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CONTENT

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Surveillance and Fire Fighter Drone

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ABSTRACT
This paper presents a drone equipped with FPV camera and GPS module, along with a carriage containing a fire extinguisher ball. The FPV camera provides a live video feed of the drone's surroundings, allowing for remote piloting and navigation. The GPS module enables accurate tracking and location data, improving the drone's precision and safety. The fire extinguisher ball in the carriage provides an added layer of safety, allowing for quick response to potential fires in hard-to-reach or dangerous locations. The combination of these features creates a versatile and effective tool for a range of applications, including search and rescue operations, monitoring and inspection of infrastructure, and emergency response services. The drone's FPV camera module enables the operator to have a first-person view of the drone's surroundings, which is particularly useful in scenarios where visual inspections are required. The GPS module provides accurate location data, which is essential for mapping and tracking applications. The fire extinguisher ball, which is mounted in the carriage, is an innovative safety feature that can be deployed in emergencies to extinguish fires quickly and efficiently. The drone's versatility and flexibility make it a valuable tool for various industries, including construction, surveying, agriculture, and firefighting. In conclusion, this drone with FPV camera module, GPS module, and fire extinguisher ball in the carriage is an excellent example of how technology can enhance safety and improve efficiency in a range of application.

Keywords- Unmanned Aerial Vehicle (UAV). COVID-19, Remote Control, Dropping Mechanism.

I. INTRODUCTION

Unmanned Aerial Vehicles (UAVs), sometimes referred to as drones, are a hot new technology. Drone technology has grown into a huge invention that is useful in many fields. Therefore, it is not surprising that they successfully mastered increasingly complex tasks while increasing their autonomy. They today serve a variety of civil and military roles in transporting people and goods, rescue services, tourism, cities, photography and videography functions, and in other areas such as mountains and seas. Deployment of UAV carriers in the maritime sector began in January 2016, when the first drone transported approximately 1.2 kg crates of Danish Maersk brand shortbread biscuits from a tugboat to a tanker off the coast of Zeeland, Denmark (Cage, 2016 Downs, 2016; Paris & Wall, 2016; West Coast Sailors, 2016). The cookie did not crack even when dropped from a height of about 5 meters. Many years earlier, in his 1898, Nikola Tesla patented "Method and Apparatus for

Regulating Drones in the Marine and Energy Sectors for Controlling the Movement of Ships or Vehicles", Drones in the Marine and Energy Sectors (Tesla, 1898).). Unmanned Aerial System (UAS). It usually consists of a UAV, a ground controller, and an communication system. Operators, who operate drones using either two or one drone fleets. UAVs can fly with varying degrees of autonomy, either autonomously or remotely controlled by a human pilot. Drone technology has grown into a huge invention that has many uses, including firefighters. In this field, drones can be used for many advantages such as: Intelligent detection of trapped creatures, inaccessible surfaces, extinguishing with a simple ball toss mechanism, and extinguishing with a ball with a single servo actuation. This cutting-edge technology can be used to increase the efficiency and safety of today's fire fighters. With these aspects in mind, drones are being developed in an automated, need-based manner. This project aims to overcome issues related to frame weight and compatibility with the equipment used in the system. Originally used in surveillance activities, UAVs have inspired people to develop systems for use in a variety of applications. Our project combines a drone with a quadcopter and launch mechanism. Drones contain various components such as frames, control panels, motors, propellers, flight control boards, batteries, transmitters and receivers. These are the main components that help drones function and operate according to our needs. The purpose of this manuscript is to explore the potential use of drones in the maritime sector. The author's goal is to study the literature on reports of successful projects and missions, as well as drone-based transportation projects currently being carried out. The results of this research will allow us to categorize potential beneficiaries and map the tasks that can be performed by drones.

II. LITERATURE SURVEY

In paper [1]. This study's main objective is to assess ATCo workload using fast-time simulations in light of the integration of unmanned aircraft systems (UAS) into the National Airspace System(NAS). We also take into account circumstances where Air Traffic Controllers (ATC) are experienced with manned and unmanned aircraft and have distinct ATCO attitudes as a result. Additionally, a comparison of the effects of UAS on workload during the first phases of theirintegration and in the long run is done. This project utilizes drones for air traffic analysis to make aircraft lifting works more reliable and effective. The ATCo seeks to ensure adequate safety and efficiency levels to address problems that arise in complicated scenarios. Additionally, with ATCO guidance, the Air Traffic Control (ATC) offers Air Traffic Services (ATS) to planes. These services' major objectives are to minimize and maintain an orderly flow of air traffic while preventing mid-flight collisions and collisions with objects. The ATCO controls the aircraft in the sector or collection of sectors for which he or she is accountable, using methods to increase safety and effectiveness, such as aircraft vectoring. In addition, the Technology Maturity Level (TML) is suggested here to differentiate aircraft based on familiarity levels, ie., the tasks carried out by ATCO change according to the TML of each aircraft. From this survey, we can utilize the autonomous technology of airlifting the UAV for surveillance.

In the paper [2]. the Urban Air Mobility (UAM) agent model Netlogo tool can be seen in this study. Netlogo is a tool for creating MAS (Multi Agent Simulation), used to create simulations for multiple domains and scenarios. The advent of the use of manned and unmanned aerial vehicles has created some problems in urban environments when considering electric vehicles known as eVTOL (Electric Vertical Take-Off and Landing). Every day, people around the world waste hours on the road. People spend a significant portion of their commute time traveling between work and home, resulting in millions of hours of unproductive time each day. One of the biggest challenges for governments around the world is urban mobility. Over the years. significant

investments have been made in domestic transport infrastructure to reduce travel times, especially in metropolitan areas where congestion is a major problem. However, in the face of continual population growth and the resulting increase in transport demand. Industry and academia have invested resources in recent years to develop new ideas to improve urban transport performance. From this research, we learned how the project will transport goods, much like urban air mobility planes.

In the paper [3], a proposed system that combines drones and remote sensing to complement traditional firefighting techniques, this study explores the potential use of fireballs. The proposed system is (1) a reconnaissance unmanned aerial system (UAS) that uses remote sensing to detect spot fires and monitor forest fire risks approaching buildings, fences, or firefighters: It consists of a communication UAS for establishment and extension. A communication channel between the reconnaissance UAS and the fire UAS, and (3) the fire UAS autonomously driving to a waypoint to drop a fireball (environmentally friendly, heat- activatable extinguishing agent). The idea was developed through an interdisciplinary and multi-institutional effort. Tests conducted to date to evaluate fireballs are included in the scope of this study, as is a comprehensive presentation of this design. Research suggests that drones carrying small fireballs may not be very useful in extinguishing building fires (unless the building's windows are already open). Based on their findings, the authors chose to fight wildfires rather than ignite flames.bottom. The study also demonstrates progress in building drones with large payloads (approximately 15 kg payload) and drone-mountable devices that emit fire-extinguishing balls,we learn how drones successfully.

In the paper [4], in this research infiltrated the maritime sector and increased security. They can effectively replace people and can be deployed where life and health are at risk during operations such as tank and hull inspections. Completely in ren=mote capacity. Used for transporting spare parts, documents. medicines, etc. It will also be used for search and rescue operations and will also offer the latest technologies such as 5G. Drones are reliable and effective, and their use minimizes costs and saves time. This article provides an overview of the latest knowledge on the use of drones in the maritime sector. It explores the potential use of drones and presents potential and successful use of drones by various parties such as classification societies, shipyards, and search and rescue missions (SAR).

Benefits and limitations, and roadmaps for drones in transportation are also analyzed. The paper also provides application forecasts for the Polish maritime sector in the West Pomerania region. Identify set goals by sifting through the literature using desk research methodologies and analyzing literature reports, articles, materials and inquiries and market offers published by successful beneficiaries using drones Did. This review paper gives an idea of how drones can be used in marine applications such as surveillance, patrol and biological surveys.

In a paper [5], this research shows how fire accidents can lead to serious injuries and property damage, and how these problems can be overcome with drones. The paper also shows how to build heavy drones for firefighting at sea and on land. Common fire accidents often occur unexpectedly and suddenly. The Times of India announced that one of his five deaths from fires worldwide in 2017 was in India, leaving

27.027 dead. That year, around 9 million fires broke out worldwide, killing 1.2 million people. According to the National Crime Records (NCRB), based on 12,748 fatalities in 2018, 35 Indians die in fire accidents every day. As such, drones could be a solution for firefighters to decide where to focus their resources and how to approach and enter the scene. As the latest global trend, you can see that the delivery of medicines and food by drones is increasing. It was a fast means of transport for delivering goods. So, from this project, we will use drones to carry out congestion transportation that will reach the destination on time.

In paper [6], from this paper, we study how to build a firefighter drone using a fire extinguisher and how to control the drone using wireless communication (using radio signals). Firefighting is traditionally done using firemen and fire engines. Later it was modified into firefighting robots. Fire Fighting Robots were controlled by Computers. Our research intends to manage and offer a solution for extinguishing fires using a fire extinguisher or other similar device mounted on a drone. A firefighter's life is constantly in danger since it is a dangerous career. In an inaccessible fire-prone location, using a firefighter drone to carry out this work can help avert and/or prevent undesirable accidents or the loss of lives. This piece of work discusses the creation of a firefighting drone with any necessary combat equipment installed on it. We have not come across any such attempt being made in the literature. The Fire Fighter Drone is made for use in harsh environments. It is operated and controlled by a remote user and has the flexibility to extinguish the flame. Its components connect wirelessly and are made to be controlled by a monitoring system. Drones may be operated in a variety of ways, including remotely, autonomously, and semi-autonomously.

In [7]. from this study, drone weather detection is a unique technology that can be used to detect weather conditions in the ocean that can provide carly detection of sources such as tsunamis and tornadoes. This technology was highly praised and was selected by the USAF GreenSight has confirmed that its WeatherHive sensor technology has been approved by the United States. Air Force and Defense Innovation Units were selected for inclusion in the prototype system. Developed with support from the National Science Foundation. the technology uses a swarm of nano-sized drones to directly measure atmospheric conditions. WeatherHive data promises to enable breakthroughs in weather forecasting and, climate science. WeatherHive with weather data Predictive models can more accurately predict tornado formation, severe storm behavior, wildfire hurricane tracks. movement, and hurricane tracks.

According to the paper [8], the use of drones for spying purposes is one military application. The US State Department said in April 2018 it would purchase four of his MQ-4C Triton drones for signal intelligence missions under his PEGASUS program (short for Persistent German Airborne Surveillance System) in Germany. Approved the German request. The program includes a sensor called "ISIS-ZB", manufactured by Hensoldt, that intercepts communications and identifies targets based on electromagnetic signatures. The main purpose of purchasing the MQ-4C is for unmanned border and enemy base reconnaissance. This literature shows how drone technology is being used for border security and espionage.

In a paper [9], this research provides insight into how drones are being used in the wild for firefighting. Wildfires are a major natural disaster that can lead to economic loss. death and environmental destruction. Recently, both the severity and frequency of fires have increased around the world. The creation of specific tools to assist and extinguish forest fires is the subject of research. A remote fire detection and tracking system has been proposed. These techniques have improved in efficiently collecting data and characterizing fires in small-scale situations. However, wildfires spread over such a large area that some of the proposed ground-mounted devices are insufficient to provide optimal coverage. Unmanned aerial vehicles (UAVs) and unmanned aerial systems (UAS) have been proposed as solutions to this limitation. Due to their maneuverability, UAVs have proven useful in remote sensing, assignment schemes, and task planning applications. We can provide affordable options to prevent, detect, and assist in real-time firefighting. This paper reviews previous studies on the application of unmanned aerial vehicles to forest fires. Adjustment techniques, fire detection algorithms and on-board sensors are taken into consideration. Use of drones improves targeted and effective teamwork of firefighter preventing wildland fires.

In paper [10], this drone project survey gives us knowledge about how to build a drone for search and rescue operations. This project entailed the design and testing of an indoor quadrotor UAV capable of autonomous take-off. landing. and pathfinding. The propulsion system produces 1500g of thrust at 46% throttle using 7 propellers, minimizing craft size, but allowing for sufficient payload to carry a LIDAR, a CMOS camera, and rangefinders. These sensors are interfaced with an Overo processor, which sends high-level commands to a low-level flight controller, the HoverflyPro. Flight tests were conducted which demonstrated flight control and sensor operation.

III. OBJECTIVES

The project was designed primarily to extinguish fires in inhospitable or hostile areas. To get firefighting balls into areas that are difficult to access by traditional methods. For inspection of environmental conditions and live recording using first person view (FPV) cameras (Fig.1). The ejection mechanism of the fire-fighting ball mounted on the drone (Fig.2) should be designed innovatively.

Fig.1) First Person View (FPV) Camera.

Fig.2) Fire Fighting Ball.Mounted On Drone

IV. CONCLUSIONS

Based on the results of desk research, this article presented the possibilities and examples of the use of drones in the maritime sector. UAV technology is currently used mainly for inspection, surveillance, firefighting, rescue and search. Overall, drones are used because they save time and money. In addition,
it can ensure work efficiency and people's safety when transporting from port to ship. Also has access to real-time location and analyze extent of fire using FPV camera. Reduced carbon footprint when used at sea, real-time traffic flow management, infrastructure management and intervention, material failure monitoring, improved hazard detection accuracy, high-quality aerial imagery, precise operation, accessibility to reachable areas, and reliability. Drones can also be useful for conducting oceanographic research and monitoring marine life, as well as for carrying out environmental assessments and monitoring pollution. They can also be used to support offshore wind and oil rig operations, by inspecting infrastructure and conducting maintenance tasks. Furthermore, drones can be equipped with a range of sensors and imaging equipment, including thermal cameras, LiDAR, and multispectral sensors, allowing them to capture high-quality data for a variety of applications. This data can be used to create detailed maps and models of the seafloor, to monitor changes in water quality or temperature, or to detect potential hazards like oil spills or submerged debris. One key area is in the development of more advanced autonomy and artificial intelligence capabilities for drones. Improving the efficiency and battery life of drones, to developing new materials and designs that make drones more durable and resistant to harsh marine environments.

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Last, but not least, We owe our debts to our parents, friends and also those who directly or indirectly have helped us to make the Project Phase-1 work a success.

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Reconfigurable Microstrip Patch Antenna Design and Simulation for 5G Application

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ABSTRACT
The project work proposes and discusses microstrip patch antenna loaded with partial ground plane. It provides a deeper knowledge of the usage of the finite element method for analyzing microstrip antenna shape such as rectangular patches. The proposed structure is simulated using ANSYS HFSS. Partial ground plane is simulated using HFSS. For all types of microstrip antennas patch shapes whereas FEM is only reliable for rectangular microstrip antennas shape due to its regularity in its configuration. Switching of the resonating frequency between the 28GHz to 36.78GHz.

I. INTRODUCTION

In modern world, the patch antennas have found enormous attention because of their huge using in electronic warfare, remote sensing, wireless communication including cell phones, space exploration and a many other electronic systems due to its easy installation, economical price, small size, and lightweight. The designing of antennas is suiting growingly difficult accompanied the development in present communication technology. Due to complexity in the antenna structure and its radiation fields, the complete treatment of the antenna problems cannot be solved with analytical methods only, but it also requires a computational electromagnetic model.

In the past few years, a large number of numerical methods have been introduced to find out the solution of antenna electromagnetic problems and microwave instrument analytic traditional methods cannot be successful to meet the radiation and scattering conditions of a complex arrangement. Current achievement on the most recent developments in can be classified into two main categories derived from differential and integral equation such as green function method, finite integration techniques and finite element method, method of moment, finite- difference time-domain method and so on.

The purpose of present study is to learn a best known-how the application of FEM in analyzing various microstrip patch antenna shapes such as rectangular, circular and triangular. Moreover, the performance of both techniques will be clarified through the computation of the mentioned microstrip antenna performances

for example, gain, voltage standing wave ratio (VSWR), bandwidth and radiation pattern with their corresponding measured values experimentally.

II. OBJECTIVE

1. To design frequency reconfigurable microstrip patch antenna.
2. To design antenna for 28GHz on four specific dielectric elements and detect one based antenna.
3. Analysis of various characteristics of microstrip patch antenna such as VSWR, Gain, Radiation pattern, Directivity,3D Gain.

III. LITERATURE SURVEY

[1]. Omar Darboe, et all, in this paper discussed about the designing part for designing of a rectangular microstrip patch antenna. We have taken for 5G application. The antenna resonates at27.954GHz with return loss of -13. 48dB.The proposed antenna can serve as good option for 5G mobile communication which requires high band width. The size of the antenna is very compact and thus is suites devices where the space is the major constrain.

[2]. T Kiran.et.al, discussed about a design and simulation for rectangular patch design using FR4 epoxy as a substrate at resonant frequency the dimensions for patch is simulates can be used to fabricate antenna.

[3]. Saman khabat Ezzulddin.et al reported on the RMPA, CMPA, and TMPA have been fabricated to operate at 28GHz for the application in the 5G technology.

[4]. Urja Sudhir Ingel.et al, discussed about presented below is a wideband monopole frequency reconfigurable antenna and switching between two resonating frequencies 24.9GHz and 25.3GHz due implementations of pin diodes are connected to the radiators via metal strip. RT duroid is used as the substrate of this microstrip circular patch antenna. The monopole helps to provide a wider bandwidth and the frequency reconfiguration is achieved by the pin diodes being used as electrical switches.

IV. METHEDOLOGY

A. Design of an microstrip patch antenna in a HFSS software.

Here the proposed antenna has the patch with x axis 4.4mm and they axis of 3.44 mm and the ground which is present at the below has the x axis 5.6 and y axis 4.65, the substrate which we are using is Rogers-(5880) has thickness of 0.2 and x axis 0.8mm and y axis 1.15 mm. The strip having the measurements of x axis o.6mm and the Y axis of 1.4 mm. The gap between the patch and the feed line is about 0.1 mm.

In addition to the design equation above, other parameters that can affect the performance of the rectangular microstrip patch antenna include the length of the patch, the shape of the patch, the feeding method, and the radiation pattern. material by using popular milling techniques which has been done with machine

Parameter	Description	Value (mm)
Wg	Ground and Substrate width	5.6
Lg	Ground and Substrate length	4.65
Wp	width of patch	4.4
LP	Length of patch	3.44

ap	Radius of circular patch	2.113
aL	Length of triangular side	3.964
h	Thickness of substrate	0.2
Mt	Thickness of patch	0.035
Gpf	The gap between patch and feed line	0.1
Fi	The distance inset feed	1.15
Wf	Width of microstrip line feed	0.6

Table 1: shows optimization antennas dimensions

Antenna design: HFSS is widely used in the design and optimization of various types of antennas, including microstrip antennas; patch antennas, helical antennas, and array antennas. Designers can use HFSS to simulate the radiation pattern, gain, and bandwidth of the antenna, and optimize its performance to meet specific design requirements Microwave circuit design: HFSS can be used to design and simulate various types of microwave circuits, such as filters, couplers, and amplifiers. Designers can use HFSS to analyze the electromagnetic fields in the circuit, optimize the performance of the circuit, and reduce signal loss. RF and microwave component design: HFSS is used in the design and optimization of various RF and microwave components, such as waveguides, transmission lines, and resonators. Designers can use HFSS to simulate the electromagnetic fields in these components, analyze their performance, and optimize their design to meet specific performance requirements. Electromagnetic compatibility analysis: HFSS can be used to analyze the electromagnetic compatibility of various electronic devices, such as cell phones, laptops, and other wireless devices. Designers can use HFSS to simulate the electromagnetic fields in these devices, analyze their interactions with other devices, and optimize their design to minimize electromagnetic interference.

