AI Based Smart IoT Systems

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Abstract The integration of IoT and AI has a potential to generate more efficient solutions and experiences. By combining the incoming data from IoT devices you can get more value from your network and improve your business. Artificial Intelligence is a critical part of IoT that makes intelligent network management and operations successful. From combination of these two modern technologies, smart gadgets will be created allowing businesses to make strategic decisions with least percentage of error. The applications of IoT are very wide such as virtual reality, mixed reality, augmented reality, use of it in healthcare, agriculture, disaster management, waste management and much more. The integration of AI with IoT has made possible many smart products commonly available in the market such as smart locks, Green IQ smart garden hubs, SmartMat and smart controllers. We are already on our way to a cyborg civilization; a cyborg is an entity where technology and biology are integrally attached. This could upgrade the human limits and abilities of a human and by this one could become more immune to injuries and have a much higher intelligence as well.

Keywords Internet of things (IoT) · Cloud · Artificial intelligence · Neural networks · Virtual reality (VR) · Augmented reality (AR) · Cyborg

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1 Introduction

The physical effects or objects that are submerged with some detectors, software, and numerous other technologies for connecting and swapping data with other systems and bias over the internet is inclusively known as IoT (Internet of effects). Some of the exemplifications are Smart Mobiles, smart Watches, Smart fire admonitions, Fitness Tracker, smart security systems, and numerous further.

In moment's world, IoT bias, artificial IoT, intelligent detectors, mobile edge computing, wireless dispatches, communication protocol, etc. are buzzwords of the assiduity of Technology. Generally, Internet of effects works through implanting short-range portable transceivers into an electric arrangement of bias and everyday objects. And for that, IoT would add a new horizon to information and communication. Bias of IoT are connected through a piece of inventive communication ministry similar as Wi-Fi, GSM, Bluetooth, etc., which can help ameliorate people's living norms. According to The rearmost check reports that the number of IoT bias like bedded bias, detectors, game consoles, laptops, and smart bias is anticipated to reach further than 60 billion in 2025, which is a veritably big number.

As the below discussion reflects, utmost IoT systems are getting decreasingly dynamic, mixed, and multifaceted; therefore, the association of such an IoT system is getting gruelling. Thus, there's a need to enhance the effectiveness and variability of IoT System-acquainted services to attract further druggies.

This chapter is useful for the introductory to depth knowledge of AI-grounded Smart IOT systems, their advancements, their requirements in day-to-day life, and numerous further.

2 What's IoT?

There are a lot of addresses these days about the Internet of effects and its impact on everything from how we travel to how we buy. What exactly is the Internet of effects, you might ask? What's the medium behind it? Is it that significant? The Internet of effects, or IoT, is concept of linking any device to net and other linked bias, as we mentioned before.

IoT encompasses a wide range of objects of all sizes and shapes, ranging from smart broilers that cook your food for the exact quantum of time you specify, to wearable fitness bias that tracks your heart rate and the number of ways you take each day and use that data to recommend exercise plans that are right for you, to tone-driving buses with detectors that descry objects in their path. Some footballs can track how snappily and how far players are launched and record those data using an operation for unborn use [1].

2.1 How Does It Work?

Now we'll talk about how it works. IoT connects bias and objects with erected-in detectors to an Internet of effects platform, which integrates data from colourful bias and applies analytics to partake the most useful information with apps designed to meet specific requirements.

These advanced IoT platforms can pinpoint precisely which part of data is useful and other may safely ignored. This data can be used to spot patterns, make recommendations, and identify implicit issues before they arise. The data collected by linked bias allows me to make informed judgments about which factors to stock over on grounded on real-time data, saving both time and plutocrat.

Let's look at some exemplifications to understand how this works in real life.

IoT in your home

Let's pretend you have to go to work every day at 6 a.m. Until commodity goes wrong, your alarm timepiece wakes you up impeccably. Your train was cancelled, so you will have to drive to work. The issue is that driving takes longer, so you'd have to get up at 5.45 a.m. to help to be late. Also, you will have to drive a little slower than usual because it's raining outdoors. Take a look at what the Internet of effects can achieve in this case-To ensure you arrived at work on time, an IoT-enabled alarm timepiece would reset itself grounded on all of these criteria. You might notice that your regular train has been cancelled. Also, figure out the driving distance and time for your alternate route to work, check the rainfall and account for reduced trip pets due to heavy rain, and figure out when it needs to wake you up so you do not miss work. Also, if it's super-smart, it might be suitable to communicate with your IoT-enabled coffee maker to guarantee that your morning java is ready when you get up.

IoT in transport

You are driving to work after being awoken by your smart alarm. Problems can do at any moment and in any position. The machine light comes on. You'd rather not go to the garage right down, but what if it's an exigency? So, the detector that checks the machine light would communicate with others in the auto in an IoT-equipped vehicle. The individual machine, which is formerly included in the IoT platform, receives data from these detectors and delivers it to a gateway in the auto, which also sends the material data to the manufacturer's platform. The manufacturer can use information from your machine to record an appointment for you to have the part repaired, as well as give directions to the nearest person.

3 Elements of IoT

We've all heard of the Internet of Things, which is a technique of linking our smart devices to a network to function efficiently and access information remotely. IoT has numerous core components, some of which are listed below.

