

IR4.0 and internet of things: future directions towards enhanced connectivity, automation, and sustainable innovation

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ABSTRACT

This study provides a systematic review of the literature on the fourth industrial revolution (IR4.0) and the internet of things (IoT) in genetics, informatics, and biotechnology, as well as their many rapidly evolving applications, which often overlap with various aspects of life. The study reviews the latest research, books, scientific theses, and official websites in this field, placing them in a coherent context for researchers. It covers innovations that have driven the continuous development of IR4.0 and its challenges. The study highlights numerous fields and modern technologies expected to bring about tangible and radical changes in health, agriculture, and industry. It addresses key aspects of IR4.0 and the significant advancements brought by smart cities, and most importantly, artificial intelligence (AI), including robots, autonomous cars, 3D printing, big data, IoT, nanotechnology, biotechnology, energy storage, and quantum computing. By applying cutting-edge technology across various disciplines to boost productivity and foster development, technology plays a crucial role in linking the physical, digital, and biological realms. This revolution is built on multiple axes, including the convergence of biotechnology, digital media, and physical systems.

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1. INTRODUCTION

Today we stand on the brink of the fourth technological revolution that will fundamentally change aspects of our lives and be unique in human history, regardless of the size or complexity of the change [1]. We do not know exactly how this transformation is happening because we are experiencing its overwhelming momentum moment by moment. Still, we know with certainty that to succeed in keeping pace with developed countries, our response to these changes must be comprehensive, integrated, and encompassing all spectrums that represent the pillars of civil society, the public, private functional sectors, academic societies, and community institutions.

The primary contemporary unrest relied on massive disclosures and creations of now could be an appropriate time, based on the utilization and version of water and steam strength to motorize performance, and from that point started the modern alternate for social orders from their farming nature to another personality portrayed via ventures that have relied on steam automobiles, regardless of whether or not underway or in transportation. Concerning the subsequent disenchanted, it was performed by using electric energy, which empowered nations with shifted ordinary belongings to commit their capacities to misuse one's property in industry, which released contemporary social orders to make the guideline of big-scale production [2]. The era of significant inventions greatly influenced human civilization's development.

The integration of internet of things (IoT) within the framework of fourth industry revolution (IR4.0) heralds a new era of possibilities, promising revolutionary advancements that transcend traditional boundaries [3]. From manufacturing to healthcare, transportation to agriculture, the amalgamation of these technologies holds the promise of unprecedented efficiency gains, cost savings, and enhanced consumer experiences [4]. However, realizing this potential necessitates a comprehensive understanding of the challenges and opportunities inherent in this convergence. As a result, we see billions of people communicating via mobile phones with the internet with incredible speeds and unlimited access to information, in addition to unprecedented technological advances in artificial intelligence (AI). Robotics, the IoT, autonomous vehicles, 3D printing, nanotechnologies, biotechnology, materials science, and quantum computing [5].

2. LITERATURE REVIEW

2.1. Artificial intelligence leading the fourth industrial revolution

The convergence of AI and big data began in the early 2000s. When Google and Baidu, the emerging search engines of the time, used AI to create personalized recommendation systems in the advertising industry, they realized that the results were much better than they had expected [6]. The more data is collected about each user, the better the results. But at the time, no one was aware that this development could be applied to other areas.

Characterizing the connection between profound learning and enormous information fortifies one another. If the AI framework is planned firmly, it will be more advantageous to utilize, more exact, and, along these lines, more helpful. This will expand the number of clients and, accordingly, provide more information that improves the AI framework [7]. With the merging of big data and AI, a new type of AI can be developed that can be called "smart data".

AI will be created in two stages. In the principal stage, all areas will endeavour to utilize this innovation. For instance, security and assurance administrations will use facial acknowledgement innovation; the financial space will utilize artificial brainpower to control chances; and so forth. They are one-of-a-kind advances and answers for addressing the issues of the present [8].

