Internet of Things and Artificial Intelligence its Concept in The Modern World

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Receive Date: 01 Jan 2024 Accept Date:12 April 2024

Abstract

The advent of Internet of Things (IoT) technology heralds the beginning of the third wave in the global information industry. This transformative technology facilitates the flow of information through a myriad of devices, such as infrared sensors and laser scanners, as well as cloud computing, thereby creating an intricate web that connects all entities on Earth to the Internet for seamless information exchange. This article delves into the profound impact of IoT and artificial intelligence on our daily lives—an influence that often remains unnoticed or is overlooked. It explores the intricate workings of IoT-operated sensors, which transmit a variety of signals to different components of objects tethered to the cloud network. These sensors receive real-time instructions, process them, and execute necessary actions. Upon completion of tasks, they send notifications to inform users of their accomplishments. We investigate the role of IoT in environmental monitoring, the preservation of perishable goods, and the extent of IoT integration, emphasizing the critical importance of data protection measures against potential cyber threats. Moreover, the article examines the realm of smart homes, offices, museums, and clubs that are adeptly managed by IoT, outlining the robust infrastructure essential for their seamless and error-free operation. The transformative potential of IoT is vividly illustrated through the concept of autonomous taxi robots, which are reshaping urban mobility. Furthermore, we analyze the symbiotic relationship between IoT and artificial intelligence, highlighting how each technology enhances the capabilities of the other. In conclusion, we explore a myriad of applications that harness the power of IoT in conjunction with artificial intelligence, paving the way for a smarter, more efficient lifestyle in our contemporary world.

Keywords: Internet of Things, artificial intelligence, environmental monitoring, smart homes, data protection.

1. Introduction

The concept of integrating sensors and intelligence into objects emerged between 1980 and 1990. However, aside from a few pioneering projects—such as an Internet-connected vending machine developed by Coca-Cola at Carnegie Mellon University—the technology experienced slow growth despite its readiness. The main challenge was not the technology itself, but rather the size and bulkiness of chips at the time, which hindered effective interaction among devices. The term "Internet of Things" (IoT) was first introduced in 1999 by English entrepreneur Kevin Ashton, specifically referring to the connections between physical objects. However, today the term encompasses a much broader meaning than its original intent. IoT is envisioned as a crucial driver of digital service provision and consumption. It is estimated that IoT-enabled business models and enhanced processes could unlock annual revenue opportunities ranging from $2.6 trillion to $6.2 trillion. By 2030, organizations could leverage the data generated by 8 billion people and 70 billion connected devices for purposes such as monitoring remote production facilities and predicting future demand [15].

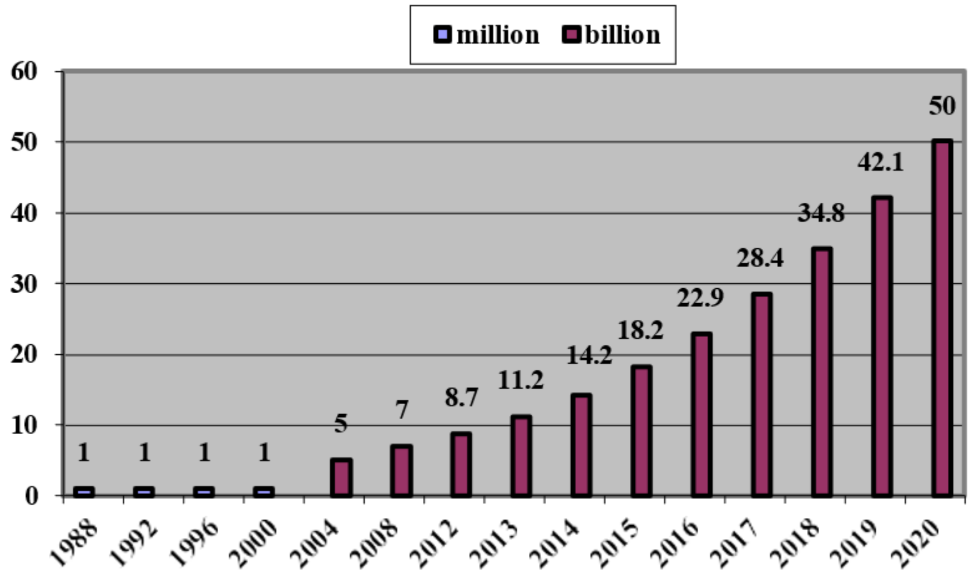

Fig. 1. The rate of increase in efficiency of devices connected to the Internet of Things