3.1 Identification

Term Identification serves a critical role in any data transfer or communication network. It is the ability to match services and name with their claims is critical to the IoT structure. The name of a device or item is represented by an ID, and its current location inside the network territory is represented by an address. Within the network region, objects can practice with public IP addresses. As a result, the built models must overcome the obstacles and accurately recognize each object within the network.

3.2 Sensing

The Internet of Things is used to collect data from a specific area, which is then organized using sensing devices. Sensing devices or items collect data of real-world from the environment and deliver it, to a database for further process: actuators are used primarily for sensing, sensors, wearable devices, or sensors.

Temperature sensors and thermostats are examples of common sensors

- Sensors for measuring pressure
- Humidity/Moisture Content
- Detectors of light intensity
- Sensors that detect moisture
- Detection of proximity.

  RFID (Radio Frequency Identification) tags.

3.3 Gateway

The bidirectional data traffic between multiple networks and protocols is managed by the gateway in the Internet of Things. A gateway can also be used to interpret multiple network protocols and ensure that connected devices and sensors are consistent. Before passing the data to the next level, gateways can be constructed to perform local pre-processing on the data obtained from thousands of sensors. It may be

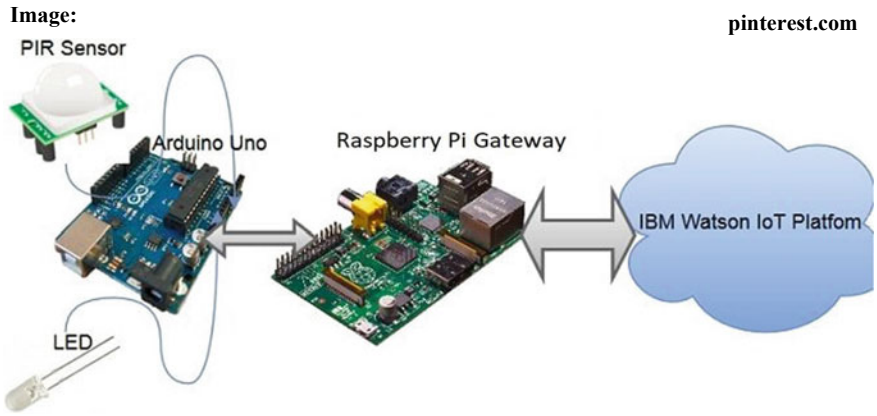

Fig. 1 Raspberry Pi gateway. *Source* Relationship between IoT and cloud computing | Tech News | cppsecrets.com

necessary in some cases due to protocol compatibility, such as the TCP/IP protocol (Fig. 1).

3.4 Cloud

The Internet of Things generates a massive amount of data from users, applications, and devices, which must be efficiently managed. In IoT, the cloud provides capabilities for processing, collecting, managing, and storing massive amounts of data in real-time. Industries and services may readily access this data from a distance and make vital decisions when they are required.

Essentially, an IoT cloud is a high-performance network of servers that is geared to process millions of devices at high speeds, give precise analytics, and control traffic. A distributed database management system is one of the most critical components of the IoT cloud.

Hundreds of billions of devices, sensors, gateways, protocols, data storage, and predictive analytics are all part of the cloud system. Companies employ billions of devices, sensors, gateways, protocols, data storage, and predictive analytics data for product and service enhancement, all of which are integrated by the cloud system. Cloud system analytics aids in the establishment of preventive measures for specific phases and the more accurate construction of business models.

3.5 User Interface

The visible, physical portion of the IoT system that consumers may access is the user interface. Designers must ensure that the user interface is well-designed to encourage more interactions and require minimal effort from users.

The Modern technology allows for a lot of interactive designs to make difficult activities easier to perform with simple touch panels. In modern domestic appliances, multicolor touch panels have replaced hard switches, and the trend is spreading to nearly all smart home gadgets.

3.6 Services

The Internet of Things (IoT) provides a wide range of services. Most of them are divided into four categories as follows:

- Identity-based services-which include most real-time appliances.
- Information-aggregative services-which collect real-world raw sensor data and connect it to appropriate IoT applications.
- Collaborative-aware services-which use the collected data to perform data analytics for decision-making.
- Ubiquitous-based services-which are designed to represent collaborative systems that can work anywhere when they are required by clients. Even said, the aforementioned services are not yet at a comfortable level; various issues, in addition to challenges, must be addressed.

4 Framework of IoT

Consider open-source IoT frameworks.

While looking for the best IoT tools to enable comprehensive analytics and interoperability among their connected devices, many businesses seek out out-of-the-box open-source platforms. Let's take a look at the five most popular open-source IoT frameworks and determine if they match your demands [2].

4.1 DeviceHive

- Python, Java, and other libraries are supported by this feature-rich technology.
- deliver resources in the public, private, or hybrid cloud that are scalable.
- Deployment alternatives such as Docker and Kubernetes are supported.
- Ramp up single and multiple production volumes.