The second stage will witness the emergence of unprecedented industrial sectors with AI at their core. For example, if a banking institution uses AI as a primary technology, it may be entirely free to dispose of investments, services, and borrowing. All that remains for the bank's staff is to make minor adjustments. It may also become possible to devise a new customer service system. In the second stage, AI will profoundly change human society and give it its future shape. Just as it did when the internet appeared: In the beginning, a traditional library created a webpage and created itself an online library. Websites like Amazon did not appear until later. The combination of big data and AI may threaten private life and social justice, and the combination of big data and AI will generate new viable economic models [9].

In the coming years, everyone will realize the importance of AI. We must be alert and attentive to what the form will look like and its application areas. Currently, AI's most open areas are finance, the internet, and self-driving cars.

The combination of big data and AI in developing countries will enable a number of the most advanced developing countries to join the developed countries and even surpass them because economic competition will depend mainly on the amount and value of data [10]. For example, the rapid development of the internet and the Chinese mobile internet has allowed the collection of massive amounts of data. This would accelerate the growth of the AI sector in China, and it could change the features of the world. On the other hand, if a country provides a high-quality infrastructure and educational system, it will benefit from AI to improve its productivity. The steam engine allowed several countries to develop faster than others during the industrial revolution.

2.2. The fourth industrial revolution and its importance

The industrial revolution lies in industrial production that depended on modern machinery instead of human hands and the United Kingdom was the first European country to witness an industrial revolution. Because she was the only one who had many ingredients that helped her to do so, where the first spark of this

revolution was the discovery of the steam engine in the first quarter of 1700, the pace of the prosperity of the textile and steel industry, which was one of the most critical industries of its day, accelerated. After that, the revolution spread throughout Europe [11]. In this regard, we raise an essential question: what do you know about the fourth and its advantages?. There is no uncertainty that the IR4.0 depends on supplanting human hands with mechanical devices, present-day methods, and artificial reasoning units, which will help in high financial development rates, diminish costs, improve quality, and offer more extensive types of assistance to individuals. What's more, the world has seen it in the previous two years, and its worth rose from 16 to 22 trillion dollars, a bounce that demonstrates the size of the change that will occur sooner rather than later.

The fourth modern picture is the pattern of the escalated utilization of cutting-edge innovative instruments and new advancements in assembling measures, depending fundamentally on the IoT, distributed computing, and mechanical technology stages of changing into the supposed "smart factory" [12]. The IR4.0 mainly depends on AI units. We may have touched on the recent period with the emergence of self-driving cars and drones, as well as computer algorithms that accurately predict the results of Supreme Court cases, for example, in addition to the emergence of other computer algorithms that predict suicide attempts with an accuracy of between 80 and 92%. We do not forget the computer programs that were developed along with algorithms used to predict human decisions and reduce crime rates (see Figure 1) [13]. The fourth mechanical upheaval relies predominantly upon numerous cutting-edge innovative advances, the most significant of which are: personal digital assistant (PDA) gadgets, distributed computing, increased reality, colossal information examination and progressed calculations, staggered cooperation with clients and gathering data, brilliant sensors, 3D printers, documentation and location fraud, progressed human-machine connection, reality identification innovation, and IoT stages.