HFSS is powerful electromagnetic simulation software used for the design and analysis of high-frequency structures. It provides designers with a wide range of simulation options, optimization algorithms, and material libraries, which can help them accurately simulate

B. Numerical methods for solving microstrip

Electromagnetic fields and solve complex problems in electromagnetic. HFSS is widely used in industry, research, and academia for a variety of applications, including antenna design, microwave circuit design, RF and electromagnetic compatibility analysis.

A reconfigurable microstrip patch antenna is an antenna capable of modifying its frequency and radiation properties dynamically, in a controlled and reversible Manner.

A reconfigurable radiation pattern antenna reduces the effects of noisy environments by changing the null positions, and it saves energy by adjusting main beam signal towards the intended user to improve the overall performance of the system.

There is a developmental trend in wireless communication systems that require the use of antennas capable of accessing services in various frequency bands, sometimes with the use of a single antenna.

So far, most of the reported pattern reconfigurable antennas can only switch the beam in a limited range. And there are few antenna designs concerned with both radiation pattern and dual-frequency. A pattern reconfigurable antenna that has multiband characteristics improves the whole system. he rectangular microstrip patch antenna is a type of planar antenna that consists of a thin metallic patch printed on a dielectric

substrate, with a ground plane on the other side. The patch is typically rectangular in shape and is fed by a coaxial cable or a microstrip transmission line.

The design equation above relates the width of the patch to the resonant frequency of the antenna and the properties of the substrate.

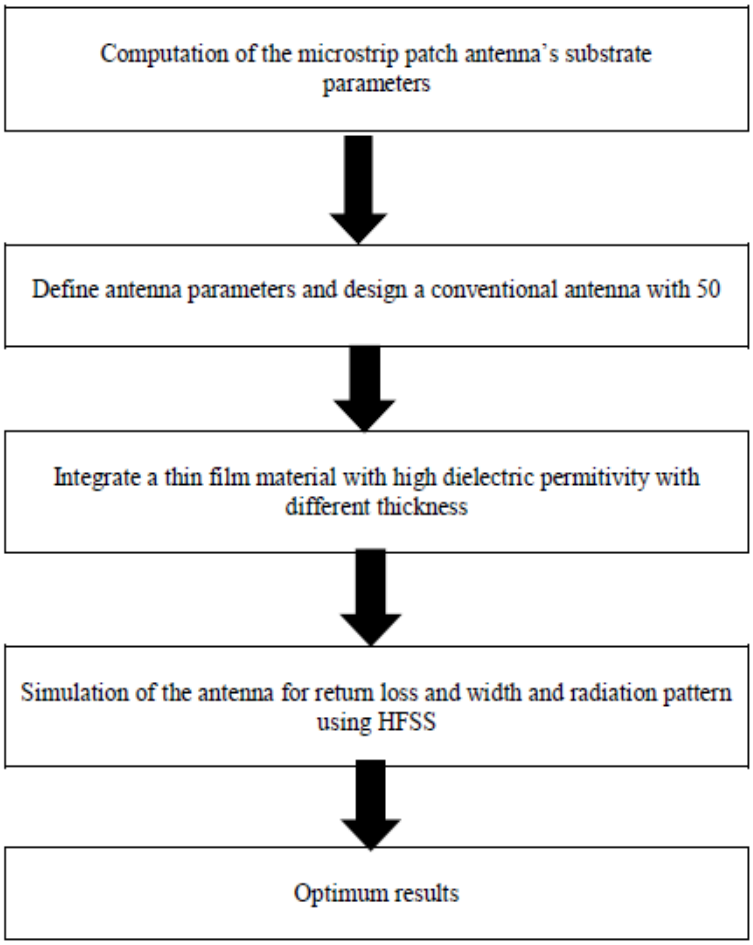

Fig 3: Design flow of microstrip patch antenna patch antenna.

The tuning components are connected to the microstrip line. It is important to provide an accurate and reliable source of knowledge in order to establish antenna design using and FEM methods. The modeling of rectangular patch antenna under consideration of microstrip inset feed.

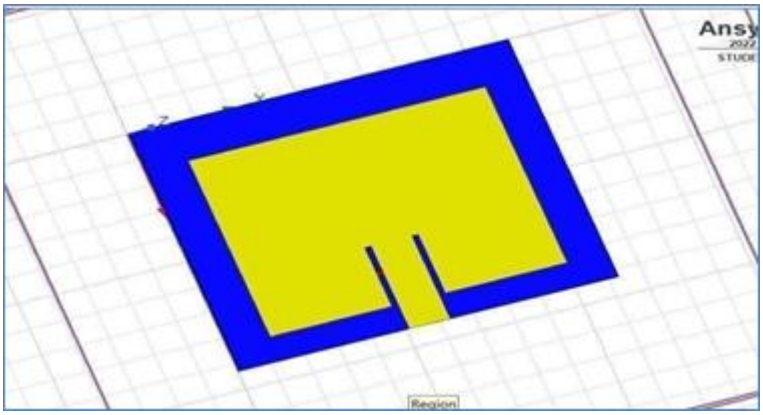

Fig 4: Reconfigurable microstrip patch antenna

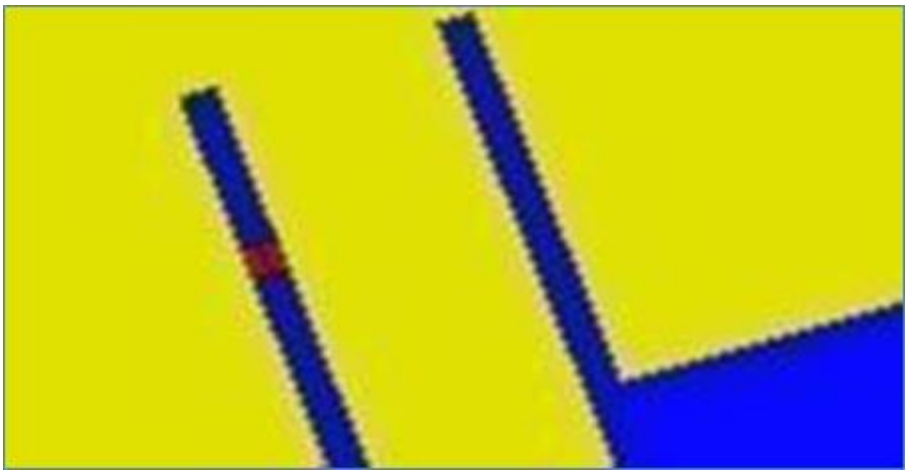

Fig 5: Pin diode in the slot

Measurement patch width (Wp)

Wp=C/2fr √ 2/Er+1

Where

Wp: Patch width (mm)

Er: Substrate dielectric constant

fr: Resonant frequency in Hz

C: Speed of light

A lumped port is analogous to a current sheet source and can be used to excite commonly used transmission lines. While the lumped port spans a physical distance in an HFSS model and includes an area, the lumped port functions as a lumped circuit element in an HFSS simulation.

Pin diode are used as current controlled resistors at RF and microwave frequency, with resistances that can range from a fraction of an ohm when forward biased, or on, to greater than 10 k ohm when reverse biased, or off.

In this project, when the diode is turned on at the resistance of 2.1 ohm, the frequency deviation is about 0.6 n Hz. And when the diode is turned off at the resistance of 3.1 K ohm the frequency deviation is about 0.6nHz. The current flowing through the circuit is about 0.02 pf.

After placing the pin diode, which is equivalent to RLC circuit we have simulated the design of reconfigurable microstrip patch antenna for 5G application and got the following plots as results.

V. RESULT

Here we have designed reconfigurable microstrip patch antenna with frequency of 28Ghz. The microstrip patch shape antennas are on a substrate Rogers (5885) of relatively permittivity of (0.2) mm and thickness (2.2) to operate at 28GHz. Highest gain is 10dB.

Table 2: Details with switch configuration

Name	X[GHz]	Y
D1_OFF1	29.4286	-14.6061
D1_OFF2	36.5000	-10.0255
D1_ON	28.0143	-14.7944

In the s parameter plot the antenna gets turned on at frequency of 28 GHz and turned off at the frequency range of 29GHz and 36GHz.

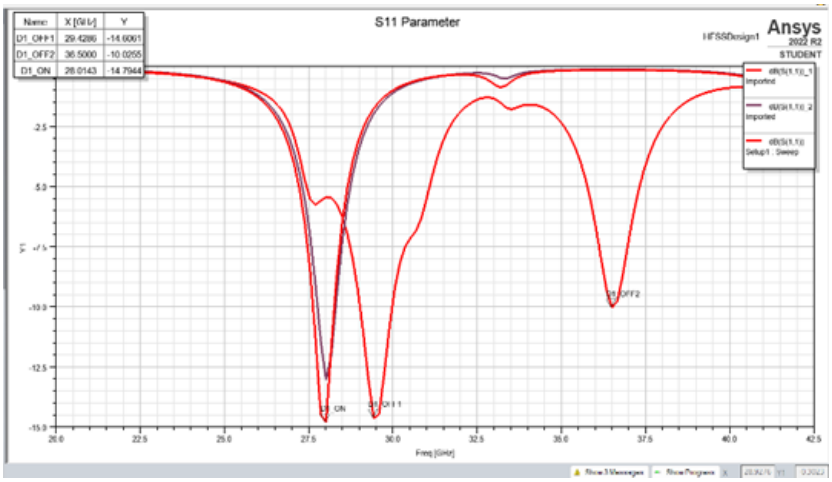

Fig.6 S-Parameter Plot

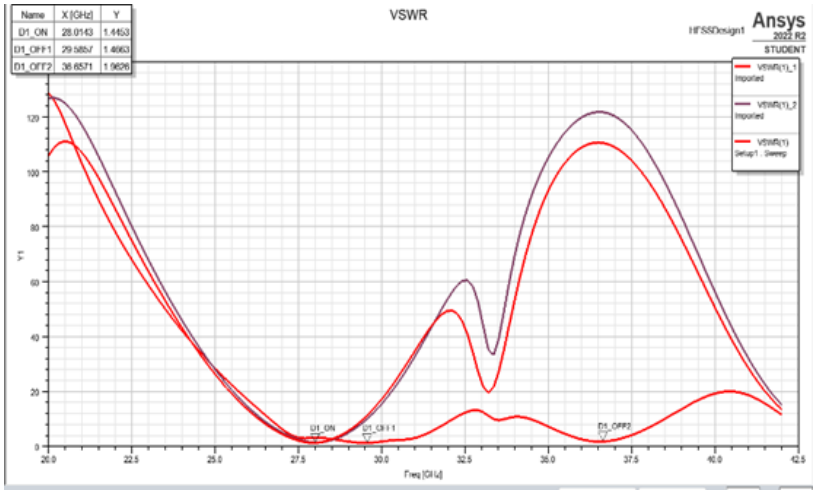

Fig 7: VSWR

In the VSWR plot the antenna gets turned on at frequency of 28GHz and turned off at the frequency range of 29GHz and 36GHz.

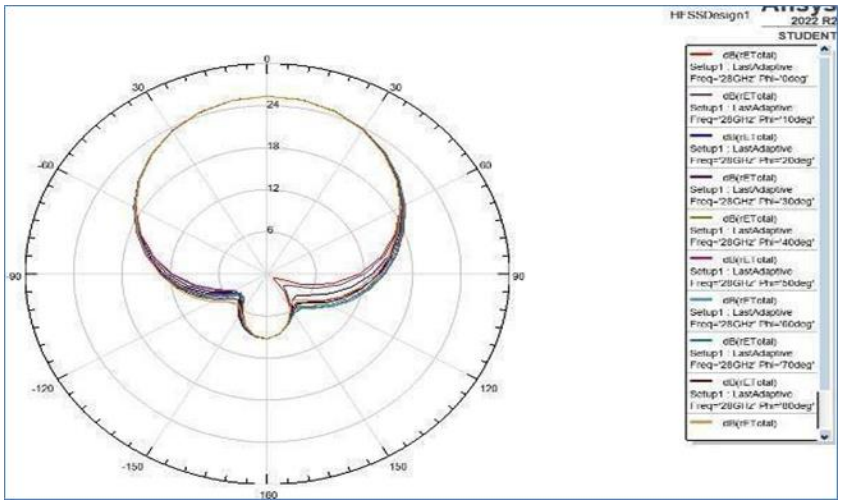

Fig 8: Radiation pattern of designed antenna in ON and OFF mode

Table 3: Details with switching configuration

Diode	State	Resistivity value
D1	ON	2.1 ohm
D2	OFF	3.1 K ohm

In the radiation pattern also, the antenna gets turned on at the frequency of 28GHz and turned off at the frequency range 28GHz to 36GHz.

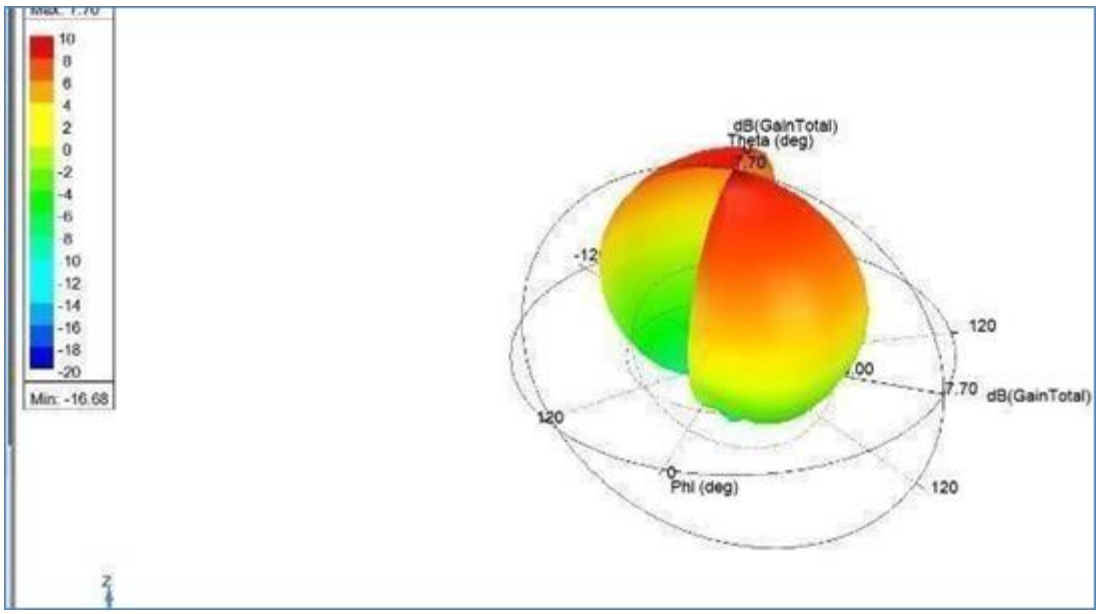

Fig 9: 3D Gain plot of designed antenna

In the 3D gain plot gets turned on at frequency of 28GHz and turned off at the frequency range of 29GHz and 36GHz, here minimum value is- 16.68 and maximum value is 7.70.

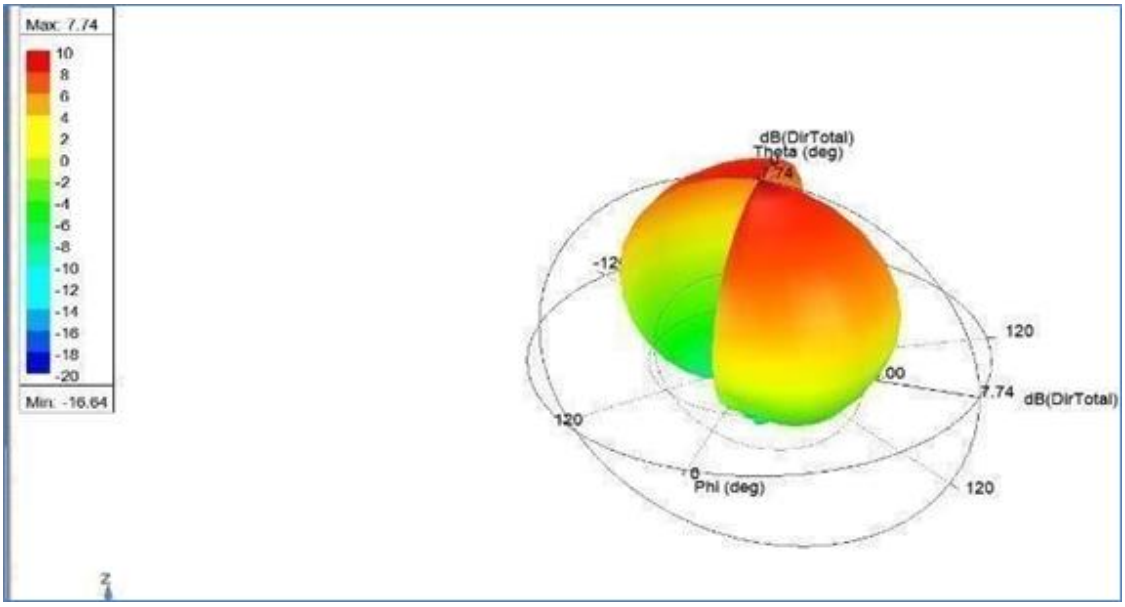

Fig 10: Directivity Plot of designed antenna

In the directivity plot the antenna gets turned on at the frequency of 28 GHz and turned off at the frequency range of 29GHz and 36 GH, here minimum value is -16.64 and maximum value is 7.74.

VI. CONCLUSION

The antenna characteristics such as return loss, VSWR, gain, directivity, and bandwidth and radiation pattern of microstrip patch rectangular shape are evaluated using HFSS Software simulators. The proposed antenna in the proposed work offers a better gain, directivity as well as the bandwidth. Also, the present assumed antennas are easily simulated using Rogers-5880 substrate with compact in size and with a reliable bandwidth of the order of(900MHz). And have been reasonable gain of (6 dB) which is suitable for 5G Applications.

