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Internet of Things

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Abstract: ***The Internet of Things (IoT) is a trend emerging in information and communication technologies, and it has been ubiquitous for the last two decades. What do you mean by "Things"? A hardware device or an object of the physical world connected to the Internet is IOT. The Internet of Things (IoT) works for end-user devices, Mobile, Tablets, laptops, desktops, etc. In recent years, there has been an increasing number of broader devices connected to networks, including vehicles, smartphones, medical units, household devices, smart televisions, etc.***

Keywords: Internet of Things (IoT), Machine-to-Machine (M2M) communication, Cloud computing, Smart devices, Wearable technology, Wireless sensor networks (WSNs)

I. INTRODUCTION

Internet of Things (IoT) can be implemented in projects like Smart cities, Health-care, the Automation industry, Smart Agricultural, Smart Vehicles, Temperature sensing, Traffic control, etc. IoT can be used in assistant devices like Amazon Alexa and Google Cast Home. The Internet of Things (IoT) is already successful and is used in almost 8 billion devices connected to the Internet. A recent study determined that IOT will be used in every device in the upcoming years. IOT is used to Automate the device and do the work with less effort. In the household, we use IOT for a Smoke detection unit, Temperature sensing unit, Solar panel, Smart Television, Heating sensing unit, etc.

One of the dynamic and existing developments in communication technologies is the Internet of Things (IoT). The Internet of Things is so well developed that we can now communicate with devices. Tesla car is the Perfect example of communication with a machine.

The car is a driverless vehicle, and the vehicle can share and have driving instructions from an enduser. Some Experts project it can generate US $ 13 trillion by 2025. The Internet of Things (IoT) refers to the capability of everyday devices to connect to other devices and have an existing infrastructure, and communicate between end-users. They can communicate with end-user and collect and transmit a large amount of data to companies. The data flow in the Distributed Manner. Things are objects of the physical world (Physical Thing) or the information world (Virtual world). Static is known for Physical networks, and Dynamic is known for virtual networks.

II. EVOLUTIONARY PHASE OF IOT

1) *Connectivity:* In this phase, end-users are connected to the clouds and web services and can have search engines for information and know about the Internet of Things. Connectivity can be from a single sensor to a big factory unit.
2) *Networked Economy:* This Phase supports e-commerce and supply chain enhancement along with collaboration engagement to cloud/drive increased efficiency in business processes.
3) *Immersive Experiences:* This phase grows the Internet understanding to surround across-the-board videotape and colonial media while frequently merging via mobility with end-user. Learning is essential in this meadow because we can only have incredible creations with hands-on experience with the project.
4) *Internet of Things:* This phase adds Connectivity to objects and machines worldwide for an end-user to enable new services and experiences. The Internet of Things will help industries accumulate efficiency and harness espionage from various supplies.

III. STAGES OF IOT ARCHITECTURE

IoT technology is a wide variety of applications, and nowadays, the use of IoT is increasing significantly faster. IoT works depending on the device's location and Internet connectivity. It will work perfectly as it is being designed/developed, but it may differ in some cases. There is a basic flow on which IoT is built.