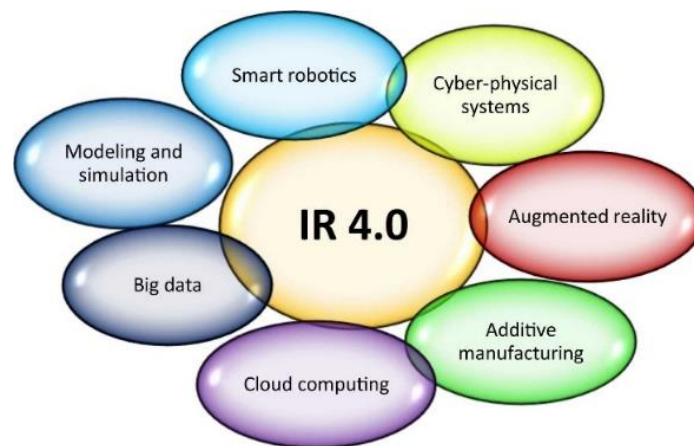


Figure 1. Leading technologies of IR4.0

2.3. Fourth industry revolution and the tsunami of technology

The Davos Global Forum picked the title "Fourth Industrial Revolution" as the motto for its forty-sixth meeting, and this decision echoes, as indicated by specialists, the "Third Industrial Revolution," which is the computerized registration transformation, which started in the fifties of the only remaining century. The only remaining century arrived at its peak with applications in artificial consciousness, biotechnology, 3D, and the transformation in online media and the advanced world [14]. Davos members portrayed the IR4.0 as a wave of mechanical advancement that would change numerous subtleties of human existence. Some communicated worry about this advanced upset and the resident's part in the computerized cooperation space, particularly his customary social collaboration. The automated association has become an instrument accessible to everybody, notwithstanding that electronic spaces have opened up in the wake of being removed or prohibited.

The idea of the "Fourth Industrial Revolution" dispatched by Germany is identified with the robotization of industry and lessening the quantity of labour in it, so the human part in business is restricted to observing and evaluating, and the condition for arriving at that is the presence of logical abilities that are utilized in having a high level of advanced and specialized construction. However, the extraordinary preferences that this "unrest" can accomplish to serve humankind are coordinated by adverse outcomes that follow social orders. The social demands of newly created nations will endure.

Today, AI is everywhere around us, from self-driving vehicles to robots, interpretation or venture programming, and more. Unfathomable advances have been made in the field of artificial brainpower lately, determined by gigantic advances in figuring power and the accessibility of immense measures of information,

from programs used to find new medications to calculations used to foresee our different. Then, advanced assembly innovation is continually interfacing with our natural world. Specialists, creators, modellers join PC plans, 3D printing, materials designing, and manufactured science to establish a climate in which microorganisms coincide, among us, the items we burn through, and even the structures we live in.

2.4. Impact on business

One of the significant issues raised by CEOs and business pioneers around the planet is the trouble in the agreement or foreseeing the speeding up of advancements and breakdowns. These components are a steady wellspring of shock, in any event, for individuals with the best methods for correspondence and data; however, there is positively clear proof across all ventures that the advancements that support the IR4.0 will significantly affect business. There are four fundamental effects that the IR4.0 can have on business: the impact on client assumptions, item improvement, shared development, and authoritative structures. Whether for shoppers or organizations, clients are consistently the focal point of the economy, which thus revolves around how to improve client support; however, now, actual items and administrations can be enhanced through computerized capacities that expand their worth [15]. New advancements make resources more solid and versatile, while information and investigation change how these resources are safeguarded simultaneously. The universe of client encounters, data-driven administrations, and resource valuation thorough analysis needs new types of joint effort, particularly given the speed at which development advances and breakdowns, the rise of worldwide stages, and other new plans of action will mean, at long last, that ability, the way of life, and strategies for organizations.

2.5. Impact on governments

The physical, computerized, and organic universes are starting to expand further. These new advancements and techniques will progressively empower residents to connect with governments, express their assessments, organize their endeavours, and even bypass public power oversight. Simultaneously, governments will gain new innovative forces that empower them to expand their command over the populace. With the multiplication of reconnaissance frameworks and the capacity to control advanced foundations, however, all in all, legislatures will confront expanding strain to change their present way of dealing with public investment and policymaking, as their focal part in overseeing arrangements will be debilitated by the presence of new entertainers. Wellsprings of rivalry and rearrangement. The centralization of energy will be accessible through innovations. At last, it is the flexibility of government guidelines, and public specialists will decide their probability of endurance. Upon advancement, it will experience expanding issues.

2.6. Fourth industry revolution challenges

According to the McKinsey consultancy, half of the existing businesses can be replaced by intelligent machines, saving \$16 trillion in paid salaries. This means that nearly half of the workers will lose their traditional jobs, which will lead to a marked doubling of unemployment rates, and this will also lead to an increase in the class difference between the rich and the poor and between workers who possess the appropriate skills and those who lack them. But at the same time, it will create hundreds of thousands of jobs in AI, data science, cybersecurity, e-commerce, and robotics [16].