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A Comprehensive Review on IoT Implementations using Raspberry Pi

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ABSTRACT
People have been more accepting of various types of personal computers, such as desktop computers, laptops, tablets and smart phone's, during the last few decades. The RPi Foundation was formed in 2012 by Ebon Upton, who released the RPi as a $35 entry-level computer. The RPi is a small single-board computer about the size of a credit card. The RPi is a low-cost computer that can be programmed and customized in ways. Because it can do almost everything a PC can, the Raspberry Pi has earned the monitor "a computer built to recreate the planet". Automation is a fascinating issue that has progressed with new technology and is now acknowledged as a key component of the "Internet of Things" (IoT) concept. Because of the Internet of Things (IoT), everything can communicate with everything else IoT. IoT is quickly becoming a serious platform for a variety of services and applications. Each device has a low-bandwidth Internet connection, which enables the entire system to interact and communicate in ways that promote safety, security, and luxury. The information is stored in a huge database that is only accessible to individuals who have been granted permission to read it on a website. Patient data is sent from medical equipment to the internet of things through a gateway, where it is stored and analysed.
Keywords: The Internet of Things (IoT), Raspberry Pi (RPi).

I. INTRODUCTION

In our daily lives, technology is increasingly vital. Technology has changed our lives in a variety of ways. The advent of computers and the internet has ushered in a global revolution. In today's world, people rely largely on computers and the internet to carry out their daily tasks. The term "Internet of Things" (IoT) was coined in 1982 to describe the connecting smart devices. During a speech to the Congressional Black Caucus Foundation in Washington, D.C., he said: The term "Internet of Things" (IoT) was invented by Peter T. Lewis in 1985. Kevin Ashton was dubbed the "Father of IoT" for coining the term "Internet of Things" (IoT) in 1999.Kevin Ashton emphasizes the significance of integrating short-range mobile transceivers into devices so that they can communicate with humans and other devices. Human-to-human, machine-to-machine, and human-to-machine interactions are all possible with the Internet of Things, and all of them can influence how we drive. Every day, new innovations of various kinds emerge in various locations around the world. The Internet of Things (IoT) is one such invention. It's received a lot of attention from all over the world and is now used in a

range of industries. In recent years, the internet has grown in importance. As a result of the internet, sensors, and new technologies, ordinary objects have evolved into smart gadgets. The Internet of Things (IoT) is the term used to describe the interconnection of these smart devices.

II. LITERATURE SURVEY IOT

Based on Healthcare

According to person, Surya Deekshith Gupta et al., monitoring the patient's vital signs, such as temperature, vital signs, and pulse rate, could be a critical aspect of the healthcare system. The Internet of Things (IoT) has had to a significant impact on the healthcare business, despite the major fact that is still a fresh revolutionary technological innovation. When new technological breakthroughs are linked to healthcare systems, a slew of new choices for improving patient care communication, decision support, and reducing inaccuracies emerge. The completed device might be used as a prototype for a healthcare system that tracks patient's vital signs. This strategy is simple to implement in any hospital, so the database can store a large amount of data [1].

Kumar and his colleagues developed a sensor that monitors to the patient's heart rate, blood temperature, movement and the breathing rate. The combination of Raspberry Pi with IoT has proven to be a game-changer in the realm of healthcare. Sensor data is collected by the Raspberry Pi and wirelessly sent to an IoT website. After that, go to the IoT website and search for this board's MAC address. The output of the sensors is then linked to the IoT website [2]. It is illustrated in Fig 1.

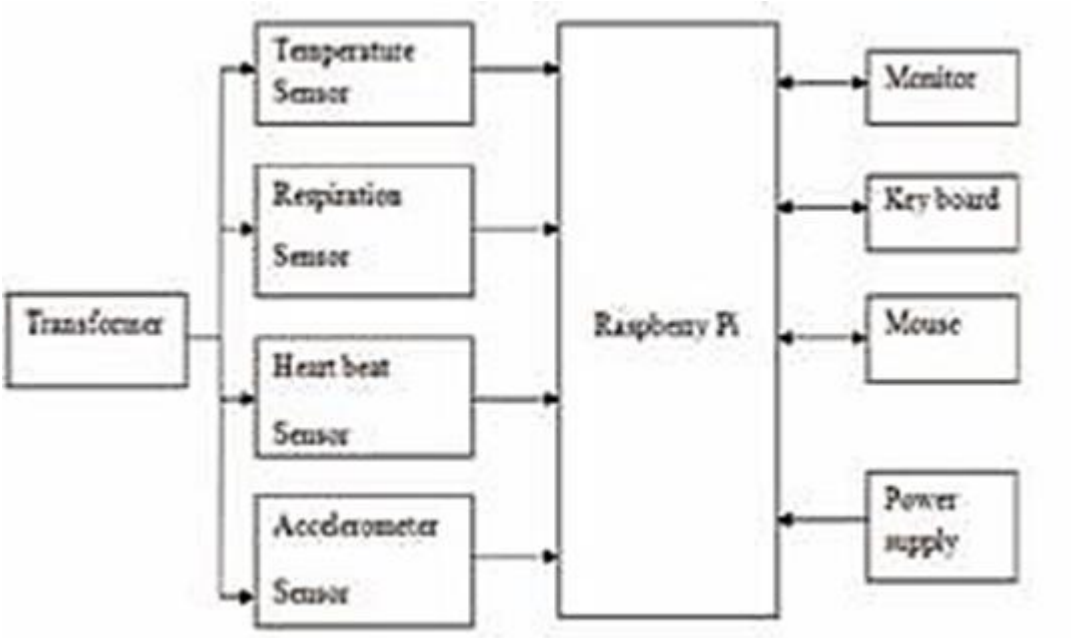

Fig 1: Block diagram of Patient Monitoring System using Raspberry Pi.

Vivek Pardeshi and colleagues exhibited a health monitoring system that uses GSM (2G/3G/4G) technology to detect a variety of biological signs such as pressure, temperature, heart rate, and ECG before transferring the data to an IoT server. GSM technology or the internet's are frequently used to track and transmit changes in an individual's health. In the event of an emergency, doctors and family members will receive automatically created alerts if any unexpected behaviour is seen by or around the patient. The LM35 temperature sensor is

used to determine the temperature of the skin's surface. Advances in management technology can assist individuals in avoiding future health problems and physicians in taking the appropriate steps [3].

Based on Home Automation

Smart gadgets that monitor physical events and turn them into a stream of knowledge, according to Vladimir Vujović et al., maximize safety, security, comfort, convenience, and energy savings. Instead of traditional sensor elements, sensor web components are used to quickly migrate the communication infrastructure from local to global, bringing the BMS with it. In the context of home automation, the use of IoT technology entails the integration of all electrical devices, as well as monitoring, control and alerting in previously imagined ways. The challenges of adaptation and functionality were solved by developing a one-of-a-kind, solitary, flexible, and low-cost home controlling and monitoring system based on restful web services [4].

Shrikrushna Khedkar and her colleague's device a system that is completely focused on the interaction of electrical equipment in the home. Everything from lighting control systems to home entertainment systems to yard watering and irrigation systems is covered by home automation. Home automation has been increasingly popular in recent years as a result of its low cost. Around 50 billion devices are linked to the internet. A centralized controller that controls lighting, HAVC (Heating, Ventilation, and Air Conditioning), and security locks on gates, doors, and other systems can be included in home automation [5].

Shakthi Murugan K.H and the rest of her crew many applications, such as biometrics, have become increasingly automated as a result of advances in information technology. As home security systems become more popular, mobile device functions have become increasingly vital. We describe a closed-circuit television system that detects motion in each frame in real-time. The system sends the user an SMS message when motion is detected within the designated location, and the video begins recording until the motion stops. Real-time video processing and a Raspberry Pi system using open CV (Computer Vision/Machine Vision) technology are used to accomplish this [6].

In their field, Ashwini Pawar and her teammates are experts. The Internet of Things (IoT) is a type of machine- to-machine communication in which we link things or devices to a platform and disseminate data between them via the platform we use to connect them to our computer/laptop/mobile via the internet. During this post, we discussed fire safety, door security, glass break alarms, and gas leakage prevention. A PIR sensor, MQ2 sensor, vibration sensor, flame sensor, and magnetic sensor are all included with the Raspberry Pi board [7].

Using machine learning technology, Chen-Yen Penget and colleagues designed architecture for a completely new intelligent family service for users. Its mission was to create a machine learning model that merged Google Home with Google Assistant Personal Voice Assistant. The solution, which includes a Raspberry Pi and a practical Bluetooth socket, is particularly useful for full smart home control using machine learning and Google Home voice commands [8].

Rutuparnna Mishra and her colleagues devised a method for gaining access to a computer by photographing your face. Every person has a distinct facial identity. In this situation, the retrieved characteristic is used as a passkey, and it is compared to the database. The system's main goal is to use the CNN approach to detect faces. The system is taught to recognize only authorized personnel's face and to report trespassers using Convolutional Neural Network (CNN) technology [9]. The artificial neural network model as illustrated in Fig 2.

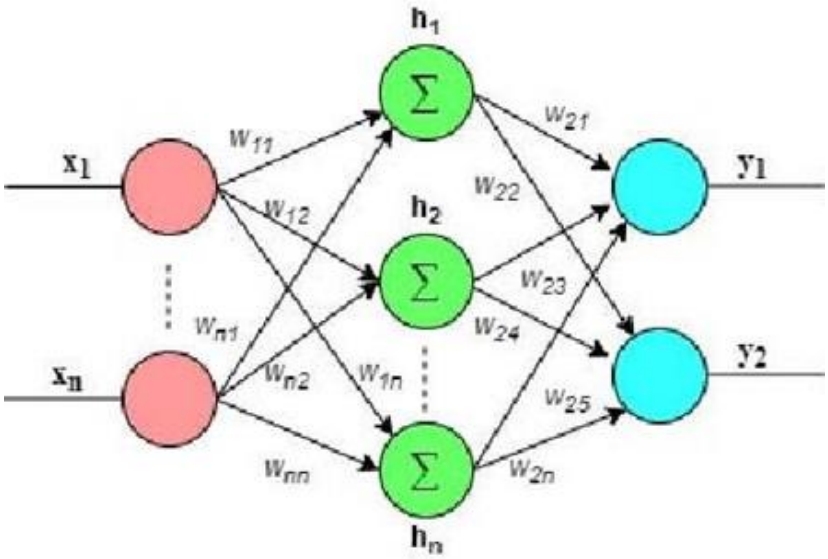

Fig 2: Artificial Neural Network Model

B Varshini and colleagues created a gadget that can identify and monitor face masks as well as blood heat, which could improve public safety. This could lower personnel needs while also adding another layer of protection against the spread of Covid-19 infection. The most effective means to prevent transmission are face masks and hand sanitizers. This has aided in the prevention of disease spread. Accurately recognize people wearing or not wearing facemasks as well as activate and log alarms [10]. It is illustrated in Fig 3.

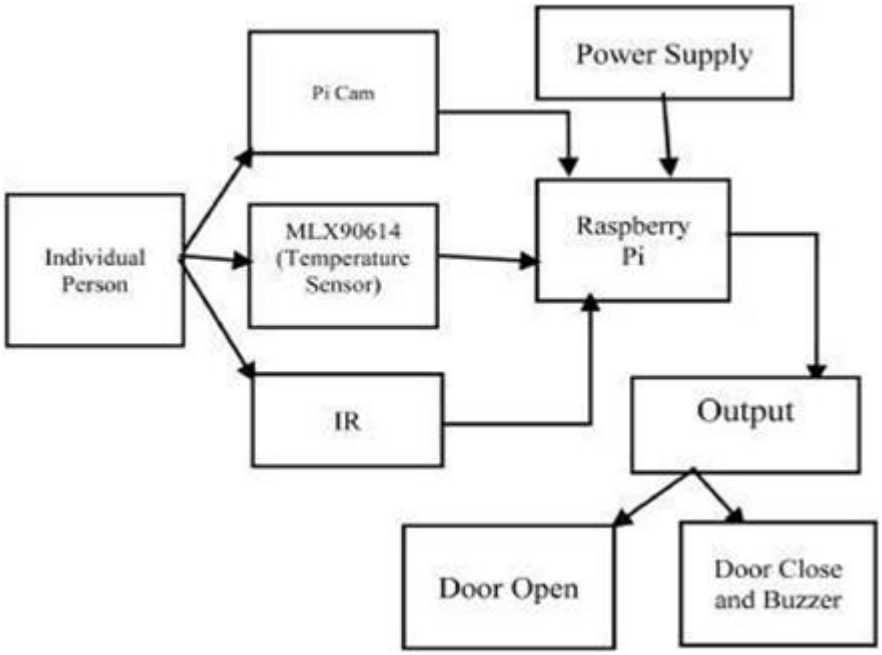

Fig 3: Overall Architecture Diagram of IoT enabled smart doors for monitoring body temperature and face mask detection.

Using LBPH and neural network, Jayanta Paul and his colleagues developed a face detection recognition solution for the door-lock system. In the detection procedure, template matching and neural networks are frequently used. In terms of accuracy, neural network techniques exceed the competition. When compared to a simple LBPH-based model, LBPH Fully Connected Facial Authentication (LBPHFCFA) improves biometric recognition accuracy while accounting for the simpler match. Although LBPHFCFA is slower than LBPH-based design in detecting faces the precision compensates [11].

Based on Environments

N Vijayakumar et al. propose a system that monitors the physical and chemical qualities of water using an excessive number of water quality parameter sensors. Temperature, PH, turbidity, conductivity, and dissolved oxygen can all be measured using a Raspberry Pi B+ core controller and an IoT module (USR WIFI 232). These gadgets are less expensive, more efficient, and have the ability to process, analyze, send and display data. This technology will be used to monitor the environment, ecosystems, and other aspects of life, with data accessible from anywhere on the planet [12]. It is illustrated in Fig 4.

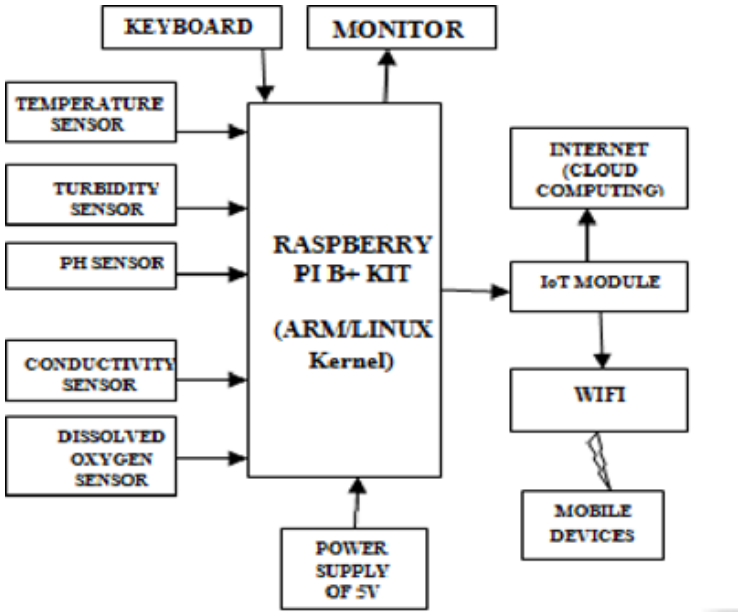

Fig 4: Overall block diagram of the Real-time monitoring of water quality in IoT environment.

Somansh Kumar and his team developed a self- contained real-time air quality monitoring system that has the following features: PM 2.5, monoxide, carbon dioxide, temperature, humidity, and air pressure are all monitored using the Raspberry Pi, a low-power, low-cost, and highly programmable minicomputer. It's also a plus to be able to work with multiple instruments at the same time. The IoT cloud system demonstrates how to design, configure, and use an API to gain access to IoT resources and capabilities from the cloud. Cloud computing is a practice of consuming the resource of remote servers such as storage, virtual machines, applications and utilities that are hosted on internet rather than building and maintaining infrastructure for computing in house [13]. The simplified diagram as illustrated in Fig 5.

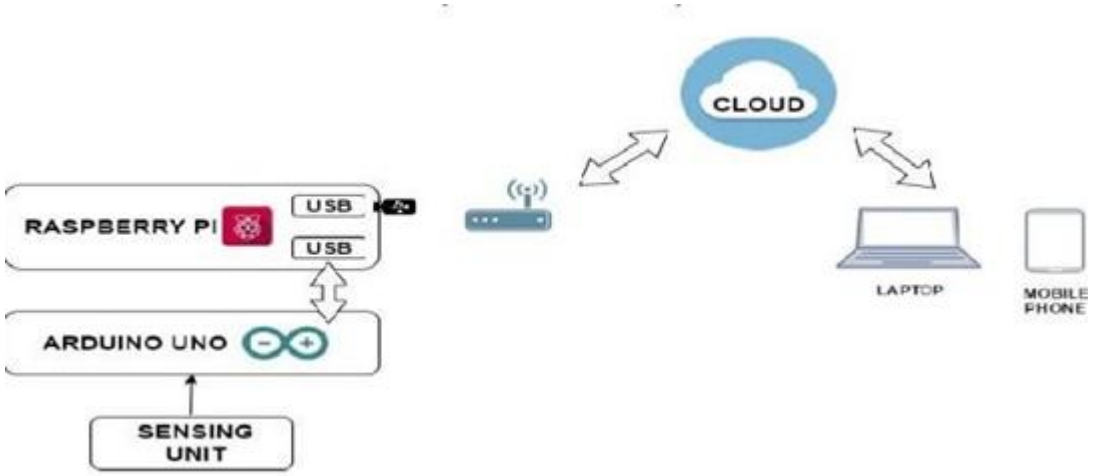

Fig 5: Simplified diagram of Air Quality Monitoring System.

Agricultural irrigation systems with low-complexity circuits were created by Nageswara Rao et al. The temperature and moisture of the soil within the circuit are required for the system to deliver calibrated data. All three nodes are successfully interfaced with two sensors and two Raspberry Pi microcontrollers. This technology allows the irrigation system to be completely automated while simultaneously providing farmers with real-time data on their fields and crops, allowing them to make the most informed decisions possible. Threshold values may vary depending on the crop and its environment [14]. It is illustrated in Fig 6.

