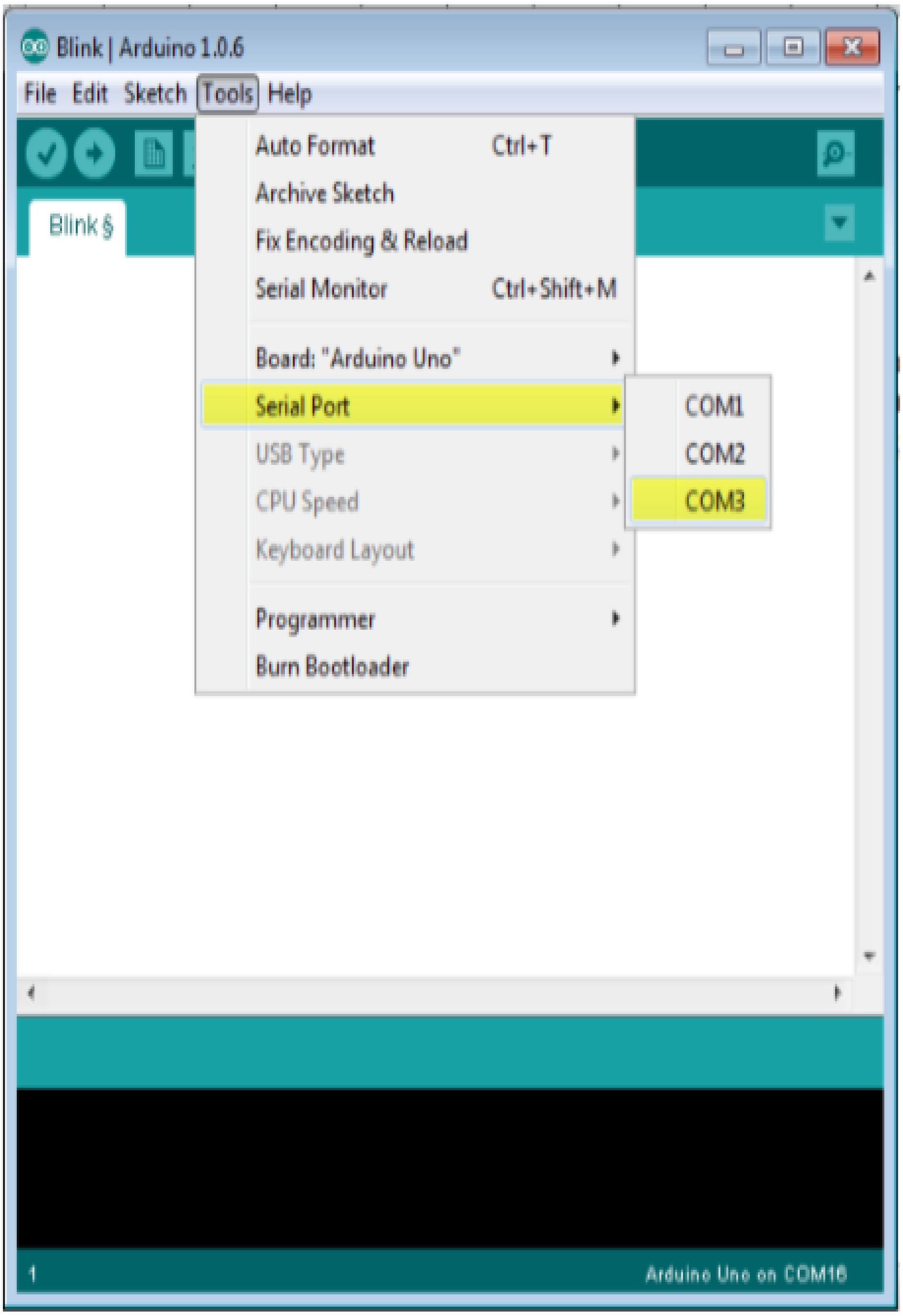


Fig 5.8 Connecting the board with Arduino software

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.