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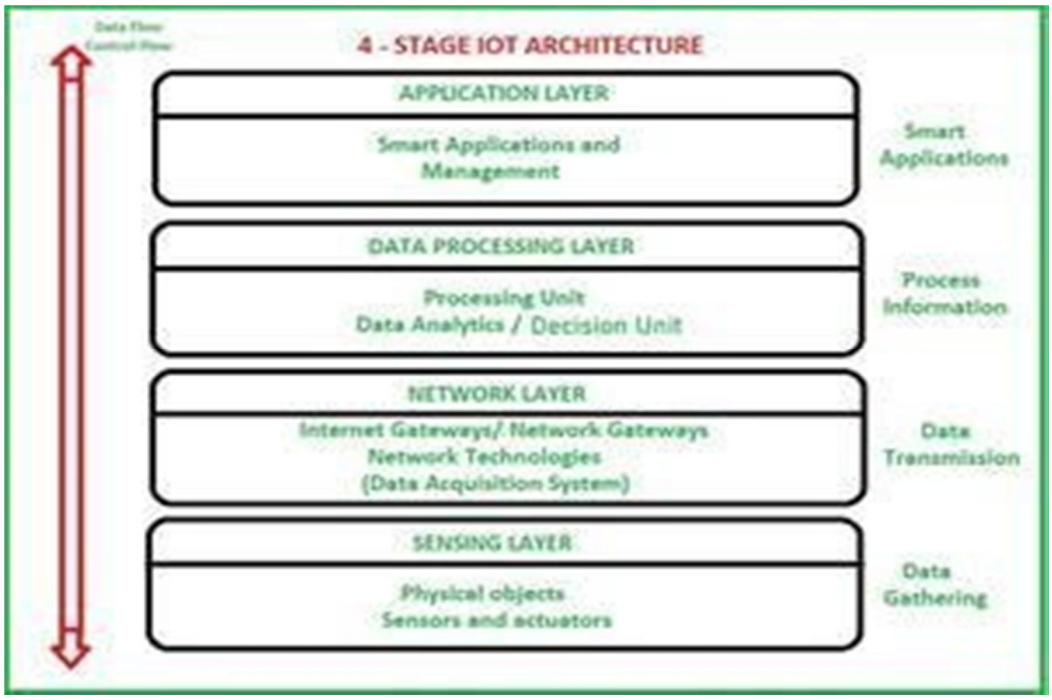


Fig 1: Stages IOT Architecture

1) *Sensing Layer:* Sensing Layer is the first Layer in the IOT Architecture. It is responsible for collecting the data from different sources. This Layer has sensors and actuators placed in the environment and gathers information like Temperature, humidity, light, sound, etc. The connection is wired or wireless.
2) *Network Layer:* The network Layer is the Second Layer in the IoT Architecture. It is responsible for communication between devices in the IOT system. The device should connect to the Internet and communicate with other devices. The connection technology used in IOT includes WiFi, Bluetooth, Cellular Data (4G and 5G), ZigBee, Ethernet, etc.
3) *Data Processing Layer:* Data Processing Layer is the Third Layer in the IOT Architecture. It is responsible for and refers to the software and hardware devices. This Layer collects the raw data and analyzes the data for further actions. This Layer has many tools like Data Analysis, Machine Learning Algorithms, Management Systems, etc. This algorithm extracts meaningful data for insight into the data and makes significant decisions from received data.
4) *Application Layer:* Application Layer is the Fourth and Topmost Layer in the IoT Architecture. It directly interacts with the end user and is responsible for giving the end user a user-friendly experience and functionality. This Layer contains various Software applications like Mobile apps and web portals, which are underlying in IOT infrastructure. This Layer includes a middleware layer, which is used to communicate with other devices and share data with the gadgets simultaneously.

A. *IOT Characteristics*
1) Interconnectivity
2) Heterogeneity
3) Things-related Services
4) Dynamic changes
5) Self-Adapting
6) Self-Configuration

B. *IOT Communication Models*
1) Request / Response model
2) Publish / Subscribe model
3) Push / Pull model
4) Exclusive Pair model

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IV. COMPONENTS OF IOT

The Hardware utilized in IOT systems includes:

- An isolated dashboard.
- Gadgets for managing wait people.
- A routing or bridge machine.
- Detectors.

The devices manage vital functions such as system activation.

A. Major Components of IOT Devices

1) Control Unit: Control Unit means the "Brain" of the IOT hardware device. The microprocessor is the microcontroller and central processing unit. It handles all the numbers and crunches of the data and the manipulation of the data. The memory includes Random Access Memory (RAM) and Read Only Memory (ROM) to store the individuals.