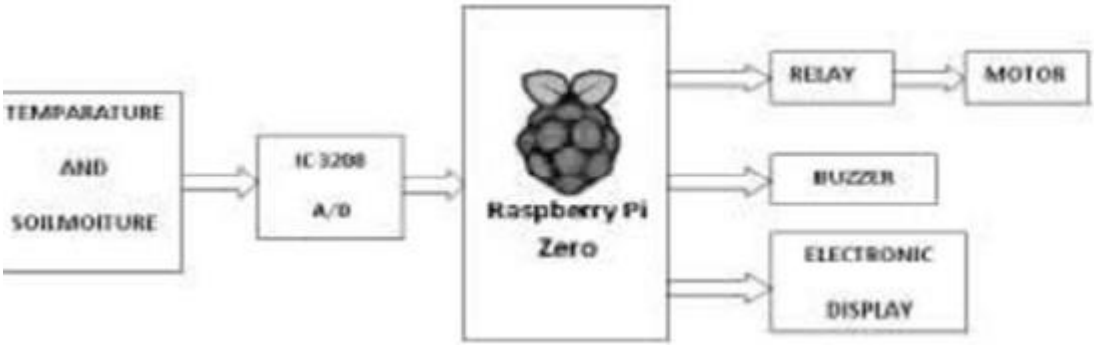

Fig 6: Block diagram of IoT based automatic crop field monitoring.

Mr. Dattatraya Shinde and colleagues demonstrate how to monitor soil quality using wireless sensor nodes. I created a simple Raspberry Pi 3 circuit that continuously monitors and reads temperature, humidity, soil moisture, and sunlight in a normal environment, all of which are updated and maintained daily to allow for optimal plant growth. In addition to the numerous values gathered from the various sensors, an LCD displays the status of the various devices. This system is tested in various greenhouse environments &satisfactory observations were found. The controlling device action is also noted and mostly it is seen that quality and productivity of crops is much better than that of crops growing without controlling actions. The time taken by each controlling device is noted which is beneficial for farmers for estimation of total power consumption & total expenditure per year for specific crop [15]. It is illustrated in Fig 7.

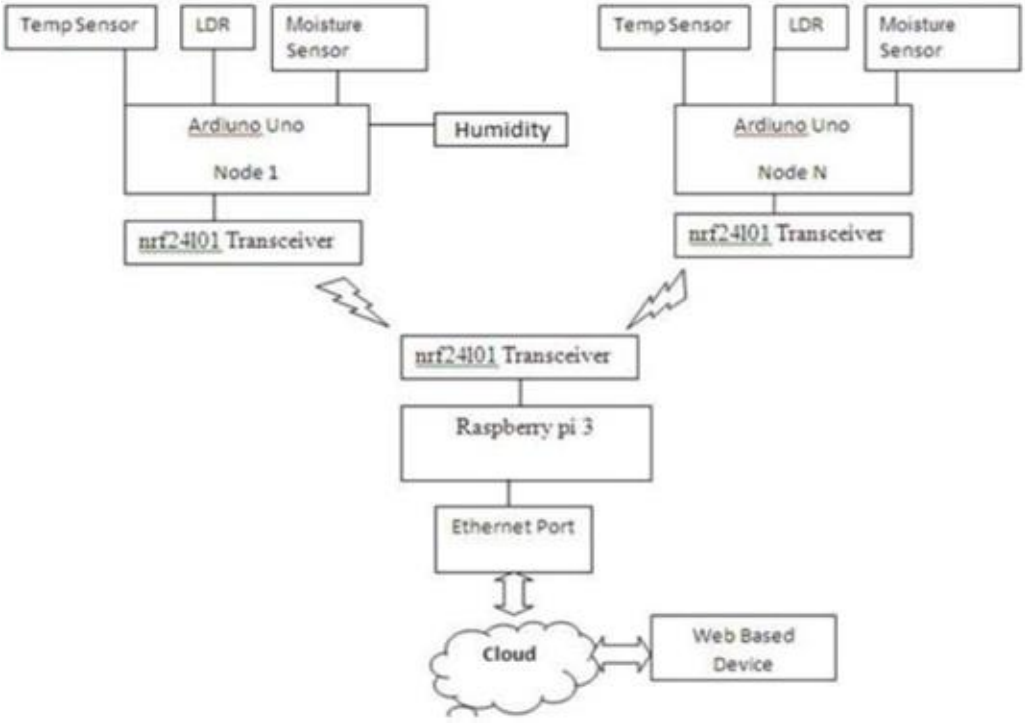

Fig 7: Greenhouse Monitoring and controlling system

To calculate the load of the dustbins, Miss Megha S. Chaudhari et al. uses a Raspberry Pi Uno microcontroller coupled to a GSM modem, an ultrasonic sensor, and a weight sensor. The ultrasonic sensor is put on the top of the trashcan to monitor its state, while the load sensor is mounted on the bottom of the trashcan to monitor the load.

When the trash bin is full, the Raspberry is set to show the height remaining from the edge height. An expert will send a message to the location's unique administrator [16]. The system architecture as displayed in Fig 8.

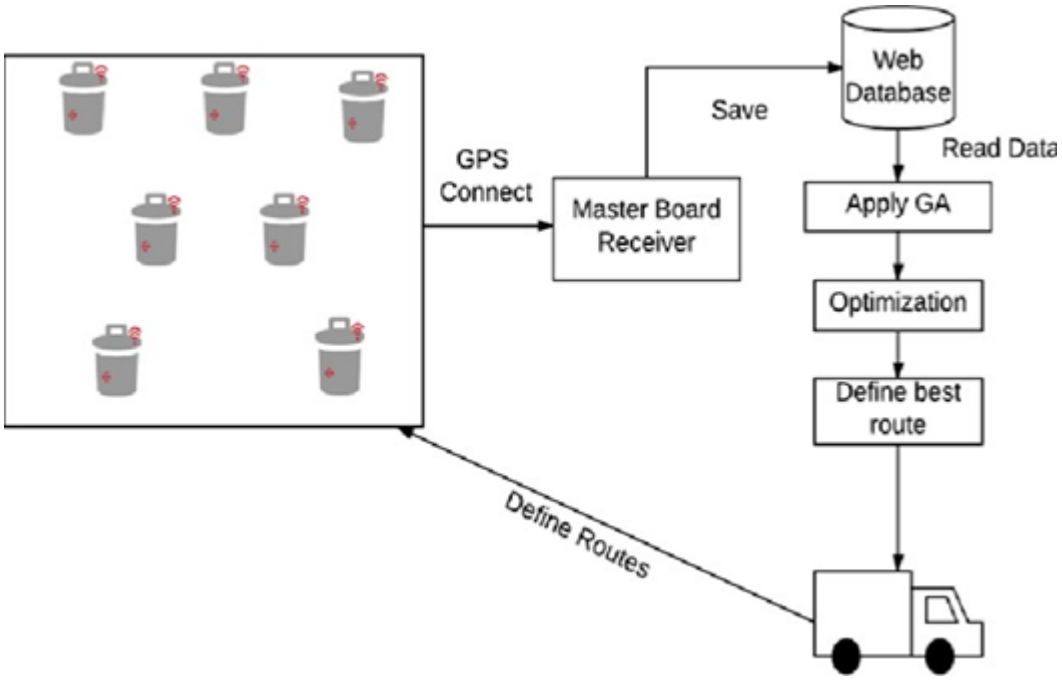

Fig 8: System architecture of IoT based waste collection management system for smart cities.

Shunmuga Sundari.M and colleagues created an IoT based greenhouse system that measured temperature, humidity, and CO2 levels as well as analyzed plant health. A image inspection component is included in the proposed system, which acquires, analyses, segments, and categorizes plant health. Open CV is used to analyze the photographs on the Raspberry Pi. The illness information is shared with farmers and agriculture specialists for further investigation. The MCU MSP432 uses relays to control the actuators and motors when certain threshold values are reached. Data security is another important issue that can be handled by using XTEA in 32-bit microcontrollers and Raspberry Pi. Agriculturists can use the autonomous framework to monitor and control the ecology of their greenhouses from afar [17]. The general architecture diagram as illustrated in Fig 9.

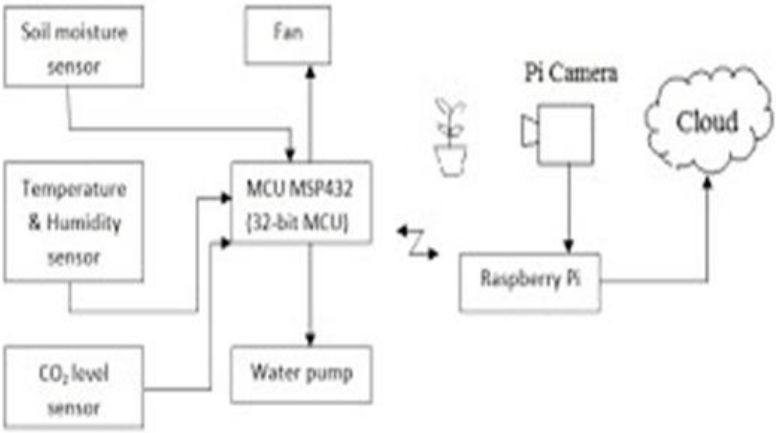

Fig 9: General Architecture diagram of Secured IoT based smart greenhouse system with image inspection.

Poornaiah Billa et al. recommended keeping track of weather and soil conditions, as well as selecting crop varieties based on climatic and soil characteristics. This technique stresses the procedures that must be eliminated in order to maximize crop production by exhibiting images of plants. Animal attacks, diseases, and pests, among other things, are depicted in the picture of plants. The IoT based system proposed in this paper might be a complex system that could be made even better by making it mobile and combining a variety of applications to increase agricultural yield [18].

Shavarsidha Gunde et al. proposed automatic water pumping. A low cost ultrasonic sensor is used to control the water level. A submersible pump prevents pump cavitations by being completely submerged within the tank. This strategy can also alert the user to SMS messages and, as a result, the availability of cloud data. Because there is a global shortage of drinkable water, using an autonomous water pumping system is a good concept. The system's efficiency is expected to be around 95%. As a result, water may be used more efficiently. As a result, there is less water waste [19].

Based on Cloud Service

Aamir Nizam Ansari et al. presented a security alarm that leverages the Internet of Things (IoT) to monitor and receive alarms when motion is detected, similar to how images and movies are uploaded to a cloud server. An IoT based application may be used to monitor activities and send messages when motion is detected. When the cloud is down, the images and movies are saved locally on the Raspberry Pi and then shared once the connection is restored [20]. The project's architecture is displayed in Fig 10.

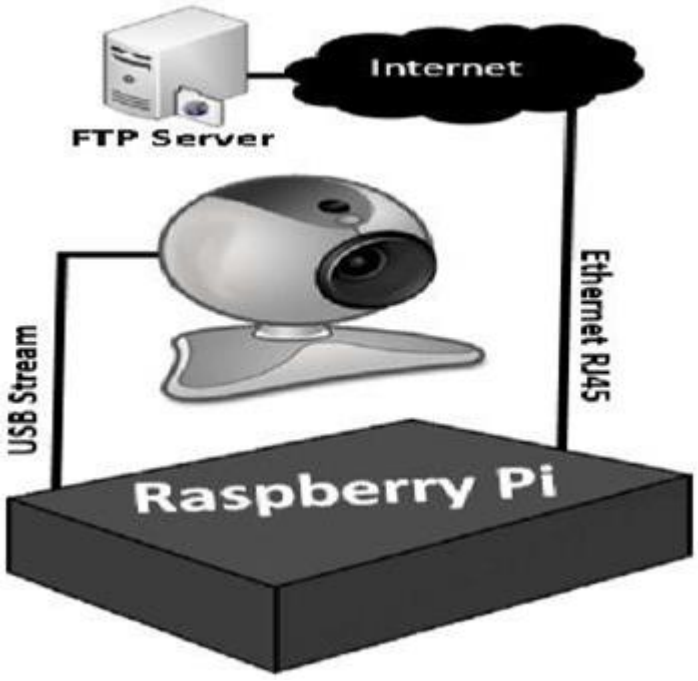

Fig 10: Project architecture of an Internet of Things approach for motion detection using Raspberry Pi.

According to Dhvani Shaha et al, biometrics can take advantage of the cloud's limitless computational resources, as well as its notable properties of flexibility, scalability, and cost reduction, to reduce the cost of biometrics system computational resources and improve the performance of biometrics systems processes. The goal is to create a low- cost biometric system that uses a low-cost wireless enrolment node and a cloud-based biometric service for authentication. The capture peripherals on the Raspberry Pi have been verified [21].

According to Prachi H. Kulkarni et al, the cornerstone of an IoT device is an autonomous industrial meter reader that uploads obtained numerical data to cloud storage for centralized processing. The Raspberry Pi serves as the device's implementation platform. A Raspberry Pi camera module handles image capture, a feature extraction algorithm handles optical character recognition, Google forms handles internet upload, and a Google spreadsheet handles online processing [22].

Neha Patil and her team are working on a low-power IoT based safety alert that can detect and indicate gesture or other activities before sending photographs to a cloud server. When gestures or other indicators are present, IoT- based use is frequently used shakily to monitor actions and receive alerts. Credit-card-sized Raspberry Pi running Open Source Computer Vision (Open-CV) software handles image processing and focus techniques, after which it transmits images to concerned people through email via the Wi-Fi module. A standard webcam is used in this strategy [23].

A controlling unit, memory, sensor or sensor network are all part of a typical data logger system created by Paresh Nasikkar et al. Implementation of a mechanical engine data logger system that serves as a defect diagnostic system and logs data on a web server for remote access. The data is stored in the cloud and may be accessed from anywhere. Because the target device may be an ICE, data is frequently acquired from it, regardless of its location [24].

Satbir Singh and colleagues developed an artificially intelligent traffic control system. For traffic flow control, the number of cars passing via a passage near active traffic congestion zones is frequently recorded in an impression station. The city's traffic congestion node can broadcast timely gathered information over the web and cloud to limit vehicle intake. This looks to be a low-cost, portable solution of minimizing crossing traffic congestion during rush hour [25].Systematic flow diagram of the image processing operations as illustrated in Fig 11.

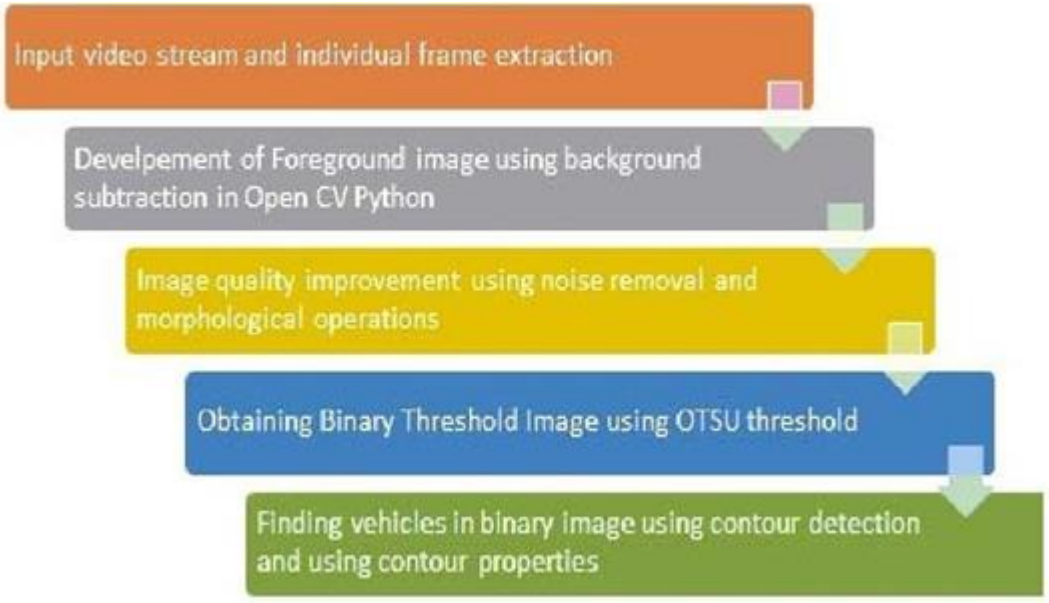

Fig 11: Systematic flow diagram of the image processing operations for obtaining the count of the present vehicles

Based on Camera System

Prottasha Ghosh and her colleagues developed a one-of- a-kind IoT-based evidence gathering device to ensure the safety and security of young women. A Raspberry Pi, a flex sensor for turning the device on by human

hand motion, a buzzer for immediate alarm, a camera for catching objects, and a GPS and GSM module for tracking the location and sending SMS make up a nice automatic running security gadget. The Raspberry Pi module and a GSM module were used to send SMS to the chosen numbers and track the victim's location. As a result, whether the evidence is defective or not will be a point of contention [26].

Bandi Narasimha Rao and his colleagues created portable surveillance cameras that might be used to monitor regions where humans aren't allowed, perhaps saving lives. It will be brought to any site thanks to the motor driver. It's possible to discern the difference between a variety of woodland animals. A camera that records video and take photos while moving in various directions. The built-in online browser is frequently used to control the motor's direction. The design includes a webcam that may be used to snap pictures and record videos [27].

A security and monitoring approach is proposed by Saurabh Singh Rajawat and colleagues. A Raspberry Pi-3 model, a PIR sensor, a Raspberry Pi-3 camera, a thumb drive and a WIFI adapter are used in this project. Thumb drive devices are used to store captured images and recorded films. Even in low light, the device will detect movement via the sensor and send a signal to the Raspberry Pi computer, which will activate the camera and take an image of the individual. We're particularly intrigued by the device's ability to take images in low light and at night [28].

With a camera setup, Ken T. Murata et al. showed a Raspberry Pi-based edge computing development environment. On the Raspberry Pi, the HpVT video transmission protocol is built for use on 4G LTE mobile networks. A variety of surveillance camera systems use the HpVT programming environment. These examples demonstrate how to use the Raspberry Pi and the HpVT environment to create visual IoT systems for security, the environment, medical and healthcare, and home automation [29].

Sushrut Nagesh Kulkarni et al. presented a comprehensive method for offering an automatic item sorting solution in the same way that information (number of various objects) is stored in a SQL database for further examination. Our objective is to assess its utility and effectiveness as a mechanical object sorting mechanism. OpenCV (Open Source Computer Vision) is a programming library for real-time computer vision. The motor driver is taught to govern the servo motors that may assist in driving the object to the desired sorted region using the processed information in OpenCV Human effort is reduced when automated is used in a system that incorporates object sorting based on colour and form resulting in enhanced accuracy as well as time and money savings [30].

Vaishnavi Mande and colleagues devised a method for autonomous video processing based on the Raspberry Pi, which was assisted by the Internet of Things (IoT). Video processing is an important component of video communication innovation, and it is influenced by factors such as video quality, data loss, model cost-effectiveness, ratio, and fog. Humidity/fog sensors ensure that there are no problems in areas with a high humidity ratio or foggy circumstances. Businesses can save time and money by using video communication. As a result, all video conferencing issues have been resolved [31].

Based on Robot

Zhi-ping SUN et al proposed a Raspberry Pi as the nuclear core processor to be used within the IoT of the family embedded robotic system, used 802.11g and TCP/IP, HTTP to achieve infinite distance signal transmission, and adopted the H264 video coding scheme for real-time monitoring of video image signal coded, and decoded RTP/RTCP for video streaming transmission, and used C/S architecture, B/S architecture, and also the database designer with the server to make that the security reliability of the robot [32].