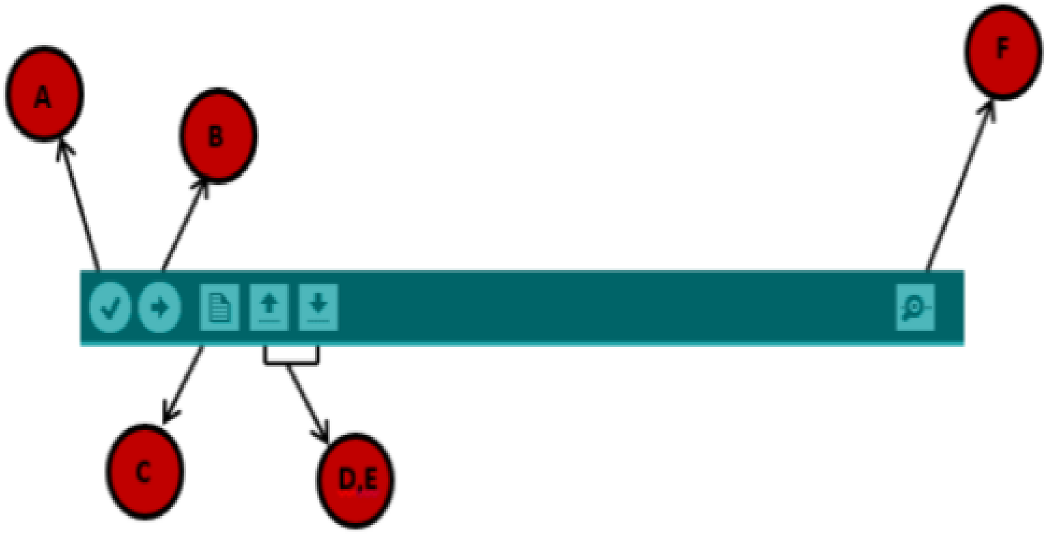


Fig 5.9 Schematic Diagram of Arduino

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.

5.3 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

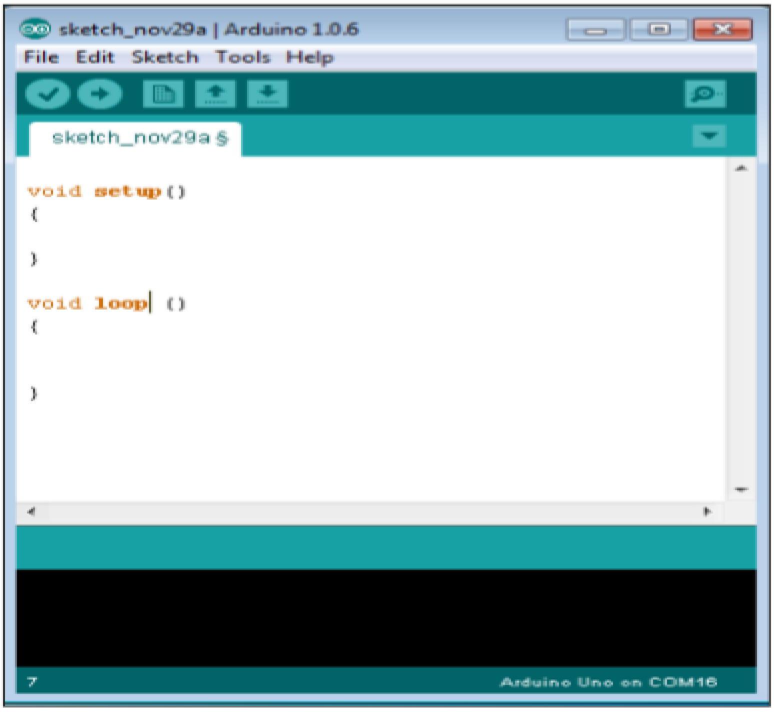


Fig 5.10 Arduino Programming Space

```