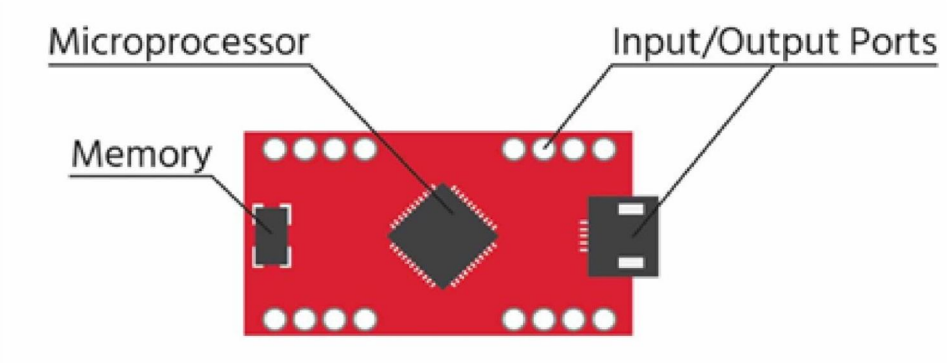


Fig 2: Microcontroller

2) Sensors: Sensors play a vital role in IOT devices. Sensors are used to Sense things in IoT. The sensor attains physical parameters and converts them into signal-suitable processing. The output of the sensor is the human-readable signal, like changes in resistance, temperature, impedance, etc.

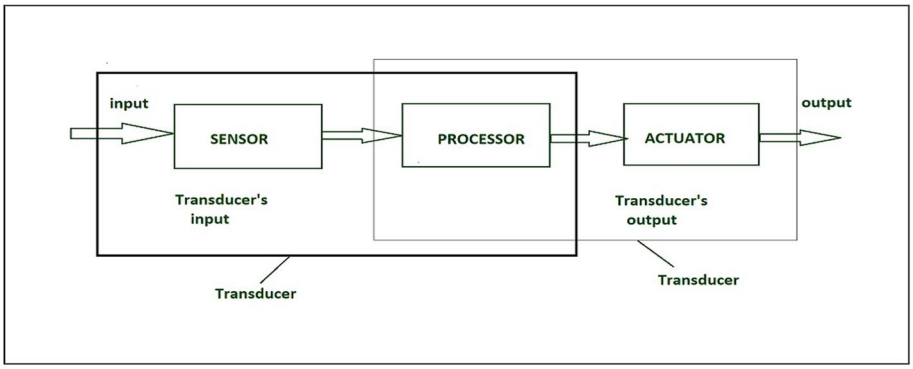


Fig 3: Sensor Hardware

a) Characteristics of Sensors

- Static
- Dynamic

b) Specifications of Sensors

- Accuracy
- Resolution
- Sensitivity
- Repeatability
- Bandwidth

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3) *Power Source:* Power source is in the form of batteries and has traditionally been the dominant source of Energy or Power source in wireless IOT systems or devices. Batteries are the storage for the Energy sources which can be used by the device when the device is held to be in use by any industry work.

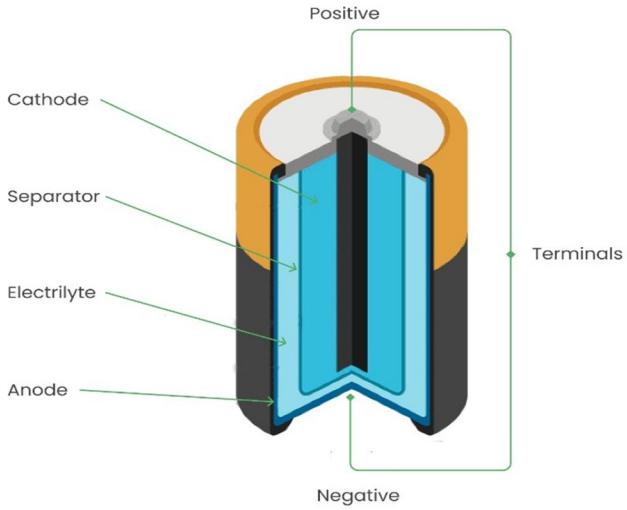


Fig 4: Batteries

4) *Protocols:* Ethernet is the protocol used for wired medium, Ethernet, in its most basic version, runs at 10 Mbit/s Ethernet has traditionally been used to network enterprise workstations and to transfer non-real-time data. The Ethernet standard allows for several implementations, such as twisted pairs of coaxial cables. The maximum length of the Ethernet is determined by the node's ability to detect collisions. The worst case occurs when two nodes at opposite ends of the bus are transmitting simultaneously. Ethernet accomplishes not supply any mechanism for recognizing obtained peripheries.