Sai Subramanya Vamsi Chavali and others, our goal is to make it easier to move data from one mobile object to another by using lossy or lossless data compression techniques. Additionally, as a mobile semi-autonomous robot that travels to far regions to transmit and receive data, proposes and develops Discrete Cosine Transfer (DCT) and Inter-Process Communication (IPC). An IPC is in charge of receiving and transferring data. Network layers facilitate IPC by allowing precise interaction between numerous objects. In military and coal mining applications, our proposed robot-based strategies could improve accuracy and bandwidth utilization [33].

Others

The most serious issue, according to Bekaroo Girish and his colleagues, is that each of those computers requires electricity to operate, making ICT a power hog. Recent computers different activities, such as communication and web browsing, have been shown to be critical components that influence their power utilization. As a result, it's critical to investigate the capacity to consume ICT devices such as desktop computers, laptop computers, tablets, and smart phones, especially since the Raspberry Pi was just released (RPi).The Raspberry Pi facility usage was evaluated in relation to the primary operations that end users can do on the platform [34].

Youssefi Ziad and his associates. Although the Raspberry Pi has grown in popularly among the general public and college students for do-it-yourself projects and maker culture, educators have yet to use it to teach software fundamentals. Linux was chosen since it is the operating system of choice for student programming projects. The Raspberry Pi 3 has four core processors, and its Linux package is designed to demonstrate concurrency and multi- threading, both of which are important concepts in the operating system class. If students have their own Raspberry Pi, they will experiment with designing and integrating their own OS components using open-source Linux [35].

According to M Narayana Murthy et al. the office automation system includes of electrical equipment such as air conditioning, lights, blowers, and low machines. An office automation system's client and server sides are the two most important components. On the client-side, the Raspberry Pi and four relay channels are present, and the Raspberry Pi IP address is linked to an HTML online page on the server side that displays the office temperature value regularly [36].

Branko Balon Raspberry Pi computers are being considered for usage in secondary and post-secondary schools, along with the rest of the team. The Raspberry Pi, which is about the size of a credit card, is a small computer with a lot of power. The Raspberry Pi Foundation, a non- profit whose main goal is to reintroduce computer skills to students, designed it without a doubt. Because it is the most recent edition of the world's most popular single-board computer, we chose the Raspberry Pi 3B for educational purposes. Students are taught through example and encouraged to approach challenges in novel ways.

Conclusion: This is a fantastic chance for young people to learn new engineering science and electrical skills [37].

Mani Dheeraj Mudaliar and colleagues describe energy saving in a variety of methods. However, it is necessary to look at the industry's history and present energy habits to put in place appropriate energy conservation measures. The switch gear manufacturer has opted to build an efficient energy monitoring system to watch and analyze day-to-day energy usage as the first step toward energy conservation programmers. This technology is extremely useful for analyzing corporate daily energy trends and implementing energy conservation measures in the future in order to run the business at a lower cost and with more efficient power consumption [38].

Rabea Cheggou and colleagues presented an intelligent system that allows parents to monitor their children remotely or locally via an online application. The goal of this solution is to provide parents with a smart, user-friendly, and cost-effective technology for infant monitoring. It's also worth mentioning that our technique might come in helpful in a medical environment. Implement a sophisticated baby monitoring system that will detect the infant's screams and movements in his cradle, as well as monitor his room's temperature remotely and in real-time. This technique employs a convolutional neural network to detect and analyze the baby's condition in his cradle in order to improve its efficiency [39].

Sun Yong et al created a number controller with the Raspberry Pi as the main control chip and an STM32F030C8T6 microcontroller as the secondary control chip. Using intelligent voice control, smart mirrors can achieve full speech control from any cast music, chat, or broadcast. The extranet's API interface, which is connected to the network via WIFI, collects weather data, clothing index, time, date, and other data. At the same time, the desired information is displayed on the plasma display. The system is capable of face recognition, speech recognition, audio playing, the device of room lighting brightness, and switch status [40].

III. CONCLUSIONS

The Internet of Things (IoT) is a set of technologies that enable various goods and things to communicate with one another and use various network technologies. They will be able to provide high-quality and low-cost healthcare services to people by combining big data analysis, cloud computing, and technology. From any place, setup and operation are straightforward. This method saves time and money by reducing the amount of time spent manually sorting. The web of Things holds a lot of potential in terms of technological innovation and human ease. IoT has also proven to be advantageous and promising for emerging countries economic and industrial development. It is expected to have a significant impact on businesses and organizations in almost every industry around the world. As a result, regardless of their business specialism, most technology businesses strategic objectives are expected to include determining how to harness the IoT potential. Every connected device sends and receives data packets, necessitating trustworthy connectivity, storage, and security, as well as an exponential increase in the number of connected devices.

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IOT-Based Contactless Body Temperature Monitoring Using Raspberry Pi with Camera and Email Alert

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ABSTRACT
In this paper we present the development of IOT based contactless body temperature monitoring using raspberry pi with camera and email alert. The proposed system offers the image of the person if the temperature of any particular person exceeds the set value. Experimental results of the suggested prototype show the measuring temperature and sending mail alert with PI.

Index Terms - Raspberry pi3, pi camera, MLX90614-IR Temperature sensor, Temperature measurement, Electronic circuits.

I. INTRODUCTION

It has become truly challenging to recognize the individuals who are influenced by the infection or not. To tackle this issue, temperature gadgets are regularly used to gauge internal heat level. These gadgets have non-contact IR temperature sensors which can gauge the internal heat level with no actual contact. There are numerous temperature weapons accessible on the lookout, however none of them gives any ready or email warning to higher specialists to make fitting moves when the temperature surpasses a specific cut-off. In this undertaking, we will interface an IR temperature sensor and send the email alarms with the picture of the individual if the temperature of a specific individual surpasses the set is important. The Internet of Things is upsetting our life by fostering various frameworks which can be observed and controlled distantly. IoT can offer generous benefit across the whole life sciences esteem chain, from innovative work digitalization to upgrading the patient experience. This distant innovation dependent on IoT stage is particularly valid in Coronavirus-19 sickness, straightforwardly affecting general wellbeing measures on help clinical in friendly region. This exploration article proposes the contactless internal heat level checking of the in-patient division (IPD) utilizing the web of clinical advancement. IoT has begun to discover more extensive applications in the field of clinical material the executive's perception. Nodaway's, health monitoring is a global challenge in peoples life time solid condition which affected by natural and careful realities. The estimation of human body fundamental signs is an essential to recognize the wellbeing status. The exhibition of any work or exercise in hot conditions upsets the decent warm homeostasis condition of human body (HB). This equilibrium recognizes the HB about physiological and intellectual execution of body. The typical internal heat level reaches by 36.50C to 37.50C. The situation with wellbeing beneath this cut-off is expressed as hypothermia and

the status above is alluded as fever and hyperthermia conditions. The hyperthermia likewise alluded as cancer contingent stage that ranges more than 38.5 0C. The singular body temperature estimation is reliant of various viewpoints for example age, effort, contamination and spot of body at which estimation made.
There are a few techniques to gauge the HBT for example oral, rental and axillary through inconsistent and contactless thermometers.

II. LITERATURE REVIEW

In [1] utilizes high LM-35DZ temperature sensor for estimation of human internal heat level. It utilizes GSM innovation and its usefulness for versatile correspondence to communicate the physiological sign data to an approved individual's PDA. This framework has GPS innovation for area recognizable proof. By using this method, we can sense, send, display, and store the physiological parameter such as human body temperature.
Thermo-vision system [2] is used to detect the overheated spots in electronic PCBs or integrated circuits in a non-destructive, contactless manner, in order to improve their thermal stability and reliability. It offers a low-cost solution for laboratory testing of electronic circuits that has good accuracy and flexibility.
IOT [3] based health monitoring system using Raspberry Pi, it uses different sensors like Pulse/Heart beat sensor, Body temperature sensor, ECG sensor, Blood pressure sensor and Patient position sensor are attached to the patient and sensor output serially are sent to Raspberry Pi. It will be helpful for students, patients, athletes, gymnastics for their health analysis easily at any place.
The iRT[4] incorporate a microcontroller with native Wi-Fi support, a Fire Beetle ESP8266 (DFRobot) and the sensor is connected using I2C interface. To make specialized upgrades, including the improvement of significant cautions and notices to inform the client when the temperature meets characterized setpoints. An embedded system using an infrared temperature sensor that works with an IoT-Wi fi controller on the NodeMCU ESP32 board and the detected data will be transferred to users via the internet network, and it will be stored on a cloud internet system. This method is helpful to reduce the contact, proximity between patients and healthcare professionals.
This system [5] starts with initialization of temperature sensors for collection of real time temperature data in compare to environmental temperature values. The affectability of temperature sensors LM35 (S1) and MLX-90614 (S2) is customized in C++ language and access through Arduino CT-UNO regulator. The daily monitoring of body temperature can prevent the people from threaten of fever, hypothermia and hyperthermia illness.
A circuit [6] consisting of a microcontroller, Bluetooth, LED, light-dependent resistor (LDR), and MLX 90615 IR temperature sensor has been designed. At the entrance of a building such as a university or a mall, the fever of the visitors can be detected safely, without contacting physically.
The temperature sensor type (MLX90614ESF) [7] was used similarly as the usage of the beat sensor type (KY039), which related with Arduino Uno where the results were taken care of and sent by a nRF24L01 development to the far away end and ensuing to tolerating them in the far side are arranged using Arduino Uno. It will show the perusing of the heartbeat sensor and blood heat sensor in BPM (Beats Per Minute) and in Celsius or Fahrenheit.
To make a classifier that will differentiate between faces with masks and without masks. A Preprepared organization called mobileNetV2 which is prepared on the ImageNet dataset with our neural organization model. Various deep learning and computer vision frameworks are used for social distance finding with our

proposed system on raspberry pi. This system [9] will help to identify people on image/ video stream wearing a facemask with the help of Deep Learning and Computer Vision algorithms by using various libraries such as OpenCV, Keras, TensorFlow etc. The images are downloaded from various open-source websites and are differentiated as “mask” and “no mask”. The pictures that we downloaded were of various sizes and various goals. Face Mask and internal heat level recognition can assist us with diminishing the enormous social affair of individuals in a single spot without veils, lessening the danger of getting contaminated.

III. NEED OF TEMPERATURE MONITORING SYSTEM

The variation in human body temperature (HBT) can lead to different disease. It is essential to quantify the range of temperature as shown in body temperature measurement range (Fig1). As expressed by analysts that, while assessing and estimating the wellbeing status extraordinarily HBT, some crucial focuses are essential. Few measurement methods are shown in temperature measurements methods (Fig2), while some aspects are justified in sub-sections diurnal variations (2.1) and emotional status (2.2) respectively and linked are listed in variations in body temperature by age (Table 1).

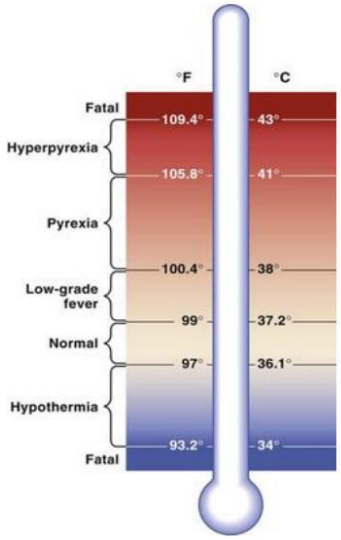


Figure 1. Body temperataure measurement range

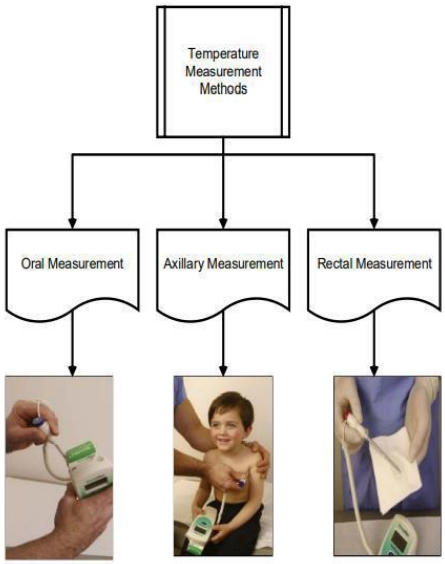


Figure 2. Temperature measurement methods

Table 1. Settings for proposed System

Variations in body temperature by age Age level	Method	Average temperature
New born	Axillary	36.1C-37.8C
1 year	Oral	37.6C
5 year	Oral	37C
Adult	Oral, rectal, Axillary	37C,37.5,36.4
Over 70 year	Oral	36C

3.1. Diurnal variations - This variety is reliant of human body digestion. During the sleep the metabolism is slower as decrement in contractions of muscles.

3.2. Emotional states- These variations frequently observed with young children during extreme anger and crying state which increase the body temperature.

IV. COMPONENTS REQUIRED

Raspberry Pi: Raspberry Pi is a credit card size computer that was designed for educational purposes. Due to its price and amazing specifications like onboard Wi-Fi, Bluetooth, and programmable GPIO header, and the quantity of potential choices to make an application, it was taken on by engineers and gadgets specialists.
MLX90614 IR Temperature Sensor: There are numerous sensors accessible in the market which can give us temperature and humidity. What makes this sensor unique in relation to any remaining sensors is that it can give us object temperature and different sensors give surrounding temperature. We have used DHT11 Sensor and LM35 extensively for many applications where atmospheric humidity or temperature has to be measured. But here for making a temperature gun which doesn't need physical contact and can measure the object temperature instead of ambient temperature, we use IR based MLX90614. MLX90614 sensor is made by Melexis Microelectronics Integrated frameworks, it chips away at the rule of InfraRed thermopile sensor for temperature estimation. These sensors comprise of two units inserted inside to give the temperature yield. The primary unit is the detecting unit which has an infrared identifier which is trailed constantly unit which plays out the calculation of the information with Digital sign preparing (DSP). This sensor deals with Stefan-Boltzmann law which clarifies power emanated by a dark body as far as its temperature. In straightforward terms, any item radiates IR energy and the power of that will be straightforwardly corresponding to the temperature of that article. MLX90614 sensor changes over the computational worth into 17-bit ADC and that can be gotten to utilizing the I2C correspondence convention. These sensors measure the ambient temperature as well as object temperature with the resolution calibration of 0.02°C. To find out about the elements of the MLX90614 sensor, allude to the MLX90614.

Datasheet.

Features of MLX90614:

- Operating Voltage: 3.6V to 5V.
- Ambient Temperature Range: -40°C to 125°C.
- Object Temperature Range: -70°C to -382.2°C.
- Resolution/Calibration: 0.02°C.
- 17-bit ADC.
- I2C communication

V. METHODOLOGY

Interfacing MLX90614 with raspberry pi

Step1: - Enabling the I2C from raspberry pi setting.

Step2: -Download the package/library of MLX90614 by going to https://pypi.org/project/PyMLX90614/# files

Pi camera interfacing with raspberry pi

Step1: -Enabling the camera from raspberry pi setting.

Step2: -To check if the camera to click a picture with the name image and store that on your desktop.

Setting up SMTP email with raspberry pi

Step1: -Go to the right corner and click on my manage your google account.

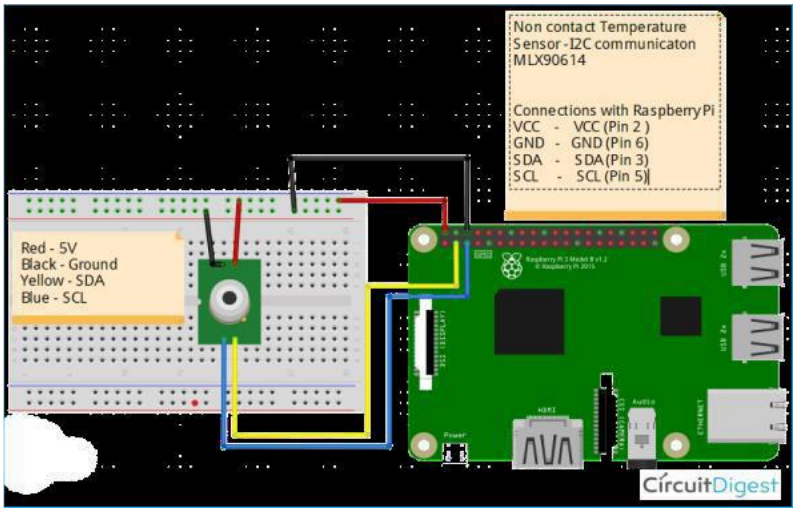
Step2: - Click on security and scroll down to “less secure app access”

Step3: - Enable the less secure app.

Step4: - Repeat with the other email id as well to send/receive the email from the python script.

Step5: -Download the required packages.

Step6: - After the establishment of the relative multitude of libraries is done, we need to make changes in the ssmtp.conf document where we need to enter the sender's email subtleties.



SMTP libraries

Simple Mail Transfer Protocol (SMTP) is a protocol, which handles sending e-mail and routing e-mail between mail servers. Python provides smtp lib module, which defines an SMTP client session object that can be used to send mail to any Internet machine with an SMTP or ESMTP listener daemon.

Steps for sending emails using Python:

1. Set up the SMTP worker and sign into your record.
2. Make the MIME Multipart message article and burden it with suitable headers for From, To, and Subject fields.
3. Add your message body.
4. Send the message utilizing the SMTP worker object.

Python SMTP secure

At the point when you send messages through Python, you should ensure that your SMTP association is encoded, so your message and login accreditations are not effortlessly gotten to by others. SSL (Secure Sockets) Layer) and TLS (Transport Layer Security) are two protocols that can be used to encrypt an SMTP connection.

Steps to Send Mail with attachments using SMTP (smtp lib)

1. Create MIME.
2. Add sender, recipient address into the MIME.
3. Add the mail title into the MIME.
4. Attach the body into the MIME.
5. Start the SMTP meeting with legitimate port number with appropriate security highlights.
6. Login to the system.
7. Send mail and exit.

The Raspberry Pi Foundation explicitly chose Python as the fundamental language due to its force, flexibility, and convenience. Python comes preinstalled on Raspbian, so you'll be prepared to begin consistently. You have various choices for composing Python on the Raspberry Pi.

Raspberry Pi program is, without a doubt, an extremely insignificant beginning. A lot more impressive applications can be composed utilizing the Python programming language. Obviously, on the off chance that you simply need a modest $35 Linux machine, the Raspberry Pi turns out extraordinary for that to.

Python is generally utilized for creating sites and programming, task computerization, information investigation, and information perception. Since it's moderately simple to learn, Python has been taken on by numerous non-developers like bookkeepers and researchers, for an assortment of ordinary undertakings, such as getting sorted out account.