The Internet of Things (IoT) technology incorporates a diverse range of innovative information technologies. Unlike the traditional Internet, which primarily facilitated the transmission of information, IoT, as illustrated in Figure 1, connects all objects on Earth to a comprehensive network, enabling true interconnectivity. With the increasing prevalence of the Internet, the application of information technology has expanded significantly. By linking all objects in the world to the Internet, we enhance the intelligence and convenience of daily life, which in turn influences national economies and future industrial development. As IoT technology continues to evolve, it is poised to shape a global network of securely managed devices that will gradually become integrated into our everyday lives. This progress promises to elevate the overall quality of public life, particularly within the realm of modern wireless telecommunications. The core concept of IoT revolves around the omnipresent nature of various objects—such as Radio-Frequency Identification (RFID) tags, sensors, actuators, and mobile phones—that can interact and collaborate through unique addressing schemes to achieve common objectives. Undoubtedly, the strength of the IoT concept lies in its profound impact on numerous aspects of daily life and the behaviors of potential users. For private individuals, the most noticeable effects of IoT integration will manifest in both professional and domestic sph×eres.

In this context, applications such as demotics, assisted living, e-health, and enhanced learning are just a few examples of potential scenarios where the new paradigm is expected to play a significant role in the near future. Identification and tracking technologies, as well as wired and wireless sensor and actuator networks, enhanced communication protocols (aligned with the Next Generation Internet), and distributed intelligence for smart objects, are among the most pertinent advancements. It is important to recognize that all connected devices will inevitably establish some form of ownership relationship. These devices necessitate responsible parties for their maintenance and the management of data availability, which entails a certain level of effort and likely compensation. It is anticipated that the Internet of Things (IoT) will connect over 30 billion devices to the internet.

2- Basics and Concept of the Internet of Things

In recent decades, communication technologies, particularly the Internet, have advanced rapidly and have become increasingly affordable. Finland, for instance, has emerged as the first country in the world to recognize broadband as a legal right for every citizen. Thanks to the evolving Internet infrastructure and electronic devices such as RFID, GPS, GIS, and various sensors, individuals today can access more information than ever before. On another front, research in Artificial Intelligence began after World War II, with Alan Mathison Turing possibly being one of the first to explore this field in 1947. He published an influential article in 1950 questioning whether machines could think. From a technological perspective, the Internet of Things (IoT) comprises interconnected objects, referred to as "Things," that possess the ability to sense, process, and communicate. These Things, a fundamental component of the IoT, are embedded in everyday objects, enabling them to perceive and interact with their environments.

The multitude of interconnected, sensing, and communicating devices generates a vast ocean of heterogeneous real-world IoT data. Before this data can be leveraged to create value, the IoT data supply process must translate, transform, categorize, and ensure the quality of the information. The development of this global network presents numerous technological challenges, leading to the perception of the IoT as primarily technology-driven. However, the technological elements of the IoT may ultimately exert a lesser influence on our daily lives than the myriad possibilities these networks provide. Numerous studies and reports suggest that we are constantly surrounded by a multitude of ubiquitous devices. It is unlikely that all these devices will belong to a single owner. Rather, they can be viewed as extensions of their respective owners, functioning in alignment with the owners' interests and delivering data accordingly. In this context, we conceptualize the IoT as a network of heterogeneous entities, each equipped to sense, actuate, communicate, and collaborate, all while adhering to the behaviors dictated by their diverse owners. As data emerges as a crucial resource for innovative digital services and transformative industrial models, organizations encounter both challenges and opportunities.

Organizations like Uber exemplify how value can be generated without owning physical products or assets. Essentially, Uber creates value by facilitating the exchange of information between customers and service providers (the Uber drivers). This innovative approach to value creation is rooted in data, leveraging Data-Driven Business Models (DDBM), Non-Ownership Business Models (NOBM), digital services, platforms, and digital products, all of which significantly benefit from the vast wealth of data offered by the IoT. The field of Information Systems (IS) research has focused on understanding how organizations are capitalizing on the opportunities presented by the abundance of real-world data. Researchers have explored new business models, developed methods and tools for organizational transformation, and assessed IoT-related challenges and requirements. However, the IoT transcends being merely a network of sensors providing real-world data. Williams et al. argue that the IoT is far more intricate than a simple sensor network; it constitutes a new Information Infrastructure that spans borders and domains, lacks a fixed notion of "user," and involves multiple stakeholders. Despite this complexity, many definitions of the IoT in research, particularly within the IS field, simplistically describe it as a global sensor network. Recognizing that the IoT offers value embedded in real-world data, and acknowledging the complexities involved in data collection beyond basic sensor querying, we contend that constructing a system or business model atop the IoT requires careful consideration of the data supply characteristics inherent to the IoT to establish a solid foundation. The realization of the IoT concept in practice hinges on the integration of several enabling technologies.