a) WiMax refers to a broadband wireless network based on the Institute of Electrical and Electronic Engineering (IEEE) WiMax standard, which ensures compatibility and interoperability between broadband wireless access equipment. A single WiMax tower can cover a large area, 3000 square miles. WiMax receiver is the antenna that could be a little box or personal computer Remembering card, or they could be assembled into a laptop the way wifi entrance is today.

b) ZigBee was introduced in 2002; seeing that neither Wifi nor Bluetooth could not fit some of their needs for embedded systems, several industrial companies formed the consortium called ZigBee Alliance, aimed at providing standard and low cost and low computation wireless communication. ZigBee communication can reach up to 500m, with a data rate of up to 250 kbs, for a typical power consumption of 125 to 400 microwatts.

V. TEMPERATURE SENSING USING IOT

Nowadays, sensors are beneficial for any work if we want to build an intelligent technology device. Sensors play a vital role in IOT devices. Sensing the signal is necessary for the devices to work correctly. Sensors sense the movement and send it to the microcontroller for further action. Some applications, such as tools for creating life-saving prescriptions, mandate temperature sensors to be responsive and authentic for vital differentia authority. However, some applications, like the thermometer in your car, don't require as accurate or responsive sensors.

A. Sensors

1) Thermocouple
2) RTDs
3) Thermistor
4) LM35
5) LM35C
6) TMP36

The above sensors are used to sense the temperature for any device in IOT where it is necessary. In some kinds of devices, the accuracy is very important. Those types of devices are fitted with thermocouples and RTDs. And some of the devices where the temperature accuracy is not that important are fitted with LM35 and LM35C. LM35 ranges from −55°C to 150°C, while LM35C ranges from −40°C to 110°C with better accuracy Temperature sensors are used to measure the temperature signals in solid, liquid, and gaseous form. They are used in industrial applications. Temperature sensing is monitored when there is a change in resistance and electrical current.

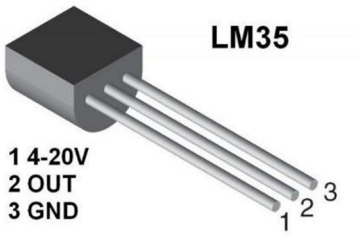


Fig 5: LM35

B. Why is Temperature Sensing Necessary

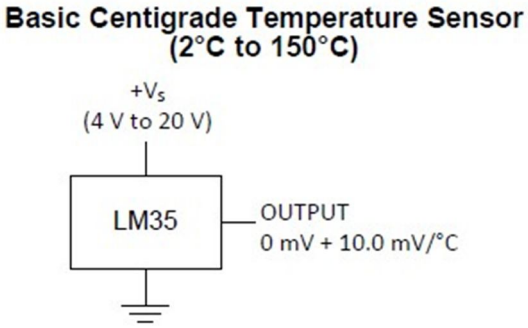
Temperature sensing is used in many electrical appliances. To hold the minimum requirement of the temperature to keep the environment safe or healthy. Temperature sensors are used in household electrical appliances like Refrigerators, Freezers, Heaters, Ovens, etc.

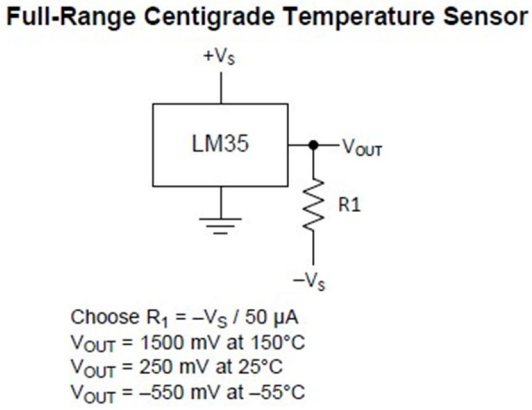
Without temperature sensing, the electrical appliances might get crash, or the control over the temperature might get disturbed, and the working of appliances might stop.