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: -

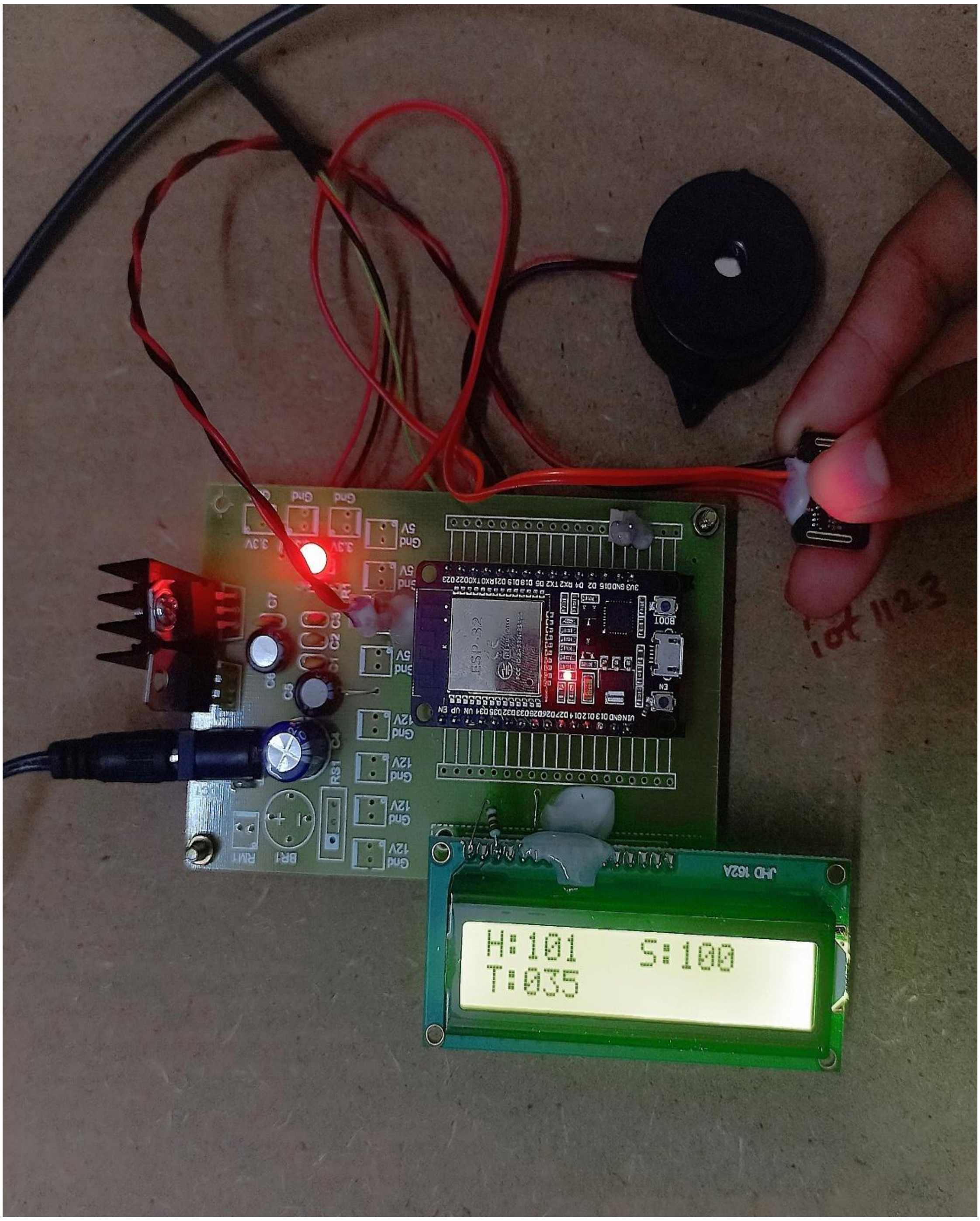
OUTPUT: -

RETURN:

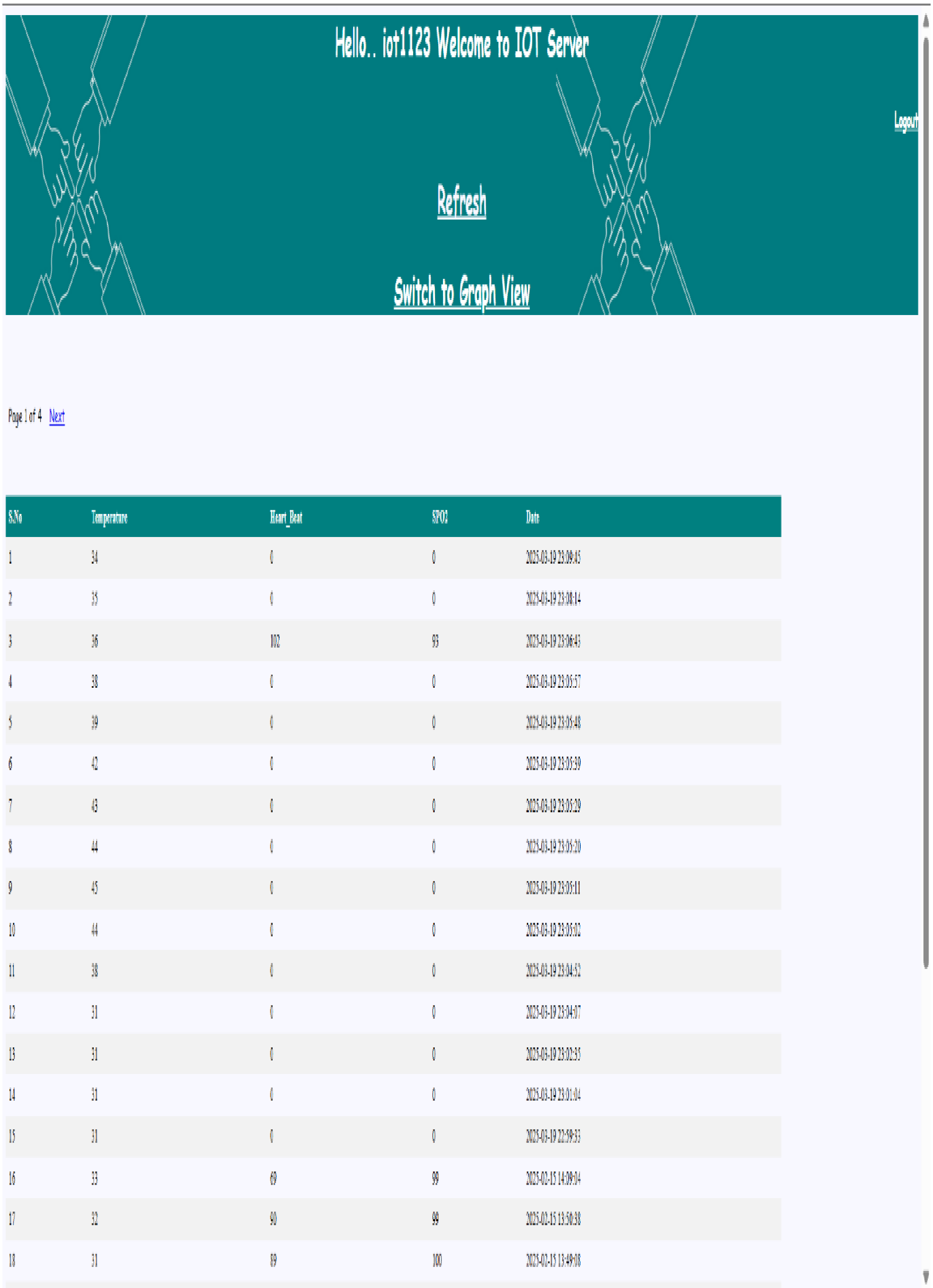
CHAPTER-6

6.1 OUTPUT RESULT

The image shows a circuit with an ESP32 development board mounted on a RPS. The circuit includes various components such as a voltage regulator with a heatsink, capacitors, and connectors. A buzzer is connected to the board, and a person vitals are collected by the circuit.



The website with real-time vitals like heartbeat, SPO2, and temperature as determined by the circuit is depicted in the image.