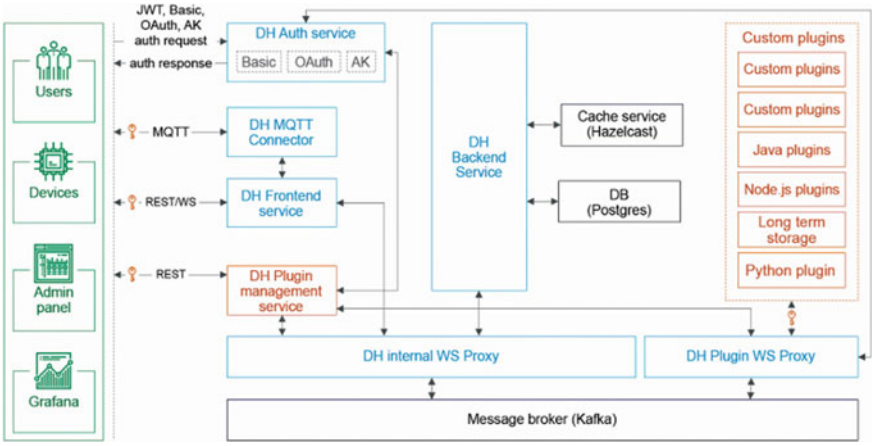

Fig. 2 DeviceHive. *Source* 5 Best Open Source IoT Frameworks | ByteAnt

- Obliterate small technological intricacies.
- REST API, WebSockets, and MQTT protocols can be used to connect any device (Fig. 2).

4.2 ThingSpeak

The platform comprises:

- aggregation and analyses of live data streams.
- the designation of public channels for data sharing.
- visualizing the data that has been gathered.
- REST and MQTT APIs are used to refresh the channel feed (Fig. 3).

4.3 Mainflux

Mainflux provides:

- HTTP, MQTT, WebSocket, and CoAP protocols for connecting things and users.
- Device provisioning and management.
- Docker's container-based deployment.
- Kubernetes container orchestration.
- Customizable API keys and scoped JWT improve data security.
- Advantages of low OPEX (operational expense) (Fig. 4).

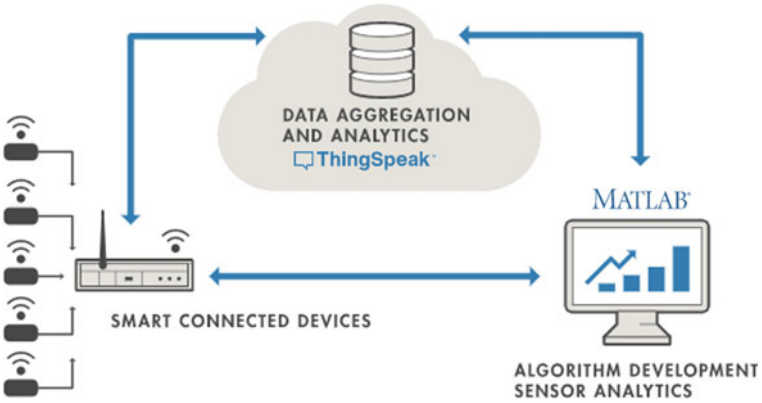

Fig. 3 ThingSpeak. *Source* 5 Best Open Source IoT Frameworks | ByteAnt

Fig. 4 Mainflux. *Source* 5 Best Open Source IoT Frameworks | ByteAnt

4.4 Thinger.io

- seamless multi-hardware integration is one of the most advantageous aspects.
- Arduino IDE, Linux, Sigfox, and ARM Mbed boards hardware support.
- a user-friendly cloud administration console.
- Data is streamed in real-time via WebSockets.
- real-time dashboards for device data visualization on the cloud.

4.5 Zetta

The list of features includes both common and unusual characteristics:

- seamless connectivity with the business logic of the customer.
- Node.js is used.
- For data streaming, it uses Reactive Hypermedia patterns.
- builds a strong API for IoT devices using Siren Format.
- independent of network protocols.
- peering servers have a secure connection.
- reliable data transfer via WebSockets (Fig. 5).

5 Architecture of IoT

The integration of IoT and its variants into numerous sectors and organizations will improve product or work performance. However, in practice, these ideas are severe and difficult to implement because the number of protocols, and operating conditions varies greatly from one device to the next. The issue of establishing a standard IoT architecture will inevitably arise during this period. facilitating the discovery of trustworthy IoT solutions Furthermore, it will cut the amount of time and money needed on IoT design. It is critical to understand what this concept signifies before unveiling the mysteries and presenting a clear architecture of this creativity. In its most basic form, IoT architecture is a collection of excellent network tools [3] (Fig. 6).

A. The physical/device layer is the first layer. The physical layer and device layer are made up of sensors, actuators, and other smart devices and connected gadgets. These intelligent gadgets either collect data (sensors) or take action (actuators), or both.
B. The network layer is the second layer. This includes network devices, as well as communication kinds and protocols (5G, Wi-Fi, Bluetooth, etc.). Although many IoT systems use general-purpose network layers, there is a growing trend toward dedicated IoT-specific networks.