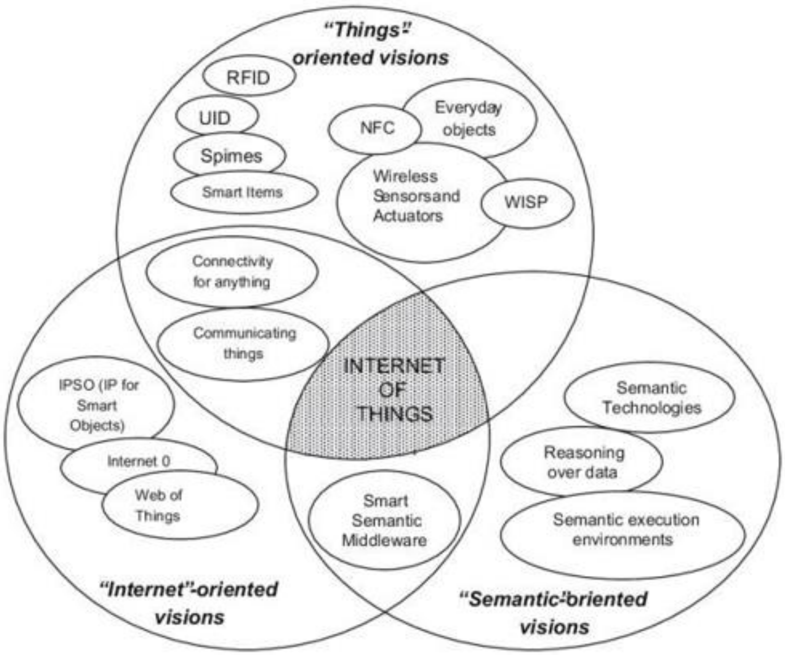

Fig 2. Internet of Things" paradigm as a result of the convergence of different visions.

In Figure 2, the primary concepts, technologies, and standards are illuminated and categorized in relation to the IoT visions they best represent. This illustration clearly demonstrates that the IoT paradigm will emerge from the convergence of the three main visions previously discussed. The phrase "Anytime, anywhere, any media" has long been the driving force behind advancements in communication technologies. In this context, wireless technologies have played a pivotal role, with the ratio of radios to humans approaching one-to-one. The ongoing reduction in size, weight, energy consumption, and cost of radios heralds a new era, significantly increasing this ratio. This evolution will enable the integration of radios into nearly all objects, thus incorporating the term "anything" into the aforementioned vision and ultimately leading to the concept of the IoT. However, the IoT cannot be reduced to a global EPC system comprising solely RFIDs; these are merely one facet of a much larger narrative. The same applies to the alternative Unique/Universal/Ubiquitous Identifier (UID) architecture, which primarily focuses on developing middleware-based solutions for global object visibility within the IoT framework. The authors contend that beginning with RFID-centric solutions can be beneficial, as the core principles emphasized by RFID technology—namely item traceability and addressability—will undoubtedly be integral to the IoT. Nevertheless, more comprehensive IoT visions acknowledge that the term encompasses a far broader perspective than mere object identification. RFID remains at the forefront of the technologies propelling this vision, a reflection of its maturity, low cost, and robust support from the business community. However, it is important to note that a diverse array of device, network, and service technologies will ultimately coalesce to form the IoT. Near Field Communications (NFC) and Wireless Sensor and Actuator Networks (WSAN), alongside RFID, are recognized as "the atomic components that will link the real world with the digital world." It is also noteworthy that significant projects, such as the Wireless Identification and Sensing Platforms (WISP) initiative, are underway to develop relevant platforms in this domain

3- How Internet of Things Censorship Works

The Internet of Things (IoT) is not a singular technology; rather, it emerges from the integration of various components, standards, and technologies that form a cohesive whole. Typically, we identify four essential links in the IoT chain.