S.No	Temperature	Heart_Beat	SPO2	Date
1	34	0	0	2025-03-19 23:09:45
2	35	0	0	2025-03-19 23:08:14
3	36	102	93	2025-03-19 23:06:43
4	38	0	0	2025-03-19 23:05:57
5	39	0	0	2025-03-19 23:05:48
6	42	0	0	2025-03-19 23:05:39
7	43	0	0	2025-03-19 23:05:29
8	44	0	0	2025-03-19 23:05:20
9	45	0	0	2025-03-19 23:05:11
10	44	0	0	2025-03-19 23:05:02
11	38	0	0	2025-03-19 23:04:52
12	31	0	0	2025-03-19 23:04:07
13	31	0	0	2025-03-19 23:02:35
14	31	0	0	2025-03-19 23:01:04
15	31	0	0	2025-03-19 22:59:33
16	33	69	99	2025-02-15 14:09:04
17	32	90	99	2025-02-15 13:50:38
18	31	89	100	2025-02-15 13:49:08

Fig 6.1 CLOUD READINGS

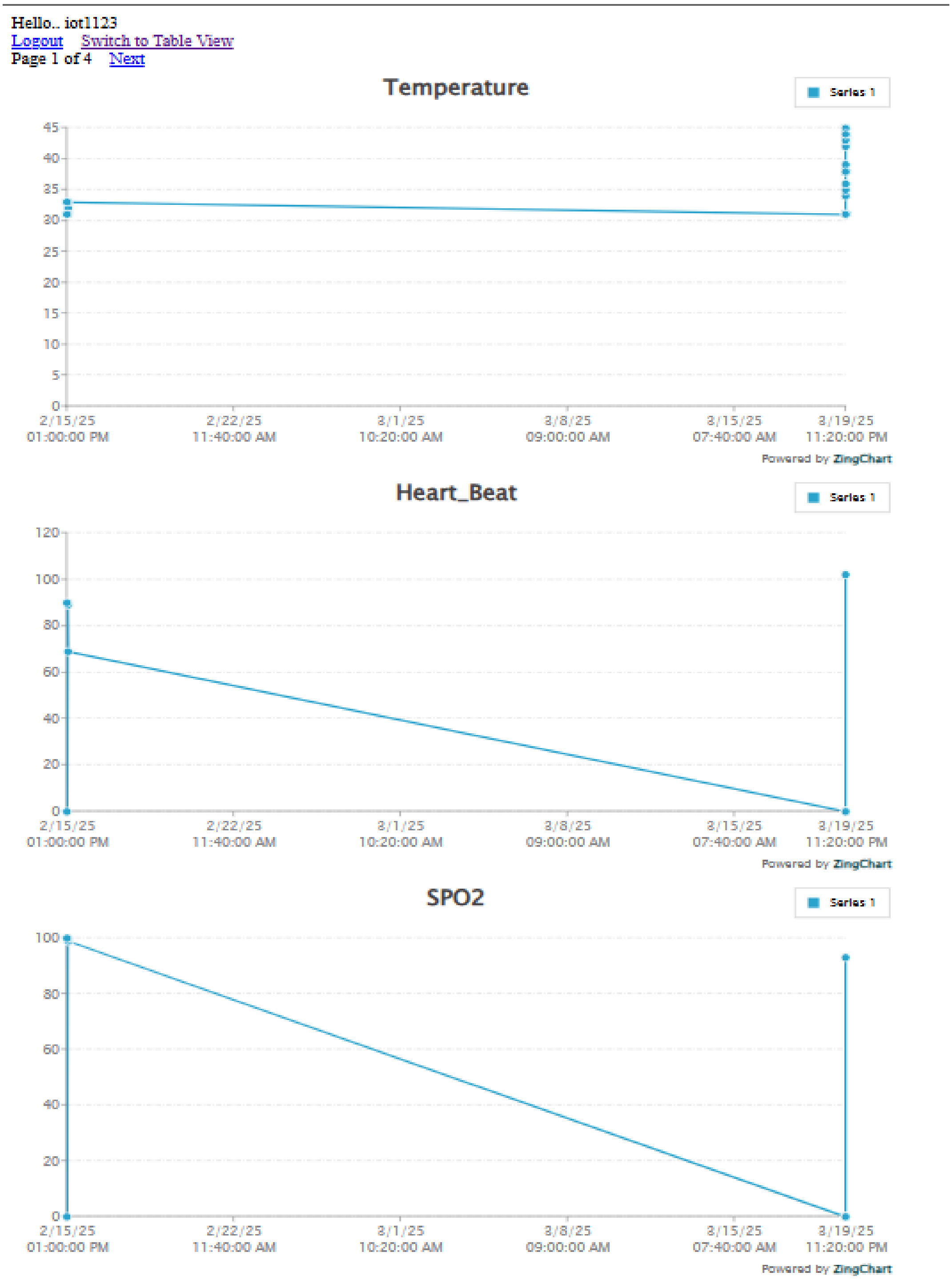


Fig6.2 GRAPHICAL REPRESENTATION

The picture displays the website with real-time vitals including temperature, heart rate, and SPO2 that are graphically represented by the circuit.