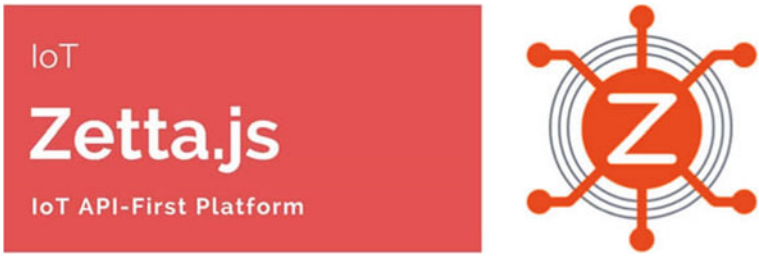

Fig. 5 Zetta. *Source* 5 Best Open Source IoT Frameworks | ByteAnt

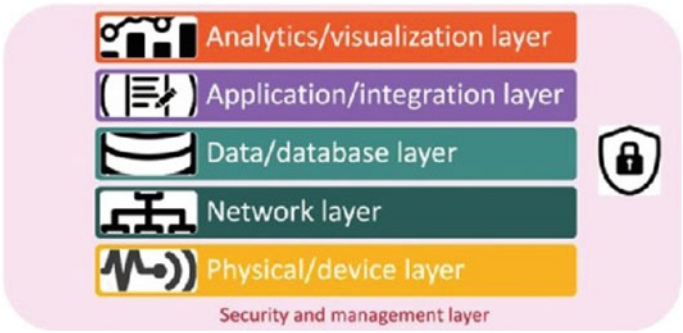

Fig. 6 The six layers of IoT architecture. *Source* 6 IoT architecture layers and components explained (techtarget.com)

C. The data/database layer is the third layer. The database platform layer is also included. Many firms spend a significant amount of time identifying and architecting the correct IoT databases, as there are a variety of databases utilized in IoT designs.
D. The analytics/visualization layer is the first layer. The analytics layer, visualization layer, and perception layer are all part of this layer. In essence, the purpose of this layer is to analyse IoT data and offer it to consumers and apps for interpretation.
E. The application/integration layer is the second layer. This is the layer of applications and platforms that work together to give IoT infrastructure capability to the business. In other words, the application layer, platform layer, and integration layer are the components of the IoT architecture that create commercial value. The application/integration layer includes the processing layer and the business layer.
F. The first layer is the security and management layer. This layer comprises both the security and management layers, as the name implies. This isn't strictly a layer because it communicates with all the other levels to offer security and administration. It is, nevertheless, a vital component that should be considered at each layer.

6 Need for IoT

The Internet of Things platform is being utilized to raise global awareness about modern technologies to a new degree. The internet of things is being implemented in a huge number of places these days, and it's growing at a rapid pace [4].

6.1 Disaster Management

Smart gadgets connected to the internet of things can keep track of forest fires and other natural disasters with fine-grained accuracy all the time. Smart gadgets can effectively handle these situations and can even alert the containment team before they begin informing them, allowing them to respond promptly and effectively. A smart disaster management system can also be used to deal with the aftermath of avalanches, mudslides, and earthquakes.

6.2 Urban Management

Rising traffic is one of the most pressing worries among emerging countries, and dealing with it is a problem that the government cannot effectively address. As a result, IoT devices can play a critical role in automated traffic management systems that can effectively notice and control traffic flow. The paring application in the smart management system quickly steers people to open parking spaces and reduces the danger of wasting time and energy. It also considerably reduces waste that surpasses the existing system's inclinations.

6.3 Smart Healthcare

In the health industry, IoT devices have been introduced in large numbers, and they are providing excellent outcomes. Wearable gadgets used in the health industry can identify a variety of health concerns at the same time and even provide warnings before they arise. When a disease is detected, these gadgets promptly notify family members so that they can take action to control it. These gadgets also provide responders with detailed information about the medications.

6.4 Interactive Performance

You may efficiently interact with others in real-time with the support of sophisticated data analytics. In addition, the organization can track the location, timing, and type of search to learn more about the clients' true needs. The dynamic interactions are formed by the internet of things devices, with the demonstration taking place in multiple sizes at the same time.

6.5 Superior Functionalities

Following the introduction of IoT devices, advanced features provide customers with delightful experiences that are nearly identical to mobile payment. The internet of things devices' advanced capabilities aid in the execution of efficient operations at various stages.

6.6 Convenient Usage

The most common reason for this is the appropriate control. Smart gadgets with the IoT function are getting more popular these days, and the most common reason for this is the appropriate control. Many Internet of Things (IoT) gadgets is installed in your home to help it become smarter. A smart refrigerator and the Amazon Dash Board button, for example, are examples of internet of things implementations that can track goods and alert users early. As a result, the internet of things greatly facilitates people's lives while also saving time.

7 AI in IoT

As we all know, combining an intelligent system with another discovery known as Machine Learning, or ML is quite beneficial. This intelligence enables them to analyze data and make judgments in the same manner as a human brain [5].

Here's how to go about the fact of utilization of Expert System to provide even more value to the IoT domain:

1. To provide people with suitable inputs, sensing units, and actuators coated in software and equipment to connect the devices in an IoT network. Because they enable these devices to grasp the data they receive, machine learning and artificial intelligence are at the heart of the Internet of Things.
2. The Software programs with machine learning intelligence capabilities analyze raw data collected and integrated by a set of linked devices. The final result, after a thorough review, contains useful information.