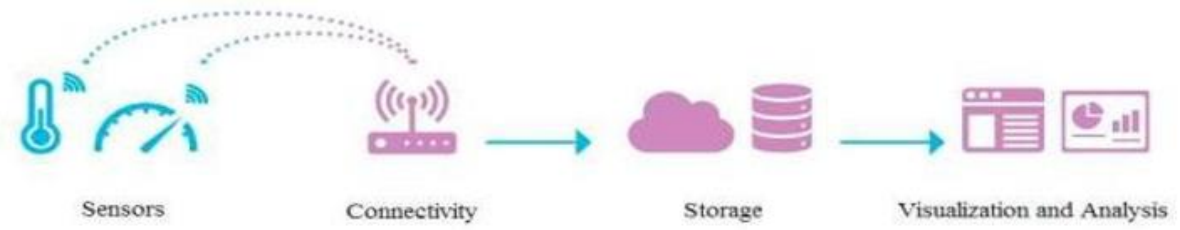

Fig. 3. Link of the IOT chain for Agriculture.

3.1. Sensors:

Sensors are deployed in diverse settings—offices, supermarkets, homes, and even attached to our bodies or implanted within us. These devices measure everything from ambient temperature to electricity consumption, GPS coordinates to liquid levels, providing a comprehensive array of data. As depicted in Figure 3, for nearly every physical quantity, there exists a technical solution capable of delivering accurate, real-time measurements. While these devices primarily address specific needs, they also incorporate communication modules, most commonly utilizing radio technology, to facilitate data transmission to business applications.

3.2. Connectivity

Connectivity is the backbone that enables data to flow from sensors to the software solutions that utilize this information. Until recently, wired technologies and mobile networks were the predominant options available, significantly influencing the autonomy of battery-powered systems and the recurring costs of such solutions. However, the advent of new technologies, particularly Low Power Wide Area Networks (LPWAN), allows sensors to operate for several years on batteries, simplifying installation and enabling data transmission over long distances. These advancements also contribute to smaller sensor sizes and cost savings on communication subscriptions.

3.3. Storage Once data is collected by the communication network, it can be stored either online or on a provider's infrastructure. At this stage, the data remains raw and has not undergone any specific processing. #### Visualization and Business Analysis This phase involves the intelligence of the implemented solution, where raw data is transformed into intelligible information through algorithms. This information can then be utilized for decision-making purposes—such as analyzing soil moisture levels, monitoring vibrations in production equipment for predictive maintenance, or sending SMS alerts in case of flooding. Such analytics not only expand the potential applications of IoT but also reduce implementation costs and foster collaboration. In addition to increasing the quantity and diversity of devices employed, key areas for IoT development encompass: the advancement of IoT-specific network technologies, enhanced security, miniaturization and integration of devices, reduced power requirements, improved software functionality and usability, as well as the integration of open-source software and hardware.

4. **The Role of the Internet of Things in Global Industry**

4.1. IoT in Transportation and Logistics

As illustrated in Figure 4, one of the most significant applications of the Internet of Things (IoT) lies in transportation and logistics. This sector profoundly influences our daily lives, allowing us to reach our destinations efficiently and effectively, thereby streamlining our daily activities.