C. LM35

1) LM35 is calibrated directly in Celsius
2) Linear + 10-mV/□C Scale factor
3) Suitable for remote appliances
4) Operates from 4V to 30V

LM35 measures temperature from -55°C to 150°C (Centigrade). The accuracy is very high if operated at a high level of humidity. The voltage might get drop while the circuit is in progress. LM35 ranges from +4V to 30V, and it acquires 60 microamperes of current. LM35 has different variants as per the appliances it is used in, like LM35, LM35C, LM35CA, LM35D, LM135, etc.





VI. ARDUINO MICROCONTROLLER

Arduino is an open-source Microcontroller that can be easily programmed and is a mini-size computer; Arduino board can be easily programmed or can be easily erased and reprogrammed in any instance; Arduino was developed in 2005 for easy interaction of professional students with their environment and IOT devices using sensor and actuator. Arduino board has the capability of working like a minicomputer by receiving the input and controlling the input, and feeding back the output for the actual electronic devices. Arduino has the ability to send or receive information over the internet with the help of Arduino services or Arduino shields. Arduino uses hardware such as Arduino uno board and software for programming such as C, C++, etc. To code for Arduino, there is an Arduino IDE (Integrated Developing Environment) which is built with an 8-bit Atmel AVR microcontroller.

Arduino Microcontroller has come into the market recently, but it has acquired half of the market because it is easy to handle and easy to work on the Arduino board. Usually, hardware developer prefers only the Arduino board because it has many functions and services that can be used to make work done easily. The Arduino board is designed very simple so that it can be connected to our regular computer using USB and coded through the IDE. Arduino programs run in C, C++ programming language.

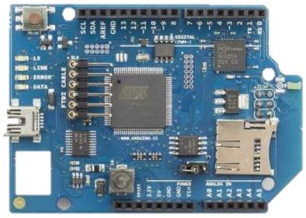
There is a variety of Arduino board available in the market, but to choose one of them then, a developer need to take a survey and check the capabilities of the Arduino board, and then select further work.

A. Types of Arduino Microcontroller

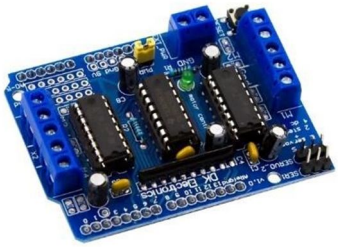
1) *Arduino Ethernet Shield:* It allows Arduino to connect to the internet using the Ethernet library and read SD cards using the SD library.
2) *Arduino Wireless Shield:* It allows Arduino to connect wirelessly using ZigBee.
3) *Arduino Motor Drive Shield:* It allows Arduino board to communicate using Motor Driver etc.



Arduino Ethernet



Ardunio Wireless



Arduino Motor Drive

B. Software

Software is a program code written in a programming language. The software written for Arduino is usually noted in Arduino IDE. This IDE contains the following parts:

1) Text editor
2) Message area
3) Consol Toolbar

C. Programming Basics

❖ void setup() ❖ void loop()

Both are always present in the programming sketch. These basics are usually known as the Functions of the code. Without a function, the code/sketch cannot compile or debug itself void setup() function has all the library files stored, which we use while programming. This function contains the initialization of the pin which are in use.

1) void setup()

This is the first routine of the sketch or a code. This function executes only once throughout the programming functioning.

Syntax: -

```
void setup()
{
pinMode(pin, INPUT);     pinMode(pin, OUTPUT);
}
```

2) void loop()

This is the second most important function in the sketch or a code. This function tells the line of code how many times it has to execute continuously. This function is written under the void setup() function. **Syntax:**

```
void loop()
{
  digitalWrite(pin, HIGH);
}
```

If we want a delay in the code, then there is one more function called delay. **Syntax: -**

```
delay(1000);  //delay for a second
```

D. Applications

Arduino is an endless application as it is vital to create projects by professional developers or professional students in the engineering field. Many projects use Arduino, and the project is going way more advanced in the upcoming years.