Overall, the convergence of IoT and AI technology has the potential to improve solutions and experiences. To get more value from your network and improve your business, you should combine AI with incoming data from IoT devices.

Smart gadgets will be created as a result of the combination of two modern technologies, allowing businesses to make strategic decisions with zero error. As a result, there will be a lot to see and do; let's hope for the best and make the world a smarter place.

8 Artificial Intelligence for Intelligent Sensing

Given the development and ubiquity of bedded detectors in a wide range of bias ranging from smartphones and smart megacity structure to consumer IoT widgets and health monitoring systems, seeing has come decreasingly pivotal in ultramodern civilization. Artificial intelligence is a abecedarian element of smart seeing because it allows a large quantum of seeing data to be reused in a way that provides environment and useful perceptivity to help smart bias make opinions and perform conditioning. Developing and integrating artificial intelligence into smart seeing and IoT systems presents several problems, ranging from memory footmark and computational complexity to sequestration and trustability [6].

Memory-effective AI algorithms, computationally effective AI algorithms, AI sequestration, AI security, and bedded AI operations are all covered in this Special Issue on bedded artificial intelligence for smart seeing and IoT operations.

9 Artificial Intelligence in Analytical Skills (IoT)

For decades, several company associations have hired logical capabilities; presently, numerous enterprises are fastening on planning their AI capacities. Organizations/ companies have been combining their chops for effective data use, statistical analytics, and quantitative styles to advance decision-making for several decades. presently, still, those enterprises are substantially concentrated on developing and planting AI to round one another. AI, unlike ML and DL, isn't statistical, thus it snappily gains supremacy in addition to demand. Analytics-focused clusters inside administrations may choose to concentrate their attention only on these machines or acquire new capacities in nonstatistical areas.

Innovation analytics has evolved into several forms, some of which are listed then. Analytics 1.0 ushers in a new period of artisanal suggestive skill, as well as the preface of scrutiny and jotting tools. A combination of chops and internal collaboration conditions are some of the reasons for incorporating AI into analytics.

10 Edge Computing in IoT

For illustration, if you have a large quantum of data and need to work in end-to-end or largely detector-ferocious or data-ferocious surroundings where data is generated at the edge, which is due to IoT as data seeing at the edge, you can use end-to-end or largely detector-ferocious or data-ferocious surroundings. likewise, with real-time data and the growing quantum of unshaped data, including detector and IoT data, traditional methodologies are no longer enough. Edge computing in IoT helps to reuse data in a variety of scripts where speed and high-speed data are crucial factors for

operation, power difficulties, analytics, and real-time requirements, among others [7]. A network of mini data centres that locally store or process vital data before transferring it to a centralized data center or pall storehouse depository. In utmost IoT use scripts, a large quantum of data passes via the data center, but because edge computing processes data locally, business in the central depository is dropped. IoT bias handle this by transmitting data to a original device that comprises storehouse, calculation, and network access. After that, data is reused at the edge, with the remainder being transmitted to a storehouse depository or the data center for central processing.

11 Neural Networks

The quest for innovative neural network designs able of running on bias with low computational power and bitsy memory space is getting an essential content in the age of neural networks and the Internet of effects (IoT). Smart healthcare services, smart husbandry, smart terrain monitoring, smart disquisition, and smart disaster deliverance are just a many of the artificial intelligence (AI) operations in the IoT assiduity. In the history, similar programmers worked in real-time [8]. Object-recognition tasks grounded on security cameras, for illustration, prisoner and respond to target events at discovery intervals of 500 ms. Data processing of mortal health and physiological characteristics from colorful detectors (heart rate monitoring, glucose monitoring, oxygen achromatism, and so on) is generally critical. marketable smart IoT bias constantly transmit data to the pall for intelligent processing. Still, harmonious network connections aren't always available, which limits the capability to meet real-time conditions. The prosecution of information processing using neural networks installed directly on IoT bias could be a result to this challenge. The quality of the Internet connection would have no bearing in this situation. Because of the limited CPU power and memory size of IoT bias, enabling artificial intelligence directly on the device is problematic. Smart operations constantly bear a featherlight operating system with a small set of libraries, which limits the operation of resource-ferocious neural networks. In mobile healthcare (m-Health), as well as in affiliated operation disciplines, AI technologies for IoT bias and edge computing are in high demand. In IoT surroundings, ambient intelligence (AmI) surroundings are erected to give smart services for people grounded on real-time analysis of mortal cognitive and mobility processes. The following are some exemplifications, but they aren't total operations for Industrial Internet when real-time monitoring of mortal movement and health parameters supports discovery of dangerous situations and incorrect exertion in technological operation; Tactile Internet with its demand in bionic operations when a person can "touch and perceive" distant objects, rather than in the specific and limited conditions of a professional medical lab at a sanitarium.