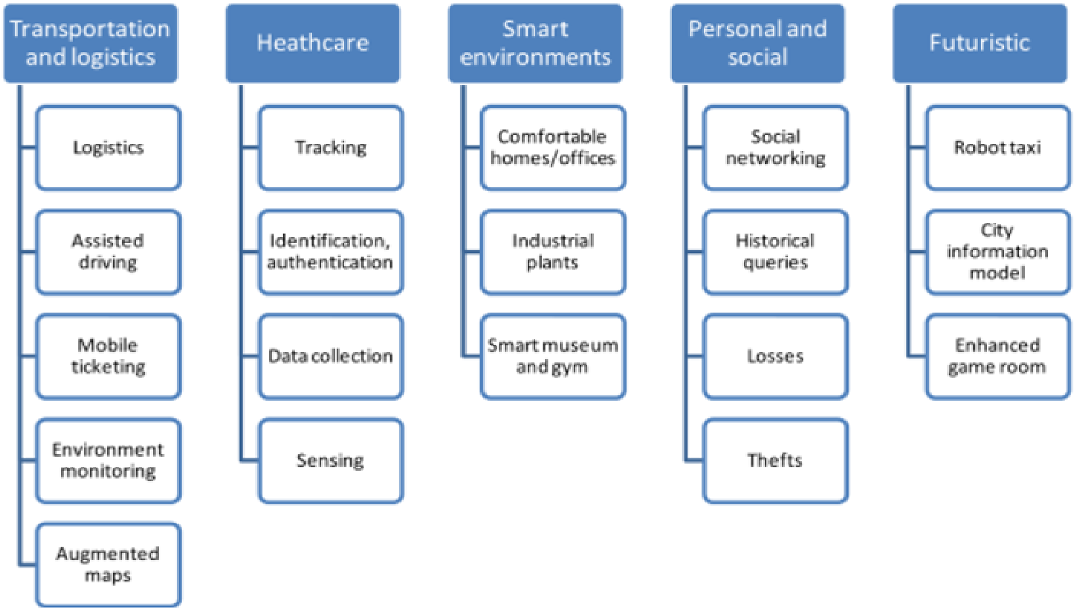

Fig. 4. Applications domains and relevant major scenarios

4.1.1. Logistics

Within an IoT framework, each object is capable of automatic positioning and identification management. It is imperative that our information security mechanisms monitor every object in real-time, ensuring accurate location tracking. In the event of a fault, timely resolution and alerts are crucial. Additionally, if a security issue arises, it should be managed, dispatched, and controlled remotely by designated personnel. Security teams must be equipped to maintain the IoT system at any time and conduct regular online upgrades. Moreover, energy efficiency and high performance must remain a priority within the IoT ecosystem.

4.1.2. Assisted Driving

Equipped with sensors, actuators, and processing power, vehicles such as cars, trains, and buses, along with their respective infrastructures, can provide critical information to drivers and passengers, enhancing navigation and safety. Figure 4 highlights the significance of assisted driving in our daily lives. Collision avoidance systems and monitoring of hazardous material transportation are prime examples of such functionalities. Government authorities can leverage accurate road traffic data for effective planning, while private transportation can optimize routes based on real-time information regarding traffic jams and incidents. Freight companies, in particular, can enhance route optimization, leading to significant energy savings. Furthermore, data regarding the movements of vehicles transporting goods, combined with details about the type and status of the cargo, can yield insights into delivery times, delays, and potential issues. This information can also be integrated with warehouse status to automate inventory replenishment.

4.1.3. Data Collection

The automation of data collection and transfer is primarily aimed at minimizing processing times, automating workflows, and reducing errors in data entry and collection. This function also involves integrating RFID technology with health information and clinical applications within facilities, potentially expanding such networks across various providers and locations. The importance of data collection in the IoT landscape cannot be understated; it influences data deployment, storage, sensor selection, processing power, security, and more. Most critically, it lies at the heart of every smart product's user experience, directly impacting its success. As intelligent devices become increasingly prevalent, we find ourselves assisting clients in planning for IoT data collection with greater frequency.

4.1.4. Sensor:

Sensor devices play a crucial role in patient-centered care, particularly in diagnosing health conditions and providing real-time insights into patient health indicators. Their applications span various telemedicine solutions, including monitoring medication adherence and ensuring patient well-being. These sensors are versatile, applicable in both inpatient and outpatient settings. Heterogeneous wireless access-based remote patient monitoring systems are designed to ensure continuous patient oversight, regardless of location. By integrating multiple wireless technologies, these systems support uninterrupted bio-signal monitoring, accommodating patient mobility. The data collected and transmitted through these networks may include sensitive information about individuals, businesses, and valuable assets. Therefore, safeguarding this data from eavesdroppers and malicious attacks is essential for maintaining content-oriented privacy in wireless sensor networks (WSNs). Several challenges must be addressed to achieve successful privacy-preserving data aggregation in the IoT. Most existing solutions are predicated on specific network topologies, typically organized in static clusters. However, the anticipated scenarios involving sensors attached to objects or carried by individuals require solutions that can adapt to constantly changing topologies, incorporating both static and mobile data aggregators.

4.2. Smart Environments:

As illustrated in Figure 4, a smart environment is one that enhances comfort and ease of use through the intelligence of its embedded objects, whether in an office, home, industrial facility, or recreational space.