VI. ADVANTAGES

Smart sensors examine ailments, way of life decisions and the climate and suggest deterrent measures, which will diminish the event of sicknesses and intense states. Decrease of medical care costs: IoT lessens expensive visits to specialists and emergency clinic affirmations and makes testing more moderate.

1. Distant observing: Real-time far-off checking through associated IoT gadgets and savvy cautions can analyze ailments, treat infections and save lives in the event of a health-related crisis.
2. Prevention: Smart sensors dissect medical issue, way of life decisions and the climate and suggest protection measures, which will lessen the event of sicknesses and intense states.
3. Reduction of healthcare costs: IoT reduces costly visits to doctors and hospital admissions and makes testing more affordable.
4. Medical data accessibility: Accessibility of electronic medical records allow patients to receive quality care and help healthcare providers make the right medical decisions and prevent complications.
5. Improved treatment management: IoT devices help track the administration of drugs and the response to the treatment and reduce medical error.
6. Improved healthcare management: Utilizing IoT gadgets, medical services specialists can get significant data about hardware and staff adequacy and use it to recommend developments.
7. Research: Since IoT devices are able to collect and analyze a massive amount of data, they have a high potential for medical research purposes.

VII. DISADVANTAGES

1. Security and privacy: Security and privacy remain a major concern deterring users from using IoT innovation for clinical purposes, as medical care checking arrangements can possibly be penetrated or hacked. The hole of touchy data about the patient's wellbeing and area and interfering with sensor information can have grave results, which would counter the advantages of IoT.
2. Risk of failure: Disappointment or bugs in the equipment or even force disappointment can affect the exhibition of sensors and associated gear putting medical services tasks in danger. Likewise, avoiding a planned programming update might be significantly more unsafe than skirting a specialist examination.
3. Integration: There's no agreement with respect to IoT conventions and norms, so gadgets delivered by various makers may not function admirably together. The absence of consistency forestalls full-scale coordination of IoT, thusly restricting its expected viability.
4. Cost: While IoT vows to lessen the expense of medical care in the long haul, the expense of its execution in clinics and staff preparing is very high.

VIII. APPLICATIONS

1. Symptom-tracking apps that send updates on responses to cancer treatment to the physician and which can avoid hospitalization .
2. Associated clinic gear that advises specialists of their present area, educates the emergency clinic the board regarding the substitution needs and screens staff execution.
3. Distant temperature observing guaranteeing the right transportation and capacity of immunizations.
4. Medical care IT arrangements that remind patients to top off prescription and edible sensors that trigger a notice if the medicine hasn't been taken on schedule.
5. Clinical consideration IT game plans that remind patients to finish off remedy and eatable sensors that trigger a notification if the medication hasn't been taken on time.
6. Smart inhalers associated with an application that help individuals with asthma and aspiratory infection get what causes the manifestations and anticipate allergens.

IX. CONCLUSION

When the hardware and software are ready, just run the python code on your pi. it will print the worth of temperature read from the sensor. If the object temperature, then our python program will take an image from the camera, save it on raspberry pi, and also share it via email.

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A Review of 5G Technology Architecture, Security and Its Wide Application

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ABSTRACT
Future 5G wireless networking will eventually aim to have very fast data throughput, incredibly low latency, significant increases in base station efficiency, and other characteristics.significant modifications to consumers expected Quality of Service (QoS) in comparison to the current 4G LTE networks. The consumption of broadband data has increased quickly as a result of the need to deal with cuttingedge technology and connection, such as smart cell phones, internet of things (IoT) devices, autonomous vehicles, virtual reality equipment, and connectivity in smart homes.Furthermore, a significant increase in system bandwidth is required to support the most recent applications. This advancement will be made by utilising a contemporary spectrum with larger data levels.
Keywords-IOT; 4G; 5G; QOS; BANDWIDTH

I. INTRODUCTION

The drawbacks of earlier communication technologies and to potentially serve as the main enabler for upcoming IoT applications. The 5G network's architecture, security issues, energy efficiency, various types of efficient antennas created for 5G, and cutting-edge requirements for Internet of Things applications and the related communication technologies are all briefly covered in this paper. We have also discussed how 5G will be used more widely and how it will affect our lives in the future. Furthermore, the necessary suggestions for the upcoming work are provided at the conclusion of each subtopic. The term "5G" refers to the fifth generation of wireless telecommunications, which will revolutionise many areas of life. New mobile technologies including virtual reality applications, high-resolution video streaming, and cloud gaming are driving the rapid growth of mobile network traffic .The speed of the increase in traffic and the predicted demands of new scientific technologies, such as driverless vehicles, virtual reality, and Unmanned Aerial Vehicles (UAVs), will unquestionably be beyond the capabilities of 4G services in a few years. As a result, numerous attempts have been made by academic and industrial researchers to make 5G technologies a reality soon.when it comes to transmission speed, a network. Data transfer speeds of up to 10Gbps, or 10 to 100 times faster, will be available with 5G.superior than 4G and 4G-LTE. In order to facilitate the development of new services, 5G is anticipated to transcend ultrabroadband networks and merge existing technologies including the Internet of Things (IoT), cloud, big data, artificial intelligence, and blockchain. Another important aspect of 5G, besides increased speed, is its reduced latency. In reality, the delay time in the 5G era is less than one

millisecond (ms), which is nearly comparable to the zero data response time in the actual world.A system can be created where "smart networks" can be used for large medical devices and offer real-time interaction based on the super bandwidth of 5G per unit area, connectivity per unit, coverage (nearly 100%), and device connectivity [4].The race for the next fifth-generation (5G) cellular technology, which is anticipated to be the most significant source of revenue in the future, has just been won by international businesses.The 5G network will be widely launched as a straightforward framework for mobile devices that are hyperconnected, and it will eventually develop into a contemporary 5GaaP (5G platform) platform [6]. Future technologies in the 5G environment would develop a "intelligent virtual power plant" that would combine energy use, production, and trade while optimising resource utilisation. Additionally, it is anticipated that 5G technology will significantly alter the energy sector.The most pressing social issues, including traffic congestion, disaster safety, and climate change, are expected to be solved or made easier to solve by the profound network known as 5G. It will also raise awareness of the idea of smart virtual power plants in the energy sectors.The 5G technology developed in South Korea may be used for distributed resource management throughout the nation, real- time energy transactions between production and consumption resources, and demand management in industries and buildings Consequently, using artificial intelligence engines and current real-time big data, it is possible to analyse and forecast patterns of energy production and consumption. enables system operators to operate and regulate virtual power plants optimally through simulations of energy production and consumption that are visualised, balancing the production and consumption of energy inside the virtual power plants. Additionally, real-time secure energy transformation between energy producers and consumers can be achieved by utilising blockchain technology.

II. USE CASES OF 5G

In the scope of 5G, three different types of usage cases are related as mention above:

- Enhanced-Mobile-Broadband (eMBB)
- Massive-Machine-type Connectivity (mMTC)
- Ultra-Reliable and Low-Latency Connectivity (URLLC)

The term "eMBB" refers to a more or less straightforward evolution of the enhanced mobile broadband consumer experience, such as by promoting even greater customer efficiency.The term "mMTC" refers to buildings that may be identified by a variety of gadgets, including remote controls, actuators, and systems tracking. The main requirements for these systems include very cheap system costs and very low computer energy consumption, enabling very extended battery lives of at least a few years. Support for big data volumes is often of less relevance because each system only consumes and creates a relatively small volume of data. There may be more use examples that do not quite fit into any of these categories.the significance of latency specifications. Similar to this, there may be situations when using relatively inexpensive equipment makes the possibility of a long battery life less likely. Systems for latency reactive tools for applications like industrial automation, automated driving, and virtual surgery are known as URLLC (Ultra-Reliable Low-Latency Communication) systems. Such systems require response times of less than 1 packet loss in 105 packets and sub-millisecond latency. Architectural Framework for the 5G E2E Network The term "mMTC" refers to buildings that may be identified by a variety of gadgets, including remote controls, actuators, and systems tracking. The main requirements for these systems include very cheap system costs and very low computer energy consumption, enabling very extended battery lives of at least a few years.

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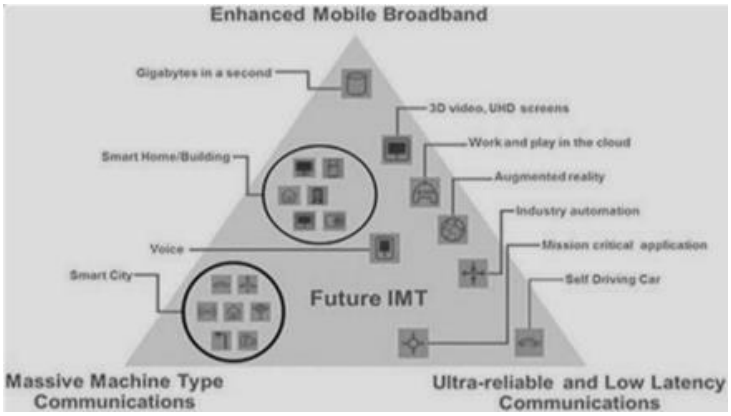
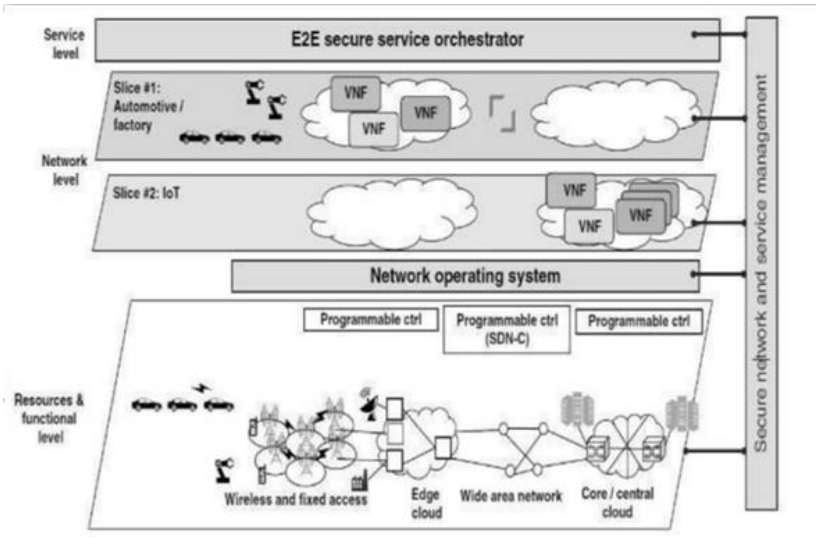


3. Architecture

The 5G E2E network architecture is depicted in Figure 3; it is the same image as that in Figures 1, 2, and 3, but with different characteristics highlighted. Due to bottlenecked wireless communication from base stations, the base stations are primarily centred on the switch from 3G to 4G [3]. The E2E design of the 5G network, however, has far more relevance when switching from 4G to 5G because the base station is not the primary bottleneck in the 5G network. The architecture of E2E created by Huawei for 5G is described in picture Network slicing design provides a number of autonomous service level agreements to suit the demands. RAN network slice subnet instance (NSSI) and CN NSSI are the two categories into which a network slice may be divided. The network slicing network and the service are autonomous and may deliver several different services simultaneously. The 3GPP network slicing diagram is seen in picture 2 below.The 3GPP slicing network requirements are thoroughly discussed in The figure 4 below from lists the 3GPP requirements Virtual Evolved Packet Core, or vEPC, is a network.



Picture.1 Network Slicing Architecture

A plan for switching and processing data for mobile networks is called Virtual Evolved Packet Core (vEPC). The LTE evolving packet core's (EPC) functions are virtualized through a number of virtual network functions (VNFs).Virtualization provides the opportunity to swiftly deploy service environments and save building costs. The components of evolved packet core vEPC and the LTE evolved packet core (EPC) functionalities are contrasted.

2.1. Management and Orchestration (MANO) for NFV

The European Telecommunications Standards Institute (ETSI) network functions virtualization (NFV) design includes a large amount of management and orchestration (MANO), and they released the NFV system architectural framework [20]. An architectural framework called management and orchestration (MANO) manages network resources, the lifecycle management of virtual network functions (VNFs), and network services for cloud-based applications. Based on the ETSI architecture as depicted in Figure 6 from [2], some open source organisations have created their own NFV MANO frameworks. 2.5 Design of the 5G mobile network architecture Figure 7 shows the all-IP system model for wireless and cellular network interoperability that combines the architecture of the network infrastructure for 5G mobile networks. The architecture includes many separate, self-sufficient radio system technologies as well as a computer terminal (which is essential to the existing structure). Any radio approach technology is audible in every terminal thanks to an IP link to the internet's external environment. However, the mobile terminal's internal Radio Access Technology (RAT) must have a unique network interface. For instance, if there is a requirement to connect to four independent RATs, we must provide four distinct methods for connecting to interfaces that are comparable inside the mobile terminal and make all 2.6 NGMN Envisionbased 5G architecture. Illustrates the 5G design, which is based on NGMN's conceptualizations and takes use of the structural separation between software and hardware. APIs are provided to accommodate various business models and multi-use scenarios.

A. Data Forwarding Effectiveness

The simplicity required by the service scenarios is an advantage of a virtualized network focusing on NFV technology and common equipment. The cost of basic hardware is less expensive for single machines than the cost of specialised hardware However, dedicated technology frequently makes use of technology acceleration strategies that can improve forwarding performance. At the current technological state, more common hardware than specialised gear is needed to attain the same data transmission efficiency. That frequently implies more use of both space and energy. Virtualization systems may therefore be employed first in the control plane.

B. Following SDN, fixed and mobile convergence

Given that all fixed and mobile networks have adopted SDN technologies, how can one tell if the two networks' communication systems are incompatible and what the differences are? With the potential for user-plane forwarding processes and delivery scenarios to increase, it is necessary to discuss how to achieve efficient control and optimal routing. In light of the growing possibility of user-plane forwarding procedure and delivery scenario, how to acquire efficient control and optimal routing needs to be considered.

C. Exposure of network capability

The initial intent of this was not for 5G. However, during the 5G era, the network capacity would be exposed to a wider and greater extent, along with the centralization of network control functions. Usable APIs and interfaces between the network visibility module and the necessary network features must be further defined for straightforward network connectivity.

III. ENERGY EFFICIENCY OF 5G

In order to extend battery life, it also entails lowering the power consumption of wireless base station antenna and client devices (such as smartphones, tablets, and Internet of Things (IoT) devices) [2]. Energy consumption is currently the most important aspect for developing communication networks, and networks are created based on this criterion. [3] Due to the evolution of technology, data traffic in the modern day is growing daily. As a result, the round-trip time delay of data packets in the network increases [4], which is becoming a more significant problem for the energy expenses on 5G systems. one of the massive challenge is to boost capacity by 1000 times for billions of devices in a reasonable and cost-effective way.

A key factor in lowering the total cost of ownership (TCO), which includes the environmental effect of networks, is how much energy the network uses. The fundamental idea behind 5G's architecture is this capability

IV. SECURITY IN 5G

Higher coverage, and significantly batten the quality of service (QoS) and extremely lower latency and very high data rates shall be provided by upcoming 5G wireless networks [9] A large number of new devices related to Internet of Things (IoT), ubiquitous, machine-to-machine communication (M2M), ultrareliable and affordable broadband access for cellular handheld devices and cyber physical system will also be provided by 5G [5]. These qualities indicate that 5G is not just an incremental upgrade of 4G that people naturally think of, but 5G is the amalgamation of new disruptive technologies that are cable to meet user traffic, emerging services, and the continuous growth of existing and future IoT devices Demand [6]. The security of 5G is even more crucial given the anticipated role it will play in society and how it will affect our daily lives. As a result, significant effort is needed to secure the security of the 5G network system, the network system's users, and the 5G network itself [7]. LTE development is a key component of 5G.

However, 5G will include advancement of all network components, including the core and management systems, as well as all protocol layers from radio to applications [8]. Security might therefore be compromised everywhere.Given the anticipated impact 5G will have on society and our daily lives, its security is even more important. The security of the 5G network system, the network system's users, and the 5G network itself must thus be protected with great effort [9]. The advancement of LTE is essential to 5G.However, 5G will see advancements across all network elements, from radio to applications, as well as the core and management systems [10]. Therefore, security may be compromised everywhere.

4.1. A summary of the 5G design tenets

With new hardware and network types, as well as changing user demands for reduced latency, greater capacity, and global coverage, new design concepts for 5G are required [4]. Different requirements apply to networks other than radio, and these requirements focus more on integrating new technologies. For instance, the general-purpose biodegradable core will disassemble the user plane and control plane using NFV and SDN to enable dynamic network function location [10].

This reduces the use of traditional networks while introducing new radio access technology (RAT) and core interfaces. The network architecture of 5G must allow for the deployment of security tools and functionalities

(such virtual security firewalls) at the edge of any network as needed. SDN [5] is the technology that stands out the most for making network administration simpler.

Through the use of a programmable Application programming Interface (API), SDN separates the network control plane from the data forwarding plane. The control plane is then logically centrally controlled to monitor the entire network below and manage network resources. The development of programmable APIs and centralised network control, however, can also lead to security loopholes in network devices. the difficulties with security

Therefore, it is necessary to analyse the security issues raised by SDN. Similar to network slicing, NFV also faces security issues including resource theft and joint conflicts. Therefore, it is important to thoroughly research the security issues related to all of the technologies used by 5G. We provide a brief definition of the 5G security architecture in the part that follows, with an emphasis on the 3GPP-defined security domains.

4.2. 5G Security Architecture, Section 4.3

The International Telecommunication Union (ITU-T) [113] states that a security architecture logically separates the security aspects into distinct architectural components. This enables a methodical approach to end-to-end service security, which aids in planning to evaluate the security of existing networks and enable new security solutions. The most recent 3GPP technical standard release, which outlines the 5G security architecture, includes the following major areas.

4.2.1. Security of network access consists of a number of security settings that allow user equipment to authenticate and access network resources safely. Monitoring 3GPP and non3GPP communication systems is necessary for service security, as is the transmission of security contexts from the SN to the userequipment.

4.2.2. Domain and network security possesses a number of security features that permit network nodes to safely exchange signalling and user-level data

4.2.3. Security for user domains incorporates security features that make it possible for users to access user equipment in a secure manner.

4.3. Security for application domains

Contains security technologies that let apps to send and receive messages securely.

Domain security for Service Based Architecture

Including security features for service-based interface security, discovery and authorisation, and network element registration security.

Security visibility and configuration

This includes informing the user if the safety feature is active.

4.4. ITU-T Security Recommendations

A variety of protective factors to guard against all threats to global security are included in the Security Recommendations of the International Telecommunications Union (ITU) Agency for the Standardisation of Telecommunications Sector (ITU-T) [3]. I The eight protection elements cover more than just the network; they also cover programmes and end-user information. In reality, the security component concerns both service providers and businesses that offer services. These security measures are listed in Table III along with a

succinct overview. The next section explains how to secure the 5G's security feature. Future health recommendations were assigned to ITUT Research Group 17 (SG17).