12 Reliability of AI in IoT Systems

With inculcation of the IoT, human life will become more comfortable and stress-free. On the other hand, some experts claim that IoT stands for "Internet of Garbage," as it contains spam, viruses and other unwanted content. Internet of Things (IoT) is quickly expanding as well as creating new needs. The deployed software programmes as well as the network connections that have been established, should be secure and they should be having the capability to become an efficient method of communication whilst maintaining the integrity as well as security of the system. The data of clients and operational personnel of smart IoT gadgets is available via the internet, so they will be particularly vulnerable. Data confidentiality, privacy, and trust are three major concerns with IoT devices and services. Cybersecurity is a paradigm for safeguarding IoT systems and their connected components. Before exchanging data or gaining access to a service, the IoT object/device must first obtain authorization from an organisation or person. When working with smaller devices, cybersecurity standards are most vital, as IoT-based cybersecurity solutions usually prevent attackers from obtaining critical data. There are several cybersecurity technologies that safeguard socket layers, including firewalls, access control, anti-malware software, intruder detection system, virtual private networks. For better security, machine learning, deep learning, blockchain, and quantum-resistant cryptography may very well be applied to IoT systems. Additionally, certain recent difficulties have occurred, such as wearable devices collecting data of the user, the data is then transferred to the people who provided them with the device. The gathered user data is then sold to other businesses without the user's permission by these device suppliers. Apart from security concerns, the most fundamental difficulty in IoT-based systems is how to avoid such data ethics.

13 AI Tools for IoT

a. IoTSim-Edge: This could be referred to as a simulation skeleton that is used in context to the conduct of various edge computing environments as per with the objective of modelling them with the help of various protocols of IoT and a profile of prominent consumption of energy could be esteemed [9].
b. iFogSim: This is a high performing tool that enables the modelling and simulation of fog computing, edge computing and IoT with the integration of resource management that could be specific to their platform [10].
c. IoTSim: In this, modelling of the IoT devices is done and their execution analysis is comprehended but energy efficiency, mobility, communication protocol is not possible to be modelled [11].

d. Vertica Analytics Platform: With the help of Python, SQL, machine learning algorithms, the analysis of SQL-compliant time series and various IoT systems could be done easily. Vertica is a renowned database and query engine that ascends the power of technologies that are cloud based [12].
e. SensiML Analysis Toolkit: This Toolkit automates all the steps in the procedure of creation of AI IoT sensor recognition code and advanced AutoML code generation that helps in the generation of autonomous working computer code. The workflow of it uses advanced algorithms to generate code that learns from the new data. It builds up smaller algorithms that run on IoT endpoints rather than in the cloud. We can have complete control over the algorithm as we are provided with an option for the selection of the level of knowledge in AI and to select our interface as well [13].

14 Applications of IoT

A tremendous worth is added up by the applications of IoT in our lifestyle. IoT applications aim to provide connectivity and intelligence to billions of common objects. This section seeks to provide an overview and discussion of a variety of fields with IoT applications.

14.1 Virtual Reality

Virtual reality (VR) has the potential to transform the industry since, in comparison to typical television systems, it provides ultrahigh clarity with visible as well as dynamic changes. With the continued in rise of virtualization, the number of Internet-connected devices is rapidly expanding. Virtual Reality (VR) can be enabled as well as enhanced by the use of Internet of Things (IoT). VR can be accompanied with different types of sensors that enhance the mesmerizing experience. Virtual reality technologies are becoming increasingly popular in smart cities. Japan launched the Tokyo virtual lab, it manages the traffic by the combination of various data sets, as well as assisting car drivers in emergency circumstances. China has already smart cities that are based on the platform of VR for fire monitoring systems in the emergency departments with reality standards. Telepresence as shown in Fig. 1 is a much desirable option for virtual meetings. The integration of VR technology with IoT is done by Empathy VR and the OdenVR Telepresence Robot. This enables us be in motion and create an impeccable illusion as like it is for real (Fig. 7).

Fig. 7 Telepresence. *Source* DORA Puts You Inside a Telepresence Robot With VR Headset (nbcnews.com)

14.2 Augmented Reality

As per an article in Investopedia by Adam Hayes, "Augmented reality (AR) can be referred to as an enhanced version of the real world that can be achieved through the use of sound, digital and visual elements or other sensory motion activity delivered through technology" [14]. As stated by a survey by BCG, "IoT-AR solutions are expected by more than 80% of the companies surveyed will be the standard in their industry in upcoming five years." That survey further states that, "Among the companies surveyed, 81% of them are currently implementing IoT, 76% of the companies are trying to develop solutions that are AR specific and they have a belief that the addition and integration of IoT in respect to the applications will turn out to be valuable" [15].

With the help of AR, the real estate industry makes properties more accessible and providing the users more realistic images showcasing their properties from various locations and its features ultimately enhancing the consumer's experience. Microsoft HoloLens as shown in Fig. 2 are a pair of mixed reality smart glasses that are Microsoft's take on augmented reality and with the help of multiple sensors, advanced optics and holographic processing that blends flawlessly with the environment, these holograms can be used to display information incorporated with the real world or even stimulate a virtual world (Fig. 8).

Simbionix Simulators are medical simulators based on 3-D systems, it helps in gaining hands on experience in performing a Minimally Invasive Surgery. Without interfering with the real environment, AR improves how people demand, realise, and show information. Caterpillar is a heavy machinery manufacturer that uses various predictive maintenance tools and with the help of that analysis, it could help in cutting down on the downtime of its machines. It can also help in cases of when numerous systems need to be replaced and how much gasoline is required.