4.2.1. Comfortable Homes and Offices:

The innovative features of the IoT in today's modern era significantly simplify and enhance daily life. Smart home automation exemplifies this trend, introducing various intelligent devices such as smart aquariums, smart storage tanks, smart lighting, and smart air purification systems. By leveraging these technologies, we can analyze and optimize the shared resources utilized by these devices, ultimately conserving energy and resources.

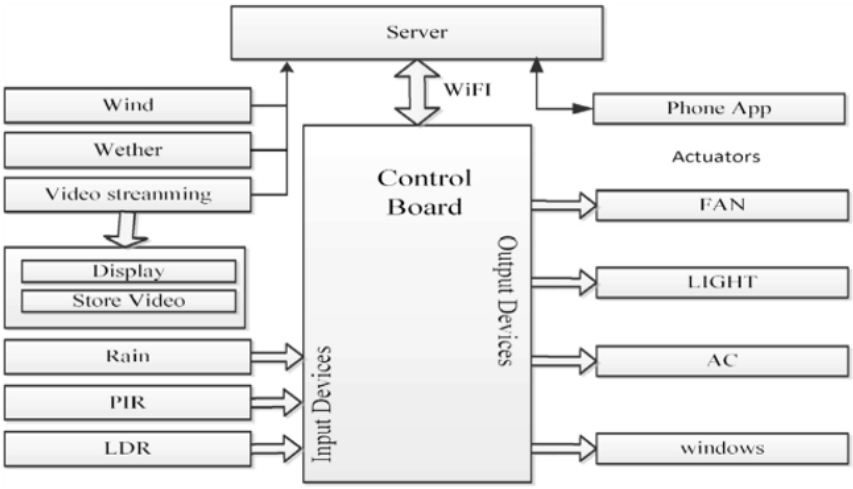

Fig. 5. Fish tank functional block diagram

The home lighting system, for instance, plays a pivotal role in monitoring the home's status when no one is present. Utilizing various sensors, as depicted in Figure 5, the wind sensor measures wind direction and speed, while the weather sensor tracks environmental conditions surrounding the home. Additionally, the rain sensor automatically closes all windows when it detects rainfall. Video monitoring systems enable remote observation of home conditions, and the LDR sensor activates lights in low-light scenarios. The PIR sensor controls lighting and fan operation based on room occupancy, with a delay time of five minutes. Moreover, depending on weather conditions, the weather sensor activates the air conditioning or heating systems. All this sensor information can be monitored by a centralized server, allowing for manual control of devices as needed.

Table. 1. IOT Sensors that are used and necessary to build a smart home

applications	Smart living	smart lighting	Smart air condition	intrusion detection	Snoke/gas detection	smart water tank	smart home
temperature	✓	×	✓	×	×	×	✓
Humidity	✓	×	✓	×	×	×	✓
Water level	×	×	×	×	×	✓	✓
CO2	×	×	×	×	✓	×	✓
Timer	✓	×	×	×	×	×	✓
Camera	✓	×	×	✓	×	×	✓
Wind	×	×	×	×	×	×	✓
Ph	×	×	×	×	×	×	✓
Smart phone	✓	✓	×	✓	✓	×	✓
DO	×		×	×	×	×	✓
PIR	×	✓	×	✓	×	×	✓
LDR	×	✓	×	×	×	×	✓
Flow sensor	×	×	×	×	×	✓	✓
Soil	×	×	×	×	×	×	✓
Ultrasonic Sensor	×	×	×	×	×	✓	✓

As shown in Table 1, a flow sensor measures the amount of water used in a household, making smart storage tanks integral to home automation.

4.3. Smart Museums and Gyms

In terms of smart leisure environments, museums and gyms exemplify how IoT technologies can enhance facility utilization.

4.3.1. Gym

In gyms, personal trainers can upload exercise profiles to training machines, which automatically recognize each trainee through RFID tags. Health parameters are monitored throughout the training session, allowing for analysis of whether the trainee is overexerting or underperforming during exercises. Technology has transformed the fitness industry, enabling users to monitor and refine their workouts. The Internet of Things (IoT), as a hallmark of modern technology, integrates wireless sensor networks into daily life, with an increasing number of sensors and devices guiding individuals toward better physical fitness.