4.5. Security Standardisation (4.5)

All spheres of life, including businesses outside the telecommunications sector like automakers, are impacted by the evaluation of the security impacts of the 5G network. As a result, several important organisations have significantly improved the rapidly evolving security measures [4]. Standardisation, however, is still in the drafting stage. The most typical standards are the ones listed below. • 3G Partnership Project (3GPP); Next Generation Mobile Networks (NGMN); The European Telecommunications Standards Institute (ESTI), the National Institute of Standards and Technology (NIST), and the 5G Public-Private Partnership (5GPPP) are a few examples.

4.6. Security in Important 5G Technologies

Knowing the main enabling technology for 5G might help to emphasise the security and privacy concerns with the technology. Large MIMO antennas, SDN, NFV, and cloud networking concepts like Multi-Access Edge Networking (MEC) are the main advancements that have transformed earlier generations, as outlined in Section IV. The security literature for SDN, NFV, and cloud infrastructure is extensive, and these technologies have been applied to wired networks [1]. Only the most important security-related technologies for 5G are highlighted in this section. Massive MIMO security, SDN security, NFV security, and cloud application security suggestions for improvement Since it is anticipated that a sizable number of devices, including Internet of Things (IoT) devices, will be connected to the upcoming 5G network, this will present new security challenges for the 5G network. Currently, three communication protocols that are based on Elliptic Curve Cryptosystems (ECCs) and other cryptographic algorithms are in wide use. Constrained Application Protocol (CoAP), standard IPv6 over low-power Wireless Personal Area Networks (6LoWPAN), and IEEE 802.15.4 are the communication protocols. These protocols won't be secure for communication with the advent of quantum computing and the vast network capacity. The approaches that are suggested in brief for the 5G network's robust security are listed below.

When necessary, security features built into software that can be deployed in any network perimeter shall give numerous opportunities to improve network security. For softwarized and virtualized networks, a variety of firewall products, like FLOW GUARD and OpenFlow firewall software, can be seen as the first step towards softwarized security.

a. Security based on AI

Cybersecurity may end up being one of the finest applications for AI since it will require self-adaptive intelligence systems to monitor and analyse the large number of devices on networks. These systems will use cutting-edge artificial intelligence algorithms and methodologies.

To fulfil the primary service needs, such as service movement from one edge node to another, proactive execution of security services such as authentication and access control is required. AI will be essential in this process to quickly detect the terminal actions and requirements in order to prevent service outages. To further improve security, we can also employ security automation and Blockchain security viewpoint approaches.

V. 5G ANTENNAS

5G mobile communications technology will offer better data rates, higher security, reduced latency, and the most recent knowledge about the environment and business. Despite the most recent extensive research on 5G antennas, there are still numerous challenges that call for more effective solutions [7]. The 5G will undoubtedly change the way we live. As capacitors, conductors, and metal rods are used in the current antennas used in wireless telecommunication systems, they are referred to as passive antennas [8].

The most recent antennas suggested for the 5G network are known as active antennas, and this key technology sets the 5G network apart from earlier generations in terms of speed, latencies, and security [9].

More challenging antenna deployment and design feats are needed for the 5G network.

Circular Patch Antenna with Three Notches

The design and analysis of millimeter-wave pinfed, three- notch circular patch antenna the writers in [3]. The antenna operates between 58.5 and 60.5 gigahertz. It measures 5x5x0.1 mm3 and is mobile station compatible. The constructed antenna provides a respectable returning loss of less than 10 dB and has a radiation efficiency of more than 88% (percent) at the reverberance band. A threenotch circular patch antenna with a 5x5 mm2 form factor has a maximum gain of 7.839 decibels at 60 GHz.

Design of a Dual-Band Eight-Antenna Array for MIMO This kind of antenna technology is based on SIRs and has four pairs of L-shaped slots. For the next 5G mobile networks, a dual band eight antenna array with MIMO has been studied and put into practise in [3]. By modifying impedance, we may increase gain since the impedance ratio of SIR is what causes the dual resonance and gain of the antenna. The simulated design demonstrates that the inter-element insulation was increased to over 11 decibels and the return loss was increased to above 10 decibels. The overall efficiency of the developed antenna was about 95% over the longterm evolution (LTE) spectrum 42 (ranges from 3400 to 3600 MHz) and LTE spectrum 46 (ranges from 5150 to 5925 MHz). It is important to keep in mind that because of the symmetry of the Only the simulated effects of Ants 1 through Ant 4 are visible in the design.

MIMO antenna system has a gain of more than 10 dB across all frequency bands. Figure 21 displays the anticipated surface current distributions of Ant 1 at 3500 MHz and 5500 MHz, which distinctly illustrate the two resonant modes of the SIRbased slot antenna feature.

VI. USES OF 5G FAST DATA RATES

The 5G network would be characterised by fast broadband and intelligent networks. With 5G, consumers will be able to download a full film in less than five seconds as opposed to the eight minutes it currently takes with 4G. Technologies including social networking sites, multimedia television, highdefinition and 3D content, augmented reality, robotics, autonomous cars, sophisticated manufacturing, and many more may be supported by networks with sufficient speed. Not all data must be sent simultaneously between the…

4K STREAMING

As new smartphone technologies like high-definition video sharing, online gaming, and virtual reality apps become more prevalent, mobile network usage tends to rise very quickly [1]. For UHD video streams using the Scalable H.265 programming coding standard, the EU 5G PPP SELFNET project [5][6] has presented a QoE-aware SelfOptimization Use Case. Holograms, 4K ultra-high definition (UHD) video sharing, and virtual /

augmented reality (VR / AR) are just a few examples of broadband gadgets that use a lot of data traffic. The ITU-R has unveiled the idea of the 5G (IMT2020) mobile broadband connected businesses "Enhanced Mobile Broadband," "Low Latency," and "Massive Internet of Things"

5G-Enabled Smart Mobility

In order to create a 5G heterogeneous network, we want to combine the MIH paradigm with the DMM techniques in the future networks, especially those involving vehicles. Additional factors like network size, vehicle speed, latency, and the likelihood of production failure should be carefully taken into account in this type of network, which is characterised by a high agility environment [7]. Traditional road and route planning, new autonomous driving systems (connected cars), and increased sharing of smart transportation are all examples of mobility technology in 5G. Road management, safe navigation, incident avoidance, fuel conservation, price reduction, and pollution reduction are some benefits of smart mobility [2][3] We intend to examine the benefits of using current and new mobile communication protocols, including the LTEX2 protocol and the 5G Deviceto-Device — D2D

5G-Used Smart Cities

The world will be connected by 5G technology in the near future, from the largest megacities to the tiniest Internet of Things in an ever-online manner. Such a connected hierarchy would unite the Internet of Things, smart homes, and smart cities into a single, comprehensive infrastructure [5].

The following have been taken into consideration in research on smart cities and self-organizing networking techniques for 5G wireless networks: Large M2 M communications in the smart city are dependent on 5G, but the network itself is unsure of how much data will be running across it. Stronger cooperation between the two will, however, lead to a shared partnership since the data created by the massive amount of data collected by the sensors may be utilised to improve connectivity performance [1]

5G and augmented reality

In recent years, augmented and virtual reality have begun to use the fast speeds of cellular networks and video streaming technologies. But we are also prevented from achieving highfidelity telepresence and integrated interactive and augmented reality applications by limitations like bandwidth and latency. Fortunately, designers and developers are aware of these issues and have established 5G networks to aid in our transition to the new era of software interfaces [8]. The two main demand drivers for the future expansion of wireless connectivity— wireless Internet and the Internet of Things— which could present a wide range of prospects for 5G—are these two. In the 5G future, there will be a wide variety of use cases, including wireless computing, augmented reality, and virtual reality

VII. CONCLUSION

This paper has covered major elements of the impending 5G network and reviewed many facets of it.that are required for the installation of the 5G network. From a simple sensor to a complex self-driving vehicle, from embedded sensors in all kinds of hardware to automated cars, from aircraft to smart businesses and towns, 5G networks would be smarter and more effective to serve a huge amount of radio spectrum. 5G networks will link everything to one another, from a user to the web. The next 5G network, which has a significantly larger network capacity, reduced latency, and greater bandwidth than the existing network, is the next generation of technology. In other words, 5G would support one of the greatest technological revolutions in history.

To put it another way, 5G would help bring about one of the greatest technological revolutions in human history, with many applications. By enhancing emergency treatment and reducing road accidents, it not only has the potential to transform human lives but also aspires to keep them intact. Before 5G technology is commercialised, it is crucial to maintain network flexibility and capability in order to handle a variety of use cases and business models.

It's also critical to monitor how cost- and energy-effective the 5G technology is. We have discussed the energy-efficiency aspects of 5G, many effective antennas for 5G mobile networks, designs, and several applications of 5G technology in this post.

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ASIC Implementation of Duty Cycle Correction Circuit

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ABSTRACT
Duty cycle is a crucial component of VLSI circuits and this paper introduces an accurate Duty cycle correction circuit with high measurement accuracy and range of correction. Experimental and theoretical results are closely correlated.

Keywords—duty cycle, multiplexer, clock, delay line

I. INTRODUCTION

In this study, a circuit for fine duty-cycle control in high- frequency systems is presented. The suggested digital circuit is more reliable, simpler to use, and capable of higher- frequency resolution improvements. It is crucial for high- speed circuits and logic families because it determines how much time is allotted for the precharge and evaluate phases; if this time is off from the desired value, performance will suffer. The clock signal can be further weakened by environmental and process variables, making it challenging to produce and disseminate high-frequency clocks with a fixed duty cycle[2].

Before giving the clock signals to sensitive parts of the design the duty cycle value is measured. The measurement is based on a specific logic and once the measurement is done, based on the duty cycle value the clock is switching to the correction circuit.[1] The correction can be controlled from the controller. The amount of correction required is controlled by the selection bits from 0 to 15. Each bit's selection will correct the input clock signal by a fixed amount.

II. TECHNOLOGY AND TOOLS USED

A. 90 nm Technology

Leading semiconductor companies such as Toshiba, Sony, Samsung, IBM, Intel, Fujitsu, TSMC, Elpida, AMD, Infineon, Texas Instruments and Micron Technology have commercialized the 90 nm process for MOSFET (CMOS) production between 2003 and 2005 with historic associated with a 70% upward trend every two to three years. The International Technology Roadmap for Semiconductors (ITRS) specifies the designation. For base layer lithography, mostly at the 90nm node, many (but not all) companies have adopted the 193nm wavelength. The significant costs associated with this change were reflected in performance concerns (due to the use of new photoresists). The 300 mm wafer is also important

B. CADANCE

The Cadence Virtuoso® System Design Platform offers the capability to drive simulation and LVS-clean layout of ICs and packages from a single schematic. It offers two main flows: implementation and analysis. The implementation flow generates an IC package design, while the analysis flow isolates and simulates any system component.

III. DUTY CYCLE CORRECTOR

By altering the adjuster circuit's control bits, the duty-cycle of the input clock can be corrected. By adjusting these control bits to reach a 50% duty-cycle, the detector determines the duty cycle.

There are delay lines in the suggested duty-cycle adjuster. The adjuster consists of two rising edge generators: one fixed rising edge generator with dummy delay lines, latch, and MUX, and the other variable rising edge generator with 6-bit programmable delay lines. The falling edge generator changes the duty-rate using the input clock's non-inverted or inverted signal, MUX selection, and 6-bit control signals of the programmable delay line.

In older duty-cycle adjuster circuits based on delay lines, the duty-rate modification is performed using falling edge generators or by employing both rising and falling edge generators

The duty-cycle adjuster's schematic is depicted in Figure 1. By turning on the PFET stack for a brief period of time (17-inverter delay) and latching one in the feedback circuit, the circuit sends the rising edge of the input clock directly to the node X. A delay line with programming options delays the falling edge. This delayed edge turns off the feedback when it arrives, pulling down the node X by activating the NFET stack. Up to the appearance of the subsequent rising edge, the feedback circuit remains latched in a zero state. Controlling the delay through the programmable delay line allows one to alter the duty-cycle of the input clock. Designing an adjuster with a specific resolution and tuning range allows for control.

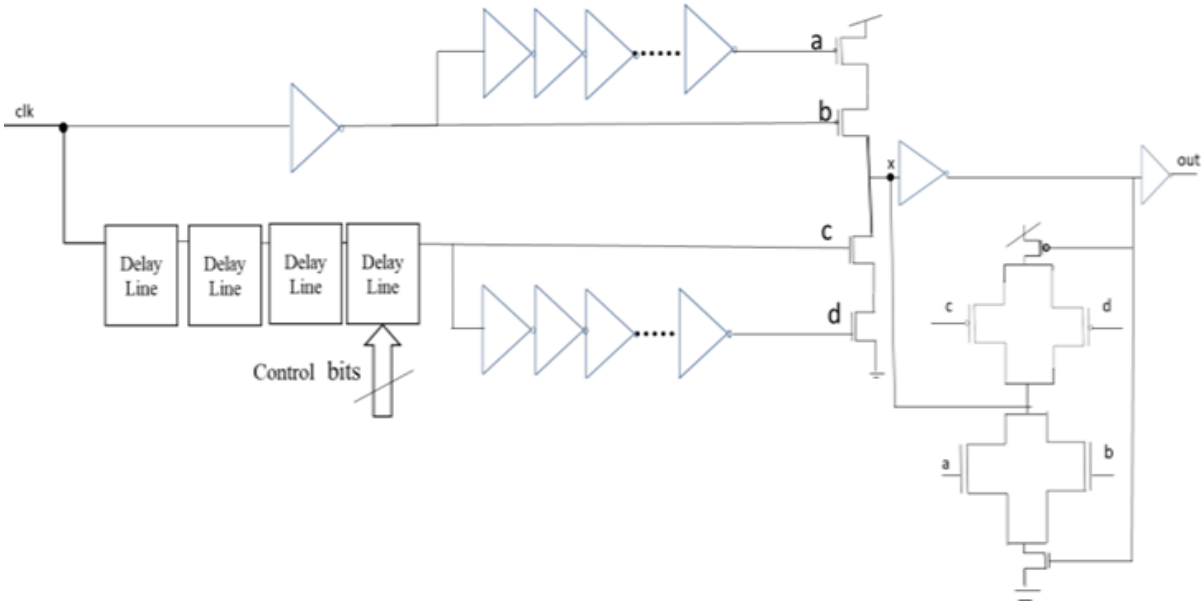


Figure1. Circuit diagram of duty cycle adjuster

If used in these circuits, the period of the lowest operating frequency is the minimum length of the delay line required to give the entire 50% correction range. To reduce delay lines, we just use a falling edge generator for

duty-rate control with a 16x1 input-inversion MUX. While conventional 1 delay line circuits without signal inversion need at least 128 delay inverter cells to achieve the required correction range for this study, our adjuster uses delay line cells that are 512 lengths long.

The adjuster circuit plays a significant role in the duty-cycle correction circuit. In order to alter the duty-cycle of the input clock, it is responsible for controlling the delay between two complementary signals. Using the phase detector's false signal as input, the charge pump generates a DC voltage from the loop filter and sends it into the adjuster circuit. The adjuster circuit then changes the distance between two complementary signals to fix any duty-cycle issues with the input clock.

In other words, the correction circuit consists of a phase detector, charge pump, loop filter, and adjuster, among other components. An essential component of this circuit, the adjuster, works with other circuits to rectify any duty-cycle errors in high-frequency clocks with very low.

There is no duty-rate change during the initial period of duty rectification for the Sign determination of the input clock duty- cycle. The duty-cycle adjuster's clock input for the Sign can be either an uninverted or an inverted clock input. There is no guarantee of the rising-edge (or falling-edge) clock having a set delay. However, Figure 4 shows the clock input as being made up of a combination of D-Flip flops and AND gates as a clock generator with the selectable edge comparison of the falling edge. The D-Flip flop, which can be used as the synchronization information of the delay line, can be given the Sign information. According to the control signal Sign from the DCC, the major drawback of this adjuster edges is that the DLL requires a specially constructed phase detector that analyses only the rising and falling edges, leading to a complex DLL design.

A. Abbreviations and Acronyms

VLSI -very large-scale integration

ASIC- Application Specific Integrated Circuit.

PFET-P-channel Metal oxide semi-conductor field effect transistor

NFET-N-channel Metal oxide semi-conductor field effect transistor

MUX-multiplexer

DCC-duty cycle corrector DLL-delay locked loop

ITRS–International Technology RoadMap for Semiconductors.

nm- Nano meter

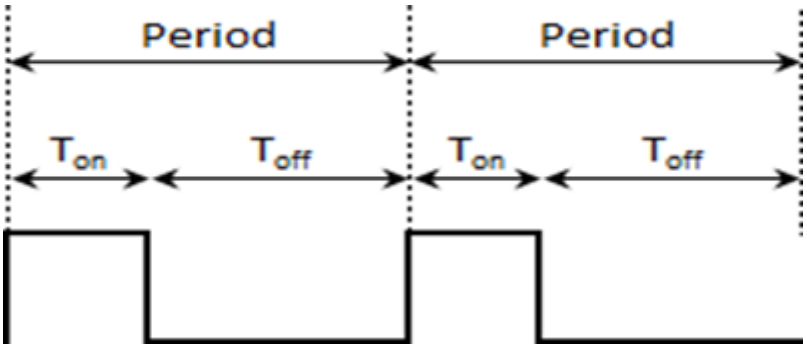
LVS- Layout Versus Schematic

PCB- Printed Circuit Board.

IC- Integrated circuit BOM- Bill of Materials.

B. Duty cycle.

The idea of duty cycle correction circuits, its significance in ASIC design, and typical implementation methods. ASIC implementation of duty cycle correction circuit and frequency range design considerations for duty cycle correction circuit performance jitter. To identify the proper circuit clock skew on the signal topology, the frequency range of the signal that the circuit should be designed to better needs to be corrected, taken into account, and reduced. A signal's duty cycle tells you how much of the time it is ON (at logical high-high voltage).



period = 1 / Frequency period=Ton+Toff

Duty cycle = Ton (Ton+Toff) *100 (on percentage)

The duty cycle adjuster is vital component of the circuit, which works on the principle of adjusting the pull up and pull- down strength of the inverter via fed back digital signals. This circuit uses two steps of correction with first stage doing coarse correction and second stage doing fine correction.