CHAPTER-7

CONCLUSION AND FUTURE SCOPE

7.1 CONCLUSION

The gadget designed is used to establish connection using internet anywhere, it is advantageous compared to zig-bee or Bluetooth, in real time doctors can monitor the patients from anywhere. The IoT based patient monitoring system is an innovative technology that brings benefits to the society. It brings the biomedical application into the users mobile. This system can be applied in areas where there is a lot of people.

This is a Real-Time IoT Application System in mobile environment of IoT applications. The Big data collected in the IoT devices are also handled through the data analytics process. This system provides an improved efficiency in real time. These techniques can also be applied for all health care services and its applications like disease supervision and elderly care. The system can be modified to the industrial needs and could be used for industrial applications and many other applications.

7.2 FUTURE SCOPE

AI-powered healthcare monitoring systems integrated with IoT and hosted on cloud platforms like AWS are set to revolutionize healthcare by enabling continuous patient monitoring, improving outcomes, and reducing costs. These systems leverage advanced predictive analytics, real-time decision support, and personalized treatment plans to enhance care. As AI models analyse data from IoT devices in real-time, they can predict health issues before they become critical, enabling early intervention.

The integration of remote patient monitoring, telemedicine, and AI-driven virtual health assistants will make healthcare more accessible, particularly in remote areas. AWS cloud services provide scalable, secure, and cost-effective infrastructure, enabling seamless data integration from multiple sources. Moreover, the combination of IoT, AI, and cloud computing can help in drug discovery, clinical trials monitoring, and personalized chronic disease management. The future will see the rise of smart hospitals, elderly care systems, and the expansion of edge computing to reduce latency and improve real-time data processing. As these technologies evolve, ensuring data privacy, security, and regulatory compliance will be critical, but the potential for AI-driven healthcare to improve patient care, reduce operational costs, and enhance healthcare efficiency is immense.

As AI algorithms become more sophisticated, these systems will provide real-time health insights, early disease detection, and personalized treatment recommendations. AWS cloud services, including AWS IoT Core, AWS Lambda, and Amazon SageMaker, will enable scalable, secure, and intelligent data processing, improving the accuracy and efficiency of healthcare solutions. With the integration of wearable IoT sensors, 5G connectivity, and edge computing, remote patient monitoring will become more efficient, reducing hospital visits and healthcare costs.

AI-driven analytics will enhance early warning systems for chronic diseases like diabetes, cardiovascular conditions, and respiratory disorders, ensuring timely medical interventions. Furthermore, blockchain integration will enhance data security and privacy, addressing concerns regarding patient confidentiality and compliance with healthcare regulations like HIPAA and GDPR. The use of robotic automation and AI chatbots for virtual healthcare assistants will further improve patient engagement and accessibility. As AWS continues to innovate in cloud computing, the AI-powered IoT healthcare ecosystem will evolve into a fully automated, predictive, and highly personalized healthcare framework, significantly improving global healthcare outcomes.

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