4.3.2. museum

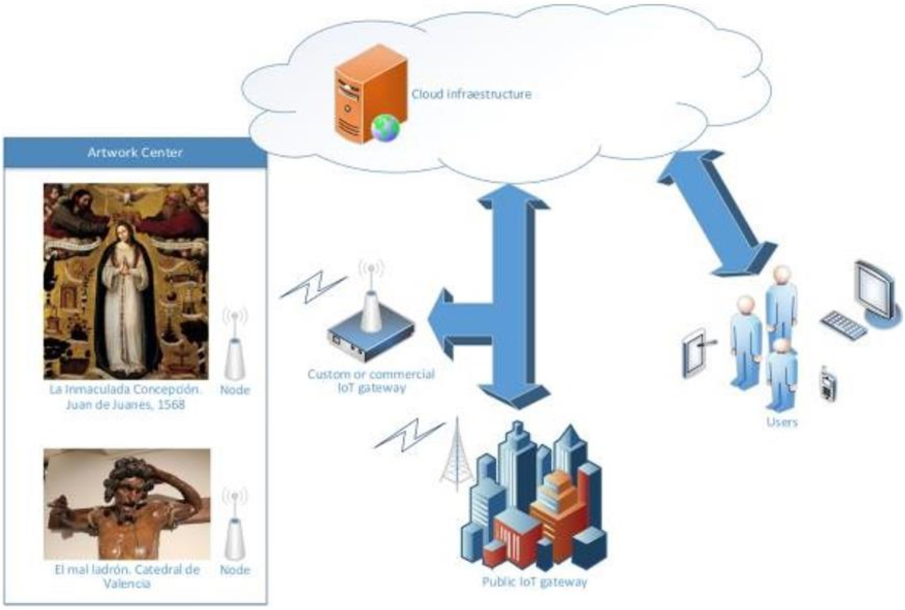

Fig. 6. IOT for CH diagram with different types of scenarios and gateways

Sensing and actuating nodes communicate with cloud infrastructure via gateways, which collect data from the nodes in customized formats or standard IoT formats such as MQTT. These gateways adapt the data for transport to the cloud, utilizing either wired or GSM-based Internet connections. The collected data can inform predictive models that anticipate potential risks. For instance, analyzing the correlation between humidity and temperature variations and artwork degradation allows for the development of predictive models in the cloud that forecast future damages, offer recommendations, and activate specific protocols. Technically, the architecture supports processes embedded in containers on the cloud, drawing from data stored in a MongoDB database as per defined requirements. IoT deployments for cultural heritage (CH) conservation have distinct needs compared to typical applications, as illustrated in Figure 6, which summarizes various scenarios. The key difference lies in node design and the necessity for diverse gateway types.

4.4. Personal and Social Domain

Applications in this domain enable users to interact with others, fostering and maintaining social relationships. IoT devices can automatically trigger messages to friends, informing them of our activities—whether commuting between home and work, traveling, meeting mutual acquaintances, or playing soccer. The following are the primary applications in this area.

4.5. Futuristic Applications

The applications depicted in Figure 4 are realistic, as they have either been implemented or can be deployed in the short to medium term, given the availability of required technologies. Beyond these, many futuristic applications can be envisioned, relying on emerging technologies in communications, sensing, materials, or industrial processes that are either yet to be developed or too complex for current implementation. These applications present exciting prospects for research and potential impact.

4.5.1. Robot Taxis

In the context of smart cities, autonomous taxis are poised to play a pivotal role in the development of intelligent public transportation systems. Among the promising solutions are cost-effective, environmentally friendly electric taxis that utilize a single front camera in a computationally efficient manner, drawing inspiration from human driving capabilities. Humans rely on visual perceptions and past experiences to enhance their driving, allowing them to infer optimal paths. Similarly, robot taxis can operate in swarms, moving in synchronized patterns to provide timely and efficient services where they are needed most. These autonomous vehicles respond dynamically to real-time traffic conditions, strategically calibrated to alleviate congestion at critical bottlenecks and service frequently used pick-up locations. Whether operated with or without a human driver, they navigate through traffic at optimal speeds, utilizing proximity sensors to avoid accidents by creating magnetic repulsion from other vehicles on the road. Passengers can easily hail a robot taxi by pointing their mobile phones at them or using hand gestures. The system automatically tracks the user's location via GPS, enabling requests for taxis at specific locations and times by simply indicating the desired spot on a detailed map. During periods of inactivity, taxis autonomously return to designated 'pit-stops,' where they efficiently stack themselves in compact bays equipped with sensors. Here, actuators initiate battery recharging, perform routine maintenance, and clean the vehicles. These pit-stops communicate with one another to ensure optimal utilization without overloading any single location.