ON time / (ON time + OFF time) = Duty Cycle

Example for 35% - 63%:

Let's take a look at the first simulated output i.e 35% - 63%.Here we have given clock as input in the form of pulse. We have taken 10ns as period and 3.5ns as pulse width which makes 35% duty cycle to the clock signal and fed it to circuit. As we simulate the results by selecting the input and output lines on ADE L suite, we obtain the output that is Vout as 63%

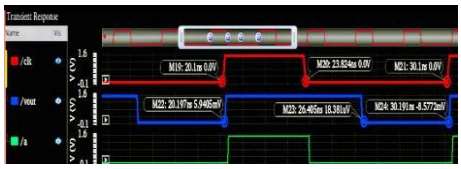
.It means that we get 6.3ns as ON time and 3.7ns as OFF time. By this we can conclude that we have enhanced duty cycle by 28% of the input value.

IV. RESULTS

By adjusting the parameters of the programmable delay line, we can measure the duty-cycle of the output while feeding the adjuster the same 8-GHz clock.

The graphic demonstrates that less than 1% steps can be used to adjust the input clock's duty cycle from 15% to 63%.

The feedback loop chooses the adjuster's ideal settings. Our findings demonstrate that the loop can accurately output a 50% duty-cycle for a wide range of input duty-cycles.

ENHANCED DUTYCYCLE	SIMULATED OUTPUTS
35-63%	

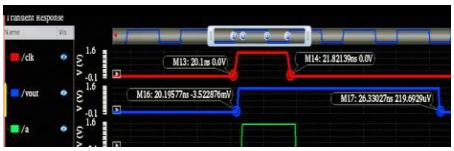
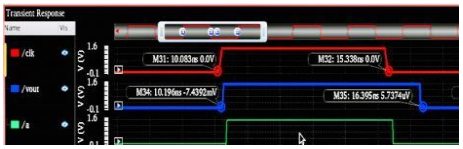
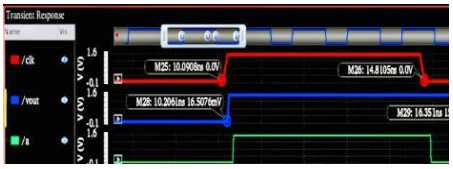
15-62%	
50-62%	
45-61%	

Figure 2: Enhanced duty cycle simulated outputss

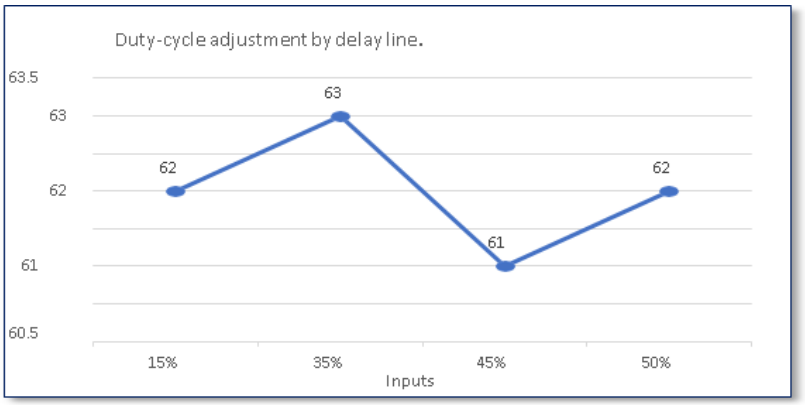


Figure 3: Duty cycle adjustment by Delay line

V. APPLICATIONS

In real-time systems where precise timing is important, the duty-cycle correction circuit has a wide range of applications.

i. High-speed communication systems:The duty-cycle correction circuit is used in high-speed communication systems to ensure accurate timing for data transmission.

ii. Digital signal processing:It is used in digital signal processing applications to improve the accuracy and efficiency of operations such as filtering, modulation, and demodulation.

iii. Microprocessors and microcontrollers: In microprocessors and microcontrollers, accurate timing is essential for executing instructions and controlling peripherals.Test and measurement equipment:It is used in test and measurement equipment to generate and measure signals with high precision by ensuring accurate timing.

Overall, the duty-cycle correction circuit has a wide range of applications in real-time systems where accurate timing is critical.

VI. ADVANTAGES AND LIMITATIONS

A. Advantages:

i. Limited input frequency range:- The duty-cycle correction circuit provides very presise resolution and great accuracy for adjusting the duty-cycle of high-frequency clocks.

ii. Limited output voltage swing:- It is digital and does not need outside references or matching devices, making it more durable and less susceptible to changes in the environment and manufacturing

iii. processes sensitivity to noise: The duty-cycle correction circuit is ideal for a variety of applications because it can correct the duty-cycle of an input clock with a wide range of duty-cycles, typically from 25% to 75%.

iv. Noise sensitivity: the duty-cycle correcting circuit is perfect for a wide range of applications because it can correct the duty-cycle of an input clock with a wide spread of duty-cycles generally from 25 to 75

B. Limitations

i. Power utilization: As the number of inverters increases, so does the area. As a result, we utilise more power consumption.

ii. Complexity: It may be more difficult to develop and implement the duty-cycle correction circuit due to its possible complexity when compared to more traditional analogue duty-cycle correction processes.

VII. CONCLUSION

For instances it is demonstrated how to control the duty cycle of clocks in high-performance systems using a digital circuit. The circuit can be used to correct for duty-cycle inconsistencies caused by environmental and process fluctuations. The results show that the circuit is more resilient and capable of producing very fine resolution when compared to analogue techniques currently being used for duty- cycle correction.

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Recent Trends in Embedded Systems : A Comprehensive Review

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ABSTRACT
Embedded systems have become ubiquitous in our daily lives, powering a wide range of devices and applications. As technology continues to evolve rapidly, new trends are emerging in the field of embedded systems. This paper provides a comprehensive review of recent trends in embedded systems, focusing on advancements in hardware, software, and system design. The aim of this paper is to provide researchers and practitioners with insights into the latest developments and identify potential areas for future research and innovation in embedded systems.
Keywords: embedded systems, hardware, software, system design, trends, research, innovation

I. INTRODUCTION

Embedded systems are specialized computer systems designed to perform specific functions within larger systems. They are found in various domains, including consumer electronics, automotive, healthcare, industrial automation, and IoT. This section provides an overview of embedded systems and highlights the importance of understanding recent trends in this field.

II. HARDWARE TRENDS

A. **System-on-Chip (SoC) Integration:** System-on-Chip integration is a significant hardware trend in embedded systems. SoC refers to the integration of multiple components, including processors, memory, peripherals, and communication interfaces, onto a single chip. This integration reduces power consumption, improves performance, and enhances overall system efficiency. SoCs enable compact and cost-effective embedded system designs.

B. **Low-Power Design Techniques:** Power efficiency is a critical consideration in embedded systems, especially for battery-powered devices or energy-constrained applications. Hardware trends focus on low-power design techniques, such as power gating, clock gating, dynamic voltage and frequency scaling (DVFS), and optimized circuit design. These techniques reduce power consumption, extend battery life, and improve energy efficiency in embedded systems.

C. **Artificial Intelligence (AI) Acceleration:** The integration of AI capabilities into embedded systems is a growing trend. Hardware accelerators, such as dedicated AI processors, neural processing units (NPUs), and field-programmable gate arrays (FPGAs), are utilized to accelerate AI-related tasks. These accelerators enable efficient implementation of machine learning algorithms, neural network inference, computer vision, and natural language processing in embedded systems.

D. **Internet of Things (IoT) Integration:** The integration of embedded systems with IoT networks is a significant hardware trend. IoT integration requires hardware components that support wireless communication protocols, such as Wi-Fi, Bluetooth, Zigbee, or cellular connectivity. Embedded systems designed for IoT applications often incorporate microcontrollers or low-power processors with built-in wireless capabilities, enabling seamless connectivity and data exchange with other IoT devices.

E. **Sensor Integration:** Embedded systems rely on various sensors to gather data from the physical world. Hardware trends focus on sensor integration, including the miniaturization and integration of sensors onto single chips, reducing the overall system footprint. Integrated sensors may include accelerometers, gyroscopes, magnetometers, temperature sensors, pressure sensors, and environmental sensors. Sensor fusion techniques are employed to combine data from multiple sensors for accurate and context-aware measurements.

F. **High-Performance Computing:** Some embedded systems require high-performance computing capabilities to handle complex computational tasks. Hardware trends focus on incorporating powerful processors, such as multi- core CPUs or Graphics Processing Units (GPUs), into embedded systems to handle demanding workloads. High-performance computing enables applications such as image and video processing, gaming, virtual reality, and data analytics in embedded systems.

G. **Secure Hardware Architectures:** As embedded systems become more interconnected, security becomes a critical concern. Hardware trends involve the development of secure hardware architectures to protect embedded systems from unauthorized access, tampering, or attacks. Secure hardware architectures may include features such as hardware-based encryption/decryption, secure boot, trusted execution environments, and secure key storage to ensure the integrity and confidentiality of embedded system data.

H. **Real-Time Interfaces:** Real-time interfaces play a crucial role in embedded systems that require timely communication with external devices or peripherals. Hardware trends focus on implementing real-time interfaces, such as CAN (Controller Area Network), Ethernet with Time- Sensitive Networking (TSN), USB with real-time extensions (USB-RTS), and industrial fieldbuses like PROFIBUS or EtherCAT. These interfaces enable precise and deterministic communication in real-time embedded systems.

These hardware trends in embedded systems are driving advancements in various industries, enabling more efficient, powerful, secure, and connected devices. Implementing these trends requires careful consideration of application requirements, power constraints, connectivity needs, and security considerations to design optimized and reliable embedded systems.

III. SOFTWARE TRENDS

Embedded systems software plays a critical role in providing functionality and managing system resources. This section explores the following software trends:

A. **Real-Time Operating Systems (RTOS):** Lightweight operating systems tailored for embedded systems, ensuring timely and deterministic execution of tasks.

B. **Middleware and Communication Protocols:** Middleware solutions for seamless communication between embedded systems, as well as standard protocols like MQTT, CoAP, and DDS.

C. **Open-Source Software:** The increasing adoption of open-source platforms and tools for embedded systems development, enabling collaborative development and code reuse.

D. **Over-the-Air (OTA) Updates:** Remote software updates for embedded devices, ensuring security patches, bug fixes, and feature enhancements without physical intervention.

IV. SYSTEM DESIGN TRENDS

System Design Trends in Embedded Systems:

A. **Safety and Security:** With the increasing connectivity of embedded systems, ensuring safety and security is a critical system design trend. This involves incorporating robust security measures, such as secure boot, encryption, access control, and intrusion detection, to protect against cyber threats. Safety-critical systems require techniques like fault tolerance, redundancy, and fail-safe mechanisms to ensure reliable operation and mitigate risks.

B. **Edge Computing:** Edge computing is a system design trend that involves moving computation and data processing closer to the edge devices or sensors, reducing latency and minimizing reliance on cloud services. By processing data locally, embedded systems can provide real-time responses, handle sensitive data locally, and reduce network congestion. Edge computing is particularly beneficial for time-sensitive applications and resource-constrained environments.

C. **Heterogeneous Computing:** Heterogeneous computing involves the integration of diverse computational resources, such as CPUs, GPUs, FPGAs, and AI accelerators, within embedded systems. This trend enables optimized performance and power efficiency by leveraging the strengths of different processing units for specific tasks. Heterogeneous computing enhances capabilities like image processing, machine learning, and signal processing in embedded systems.

D. **Human-Machine Interaction:** Designing embedded systems with intuitive and seamless human-machine interaction is an important trend. This includes incorporating user-friendly interfaces, voice recognition, touchscreens, gesture-based interactions, and natural language processing. The aim is to enhance usability, user experience, and accessibility, making embedded systems more intuitive and easier to operate for end-users.

E. **Connectivity and IoT Integration:** The trend of connectivity and IoT integration focuses on embedding devices and sensors within a networked ecosystem. This enables seamless communication between embedded systems, as well as with cloud platforms, mobile devices, and other IoT devices. Communication protocols such as MQTT, CoAP, and DDS facilitate efficient data exchange, while IoT integration allows for centralized management, remote control, and data analytics.

F. **Software-Defined Systems:** Software-defined systems involve the separation of hardware functionality from software control and configuration. This trend enables flexibility, scalability, and adaptability in embedded systems. By abstracting the hardware layer, software-defined systems facilitate easier updates, reconfiguration, and customization of embedded systems, allowing for more agile and versatile deployments.

G. **Power Management and Energy Efficiency:** Energy efficiency is a crucial aspect of embedded system design. With the growing demand for battery-powered and energy-constrained devices, system design

trends focus on optimizing power consumption. This includes techniques such as power gating, dynamic voltage and frequency scaling (DVFS), sleep modes, and power-aware scheduling algorithms to maximize battery life and minimize energy consumption.

H. **Real-Time and Deterministic Operation:** Many embedded systems require real-time and deterministic operation, where tasks must be completed within specific timing constraints. System design trends focus on utilizing real-time operating systems (RTOS), scheduling algorithms, and prioritization mechanisms to ensure timely and predictable execution of tasks. Deterministic operation is critical for applications such as industrial control, automotive systems, and medical devices.

These system design trends in embedded systems are driving advancements in various industries, enabling enhanced functionality, connectivity, security, and energy efficiency. Implementing these trends requires careful consideration of application requirements, hardware capabilities, and system constraints to design robust and optimized embedded systems.

V. CASE STUDIES AND APPLICATIONS

This section presents case studies and real-world applications that showcase the practical implementation of recent trends in embedded systems. Examples may include smart homes, autonomous vehicles, wearable devices, and industrial automation.

A. Smart Homes:

Case Study: Home Automation System

Description: A smart home system that integrates various embedded devices and sensors to automate and control household appliances, lighting, security systems, and energy management. The system utilizes IoT connectivity, wireless communication protocols, and edge computing capabilities to provide a seamless and personalized home automation experience. Users can control and monitor their homes remotely through mobile applications or voice assistants.

B. Autonomous Vehicles:

Case Study: Self-Driving Cars

Description: Self-driving cars are a prime example of the practical implementation of embedded systems in the automotive industry. These vehicles employ a combination of sensors, such as LiDAR, radar, and cameras, along with powerful embedded processors to perceive their surroundings and make real-time decisions. The embedded systems in autonomous vehicles enable features like lane keeping, adaptive cruise control, object detection, and collision avoidance, revolutionizing the concept of transportation.

C. Wearable Devices:

Case Study: Fitness Trackers

Description: Fitness trackers are wearable devices that monitor and track users' physical activities, health metrics, and sleep patterns. These devices integrate multiple embedded sensors, such as accelerometers, heart rate monitors, and gyroscopes, to collect data. Embedded systems within the fitness trackers process this data, provide real-time feedback to users, and synchronize the information with smartphones or cloud platforms. The trends in this area include miniaturization, power efficiency, and advanced health monitoring algorithms.

D. Industrial Automation:

Case Study: Smart Factory

Description: In industrial automation, embedded systems are utilized to create smart factories that optimize production processes, increase efficiency, and enable real-time monitoring and control. These systems incorporate embedded sensors, actuators, and controllers to automate tasks such as assembly line control, inventory management, predictive maintenance, and quality control. Communication protocols like MQTT and OPC UA facilitate seamless data exchange between machines, while edge computing enables faster decision-making and reduced latency.

These case studies demonstrate how recent trends in embedded systems are being applied to practical applications, enhancing convenience, safety, efficiency, and overall user experiences in various domains.

VI. CHALLENGES AND FUTURE DIRECTIONS IN EMBEDDED SYSTEMS

The advancements in embedded systems also present various challenges and opportunities for future research. This section highlights key challenges and suggests potential research directions to address them.

A. **Power Management and Energy Efficiency:** Embedded systems often operate on limited power sources, such as batteries or energy harvesting. Ensuring optimal power management and energy efficiency is a continuous challenge. Future directions involve developing low-power hardware designs, energy-aware algorithms, and power optimization techniques to extend battery life and minimize energy consumption.

B. **Security and Privacy:** As embedded systems become more interconnected and communicate with external networks, ensuring robust security and privacy measures is crucial. The future direction involves developing secure hardware architectures, encryption techniques, secure communication protocols, and authentication mechanisms to protect embedded systems from cyber threats and safeguard sensitive data.

C. **Real-Time Performance:** Many embedded systems require real-time performance, where tasks must be completed within strict timing constraints. Future directions involve developing real-time operating systems (RTOS) with enhanced scheduling algorithms, predictable task execution, and efficient resource management to meet real- time requirements in complex and dynamic environments.

D. **System Complexity and Integration:** Embedded systems are becoming increasingly complex, incorporating multiple functionalities, sensors, and communication interfaces. The future direction involves developing design methodologies, modelling techniques, and system integration frameworks to manage the complexity, facilitate interoperability, and ensure seamless integration of various components within embedded systems.

E. **Heterogeneous Computing and AI Integration:** The integration of heterogeneous computing resources, such as CPUs, GPUs, FPGAs, and AI accelerators, is a growing trend in embedded systems. Future directions involve exploring innovative architectures, programming models, and optimization techniques to effectively utilize heterogeneous resources, leverage AI capabilities, and achieve high-performance computing in resource-constrained environments.

F. **Safety-Critical Systems:** In safety-critical applications like automotive, aerospace, and medical devices, embedded systems must adhere to stringent safety standards. Future directions involve developing safety-critical design methodologies, fault tolerance mechanisms, and verification/validation techniques

to ensure reliable and fail-safe operation of embedded systems, minimizing the risk of accidents and hazards.

G. **Internet of Things (IoT) Integration:** The integration of embedded systems with IoT networks presents both opportunities and challenges. Future directions involve addressing issues related to scalability, interoperability, data management, and edge computing capabilities to effectively connect and manage a large number of embedded devices within IoT ecosystems.

H. **Human-Machine Interaction:** As embedded systems become more pervasive, enhancing human- machine interaction and user experiences is crucial. Future directions involve developing intuitive interfaces, voice recognition, natural language processing, and gesture-based interactions to improve usability, accessibility, and user satisfaction with embedded systems.

I. **Software Development and Testing:** Embedded systems software development requires specialized skills, tools, and testing methodologies. Future directions involve advancing software development environments, debugging techniques, simulation platforms, and automated testing frameworks to streamline the development process, improve software quality, and reduce time-to-market.

J. **Standardization and Collaboration:** With the rapid evolution of embedded systems, standardization efforts and collaboration among industry stakeholders, researchers, and regulatory bodies become vital. Future directions involve promoting standardized interfaces, protocols, and frameworks to enable interoperability, facilitate knowledge sharing, and accelerate innovation in embedded systems.

Addressing these challenges and exploring future directions will contribute to the advancement of embedded systems, enabling the development of more efficient, secure, and intelligent solutions that meet the evolving needs of various industries and domains.

VII. CONCLUSION

This paper provides a comprehensive review of recent trends in embedded systems, covering hardware, software, and system design aspects. By understanding these trends, researchers and practitioners can stay up-to-date with the latest developments and contribute to the advancement of embedded systems.

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