E. Temperature Sensing

The temperature detector in Arduino transforms the surrounding Temperature into Voltage and Voltage into Celsius and Celsius into Fahrenheit and prints the Fahrenheit on the LCD screen.
We are going to use TMP36 (Temperature sensor). This sensor is also stable for low voltage and high capacitive loads.
The operating voltage of the TMP36 ranges from 2.7V to 5.5V.

F. The Pins are arranged as

- Pin 1: DC voltage

We will connect the DC voltage pin to 5V on the Arduino UNO board.

- Pin 2: Analog voltage output

We will consider the Analog voltage output pin as the output.

- Pin 3: GND

We will connect the GND pin to the Ground on the Arduino UNO board.

G. Hardware Requirements

1) 1x TMP 36 sensor (Temperature sensor)
2) 1x LCD display
3) Arduino board
4) Jump wire

H. TMP 36 Sensor

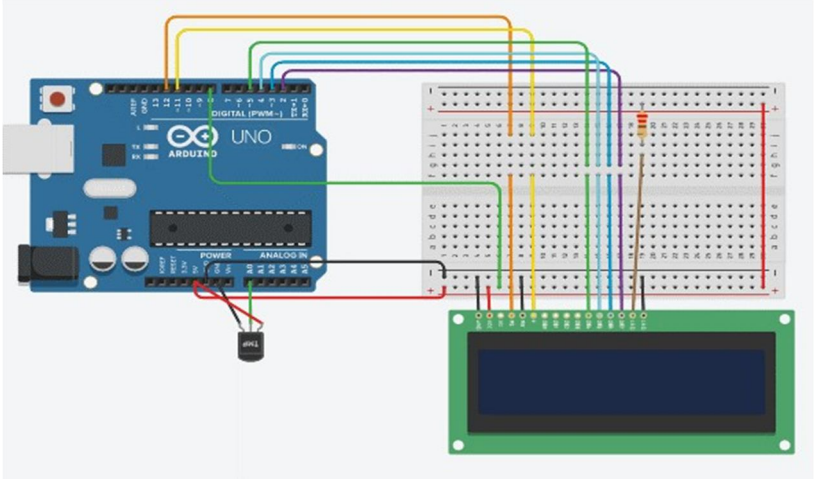


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I. Arduino Program for Temperature Sensing

```
#include <LiquidCrystal.h>
// initialize the library with the pins on the Arduino board  LiquidCrystal lcd(13, 12, 6, 4, 3, 2);  const int temperature = A0; //A0 is the analog pin  const int D = 8; // Vo of LCD is connected to pin 8 of the Arduino  void setup()
{  lcd.begin(16, 2);  Serial.begin(9600);  pinMode(D, OUTPUT);
}  void loop()
{
 digitalWrite(D,LOW);  int Temp = analogRead(temperature);  float volts = (Temp / 965.0) * 5;  float celcius = (volts - 0.5) * 100;  float fahrenheit = (celcius * 9 / 5 + 32);  Serial.println(fahrenheit);  lcd.setCursor(5, 0); lcd.print(fahrenheit);  delay(2000);
 // time delay of 2000 microseconds or 2 seconds
}
```