5. The Integration of the Internet of Things and Artificial Intelligence in Modern Life

As depicted in Figure 7, the Internet of Things (IoT) is increasingly intertwined with artificial intelligence, facilitating advancements across various domains such as home automation, assisted living, e-health, smart energy management, and logistics.

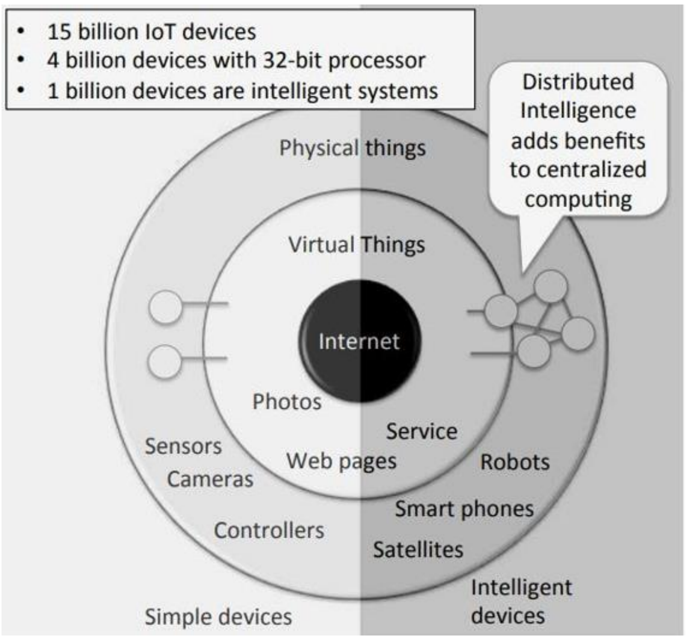

Fig. 7. Internet of Things with artificial intelligence and devices

Currently, approximately 15 million smart devices are connected to the IoT, all of which are enhanced by artificial intelligence. Rapid developments are underway to further this phenomenon by embedding short-range mobile transceivers into a multitude of everyday gadgets, fostering new forms of communication between people and objects, as well as between objects themselves. Smartphones are expected to play a crucial role in this ecosystem, serving as aggregators of data from various sensors—either internal to the device or in the surrounding environment—and as platforms for artificial intelligence algorithms to analyze and learn from the acquired data. Millions of users engage with online social networks, and research has explored how phone sensors can automatically classify significant events in users' lives. These classifications can be selectively shared within social networks, streamlining processes that previously required manual intervention. By integrating social networking with the IoT, intelligent devices can collaboratively tackle complex problems autonomously. The collective intelligence of large groups—whether human or machine—can yield more accurate solutions to intricate challenges than any single entity could achieve alone. The foundation of this evolution lies in the advent of artificial intelligence. Years ago, AI emerged to create programs enabling computers to learn from data. This process relies on sophisticated learning techniques that allow machines to analyze data, apply algorithms for processing, and make informed decisions based on the insights gained.

6. **Conclusion**

The Internet of Things (IoT) and artificial intelligence (AI) have become integral components of our daily lives, seamlessly woven into the fabric of the Internet, often without our conscious awareness. These technologies operate quietly in the background, fulfilling their roles in the cloud, sometimes unnoticed yet profoundly impactful. Consider a chain store equipped with IoT and AI capabilities; the possibilities are transformative. The internal temperature can be precisely regulated, and pricing can be dynamically adjusted in real-time through the integration of CCTV cameras. Security systems can be monitored and controlled remotely via IoT, ensuring 24/7 surveillance. Most critically, transactions are meticulously tracked, with payments processed securely through these advanced systems, reinforcing the notion that modern commerce relies heavily on IoT and AI. This paper underscores the necessity of viewing IoT and AI as foundational elements of the future Internet, which promises to be vastly different from what we experience today. I have explored key aspects of AI and IoT, highlighting ongoing advancements and identifying areas that warrant further investigation. Current technologies not only make the concepts of IoT and AI feasible but also practical. The analysis presented herein demonstrates the potential of applying IoT and AI technologies to enhance connected health (CH) systems. By examining the requirements and proposing relevant cloud and field solutions, this work illustrates how humans can leverage visual perceptions and past experiences to improve decision-making, such as optimizing driving paths for safer travel.

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