Fig. 8 Microsoft HoloLens. *Source* Microsoft HoloLens | Mixed Reality Technology for Business

14.3 Agriculture

The need for food has risen dramatically as the world's population grows. Agriculturalists are being assisted by developed countries and research institutes to employ cutting-edge ways to increase food production. One of the fastest-growing IoT sectors is smart farming. Farmers in this case are leveraging data-driven expressive visions to provide a better return on investment. IoT in agriculture uses various techniques such as robots, drones, remote sensors and computer imaging combines with continuously progressing machine learning analytic tools. Smart irrigation uses IoT sensors to measure the moisture content of soil, release the water through irrigation pipes to control water use and regulate conventional peats. Weather stations are one of the most popular gadgets that is used in agricultural practices, they integrate many sensors that could deliver the data related to farming. GreenIQ as shown in Fig. 3 is a device that uses sensors related to the agricultural practices. It is a controller that enables you to control the system remotely and it gathers weather data and in accordance to that all the sprinklers would work and hence this model can help us save a lot of water [16] (Fig. 9).

14.4 Smart Locks

In contrast to the traditional locks that requires physical keys to unlock them, the smart locks with the help of IoT enabled sensors provides the operators a seamless experience with keyless entry and all the credit goes to the use of IoT in smart home security. Locks can be opened by the user with various biometric systems such as the fingerprint scanner, face mapping and iris scanner. We can give our visitors virtual keys so that they can unlock the doors. The smart locks also provide us with wider applications through compatibility with other IoT systems that are used is homes and the application and further include turning off your lights when your door is locked or turning on the lights when the door is unlocked or we can also receive notifications

Fig. 9 GreenIQ Smart Garden Hub. *Source* Gardening in the age of new | technologies Lausanne Cities (lausannecites.ch)

Fig. 10 Zemote smart IoT smart door lock. *Source* Zemote IoT smart door lock with fingerprint, password and app access, 34 × 7.5 × 3 cm: Amazon.in: home improvement.

if the door is being unlocked that will allow us to act upon it immediately if that is an unwanted access [17] (Fig. 10).

14.5 Intelligent Road Toll

By connecting a modern car to the IoT and with the help of it we can detect it at a distance of up to a kilometre from the point of payment and deduct the charge from the digital wallet linked to the phone and raise the barriers. The quantity of vehicles

are constantly increasing and in contrast to that the queues on the toll booths at the highways are common and to deal with it we can we IoT here. We can accumulate data from various devices such as cameras, sensors and other IoT devices and by using them we can timings of the traffic lights can be automated.

14.6 Use of IoT in Factories

The applications of IoT in factories can help the manufacturers to adopt a phase of digital transformation in various aspects such as working efficiently to consume less time, data analysis, automation and consumer centricity. With the introduction of RFID (Radio Frequency Identification) system in the factories, the process of inventory management could turn out to be much efficient. A RFID tag is given to every item in the inventory and every tag is having a UID (Unique Identification Number) that contains information in regard to the item in digital forum and that tag could be scanned and the information gets passed onto the cloud for processing. The IoT here transforms that information into business insights creating appropriate records. With the help of various sensors such as thermal and video sensors we can collect data about a product throughout its product cycle and the testing of products could be done at various steps in the manufacturing process of it to keep an eye on its specifications and tell us that is they are within their specifications or not. IoT has also introduced smart meters into the manufacturing sector, fuels like electricity, petrol, diesel and other ones could be monitored, and by the help of that data we can use the fuel efficiently.

14.7 Waste Management

The waste collection procedures in the metropolitan cities faces many issues but with expanding the usage of smart devices and sensors in the machines and communication between the machines can save both time and money. IoT can help making the waste collection process much efficient. The garbage collection trucks can be alerted by the help of sensors to tell us if the driver should continue or not and if the capacity is full, for that weight sensors can be used. Whenever a truck is full then it can stop and another truck could be rerouted to its way to complete its track hence resulting in highly optimal waste collection plans.

14.8 IoT in Healthcare

Devices that are IoT enabled have made remote monitoring possible. Treatment outcomes are highly improved and a significant cost reduction is there and all the

credit goes to IoT. Heart rate can be monitored by the help of fitness bands. IoT devices with sensors can be used for tracking real time location of various equipment and hence can be beneficial in the hospitals. A lot of data can be gathered by actuators, monitors, sensors and many more and then it could be moved into the cloud and then analysis could be done according to the needs. There are wearable devices which monitors blood pressure and heart rate, when there is an emergency, these devices can give an alert or follow an emergency protocol that may involve giving a call to an emergency number.

14.9 Disaster Management

Disaster management includes preparedness, mitigation, providing suitable assistance to the victims and aim for a rapid recovery. Sensors can collect real time data and detect volcanic activities, earthquakes, wildfires, cloudbursts, tsunamis and other activities and send early warnings. The devices connected to the network deployed in roads, buildings and other things can be used to generate alerts that can help increase the preparedness on individual level also. With the help of IoT devices we can monitor the real time data of food reserves, clothing, water, medical equipment and other supplies. Sensors can be used for the identification of the damage caused as well its location and then appropriate action could be taken on it.