J. Diagram

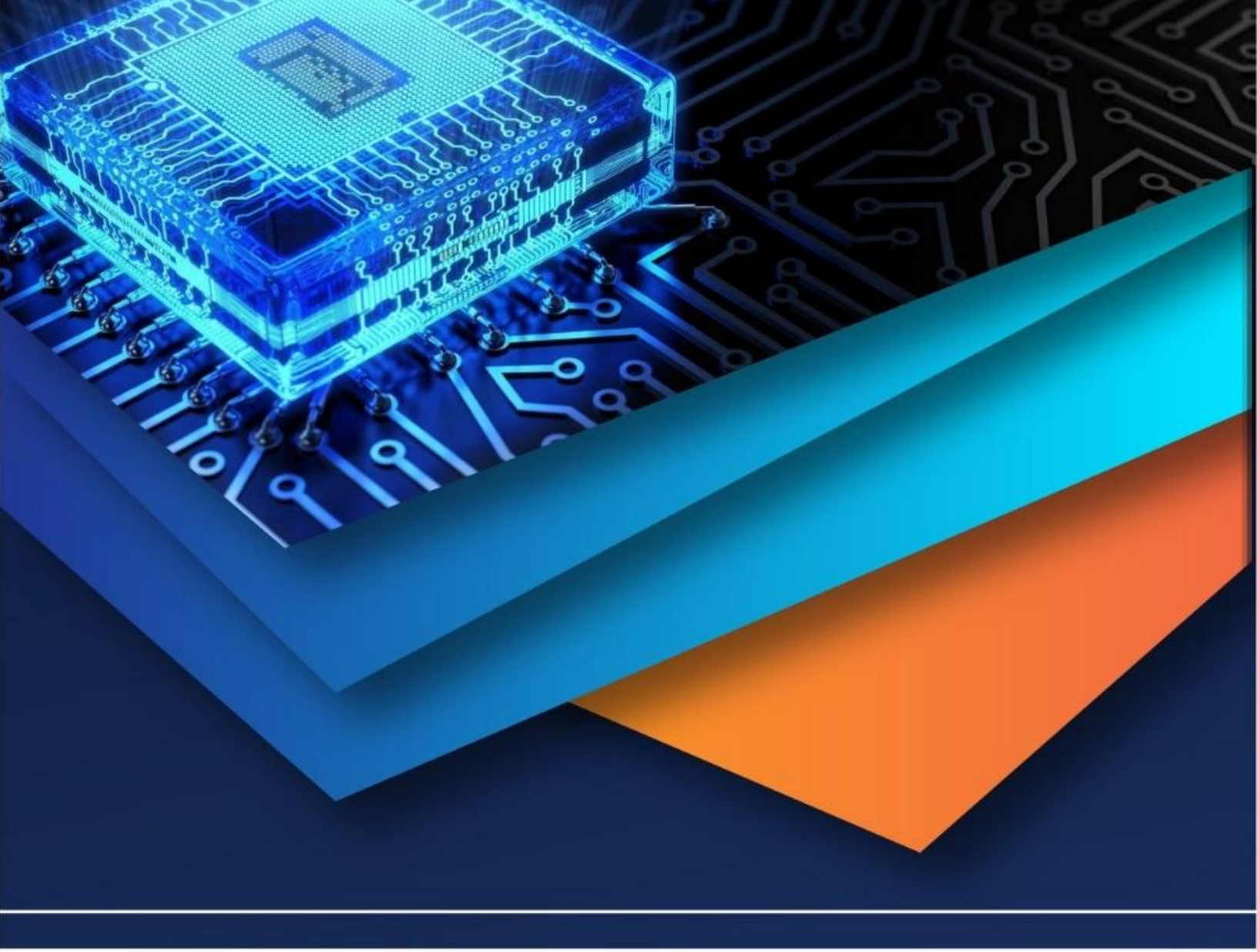


VII. CONCLUSION

In this research paper, we have studied the basics of the Internet of Things (IoT), temperature sensors, Arduino board, and hardware/software requirements. We learned to develop or write sketches of Arduino in Arduino IDE for Temperature sensing. Arduino is an endless stream for IOT devices. A professional developer usually uses Arduino to create innovative things. Arduino is also known as a minicomputer that can control the process's input and output. The microcontroller of the Arduino is very intelligent, and it can be used in multiple programming languages. Arduino innovation can be done from wearable fashion to space satellite research programs. Arduino is a designed board that can be accessed from our setup or computer using a single USB cord. Arduino has no limitations and can be a learning platform for electronic students.

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