14.9.1 SmartMat—Intelligent Yoga Mat

This is an interactive yoga utility that helps us to improve our posture through real time pressure sensing technology. A layer of micro thin pressure sensors embedded in the yoga mat that are linked with your smartphones through smart mobile interface. It is very precise and whenever the sensors notice that we are out of position, it gives us a feedback immediately to correct our position [18] (Fig. 11).

14.9.2 Logitech Harmony Elite—Smart Controller

We can control intelligent devices remotely with the help of this IoT based smart device, Logitech Harmony Elite—Smart Controller. It incorporates the control system of your connected devices and make them all accessible from a mobile app or a rechargeable touch screen remote. It inculcates many capabilities which ultimately helps in deducting the complexities in the house efficiently [19] (Fig. 12).

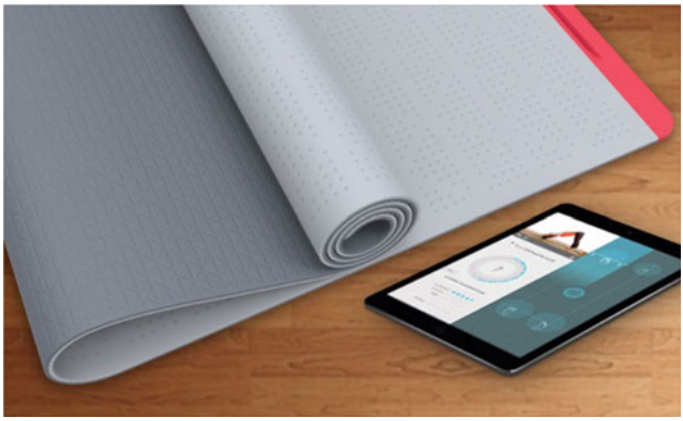

Fig. 11 SmartMat—intelligent Yoga Mat. *Source* SmartMat Info (iotlineup.com)

Fig. 12 Logitech Harmony Elite—Smart controller. *Source* Logitech Harmony Elite Info (iotlineup.com)

14.9.3 Cyborg

The term 'cyborg' came as a short form of the term 'cybernetic organism,' this is an entity made up of both technical and biological elements. In the first instance it was used to represent any system of mixed type and hence people riding bicycles or wearing glasses could be included in that definition. Afterwards this has been employed more specifically for entities where technology and biology are integrally attached [20].

The mankind has dreamt of been able to combine man to machine to escalate the human potential and give birth to a cyborg which has a much greater potential than humans and has a much greater intelligence.

The scientists and giant technology companies have bet on the use of four technologies in order to achieve a better integration between man and machine to reach

a cyborg civilization. Those four technologies are Extended Reality (XR), Artificial Intelligence, Brain Machine Interface (BMI) and Internet of Things (IOT), combining these will lead the humanity to a new era of integration between man and machine that will be more intuitive, immersive, natural and interactive. For those who are dealing with motion disabilities, IoT combined with AI, BMI and XR will impact them to a great extent [21].

The cyborg technologies can take four different forms according to the authors of the Cyborg Handbook, those are normalizing, restorative, reconfiguring and the last is enhancing cyborgs.

- The restorative form of cyborg technologies could replace body parts by artificial limbs and organs and restore their lost functionality.
- Normalizing cyborg technologies can help in restoring someone to its normality.
- Reconfiguring form of cyber technologies can be used to create a more developed human that is different than a human that could survive and adapt outside the earth also.
- Enhancing cyborgs can enhance and improve capabilities which is the goal of most militaries [22]. The cyborg translators are referred to almost as enhancing form of cyber technologies, they speed up the translation process and make them more economical and reliable [23].

Direct brain implants have been implemented to treat non-congenital blindness by implanting a single array BCI consisting of 68 electrodes into the visual cortex of Jerry (he was blinded in adulthood) and it enabled in producing phosphenes. William Dobelle was one of the first scientists that came up with a working brain interface that could help in restoring sight [24].

British artist Neil Harbisson has an ability of experiencing a wider perception of colours that is far beyond the visual spectrum of a human with the help of cyborg antenna that has been implanted in his head through vibrations in his skull [24] (Fig. 13).

Fig. 13 Cyborg Neil Harbisson with his antenna implant. *Source* https://en.wikipedia.org/wiki/Cyborg

15 Conclusions

We started off with the basics of IoT to the elements, architecture and working of it and its need. The basic concepts were discussed with respect to their practical applications. We have also discussed how AI is being implemented in IoT and many applications of IoT with the products available in the market. The concept of the cyborg is also very interesting, it's about taking a leap in terms of technology and human biology. The addition of IoT will make human life more comfortable and stress-free by many ways [25]. Once IoT becomes a part of someone's daily life, they would not want to give it up because of the beneficiaries it provides us with. IoT devices are drastically increasing in the market. These days, sensors, wireless communications, IoT devices, edge computing, fog computing and cyborgs are the buzz words in the communities. This chapter is useful for the basic to depth knowledge of AI-based Smart IOT systems, their advancements, their needs in day-to-day life, and much more. On concluding with the terms, we can easily find that IoT would be one of the most demanding factors in upcoming days which makes everyone's life easier and helps them to save their time and energy.

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