For the industrial revolution to succeed, it required comprehensive economic restructuring, which required a social and political reorganization. This requires an advanced economic, social, and political structure in line with the new content. In addition, most of the challenges companies face revolve around internal issues such as culture, organization, leadership, and skills. It stipulates a comprehensive economic restructuring, and social and political restructuring must be attached to it.

2.7. The future of internet of things

Developing the bounty of innovation and the move to advanced devices that help tasks, interchanges, investigation, and dynamics in each part won't change the fundamental reason for creating frameworks. Notwithstanding, how it is constructed and worked will change, and upgrades to the IoT will be presented across four fundamental territories: availability, speed, access, and strengthening (see Figure 2) [17] in several sectors, IoT applies. In like manner, the security of the IoT won't change a lot, as people will at present be people who commit errors, and quantum PCs may, at last, have the option to penetrate a code in portions of a millisecond. Yet, quantum encryption will permit better approaches to guaranteeing the exchange of information.

Billions of passwords were compromised overnight, a few hundreds of thousands of bank accounts were drained, transactions were halted for days, and it took months to get all the money back correctly. Not long after, federal regulations required quantum encryption in the transmission and storage of financial data [18]. The last thing that is important to talk about is more significant than the IoT, but it's related to it, which is the economic implications of the internet 50 years later; the internet makes everything it touches more efficient.



Figure 2. Examples of IoT applying sectors

2.7.1. Industry 4.0, smart city and smart transportation

The transportation sector has evolved swiftly due to the advent of Industry 4.0 and the challenges posed by smart cities initiatives. The initial alteration to note is the service-oriented emphasis. Transportation can no longer be perceived merely as the act of relocating individuals and commodities from one location to another. Transportation should be seen as a service.

The citizen and industrial process generally disregard the experience of travel; however, some individuals may like to operate a powerful vehicle for enjoyment and to appreciate the scenery. Participation in designated events at a certain location and time, or the timely delivery of goods/components to the intended destination, is essential. In smart cities, it is essential to construct urban environments that facilitate the reduction of travel.

If the activity place is proximate to my residence, can access it without the necessity for transportation. High-speed internet enables remote work without the necessity of travel (remote working). Thus, through intelligent urban planning and supplementary elements of smart cities, the emphasis should shift from mobility to accessibility.

2.7.2. Smart buildings and homes

Brilliant meters are the most mainstream, and the most famous are shrewd meters. The IoT permits you to control all home gadgets associated with the internet, particularly shrewd home amusement gadgets, for example, TVs, speakers, clothes washers, coolers, boilers, cooling, warming, and other savvy home gadgets, through a cell phone or voice aides, for example, Alexa (Amazon Echo) and Bixby from Samsung. Cortana from Microsoft and Siri from Apple are among the most well-known voice assistants utilized on all intelligent gadgets, and there are also extraordinary voice colleagues for the home.

2.7.3. Wearables

Among the most significant of these gadgets are shrewd watches that, as of late, have attacked the market, regardless of whether Apple keen watches, Samsung, Huawei, Xiaomi, and numerous others. There are likewise electronic wristbands that we are presently finding out about to be utilized for the motivations behind isolation, safety officer, or illness observation, particularly for patients with coronary disease, epilepsy, and different infections that compromise human security and wellbeing and the whole sickness record, notwithstanding prescriptions and the specialist who follows the case. Also, to wrap things up, keen glasses that help computer-generated reality and expand reality.

2.7.4. Connected vehicles

The virtual proving ground emerged in the 1990s and continues to be utilized today. A virtual proving ground in the automobile industry consists of a high-fidelity model of a vehicle or vehicle subsystem, coupled with the interacting environment. An ideal environmental model would emulate a real-world scenario, such as a test track or proving ground, instead of a fictitious one. Subsequently, test data obtained from the track can be utilized to evaluate and validate the models and simulation results. The third element of a virtual proving ground is the driver, whose role can be fulfilled by either a model or a human in a driving simulator.

The driver's role has been mechanized via standardized vehicle maneuvers, with robotic steering actuators commonly included into cars to ensure uniform results in J-turns, double lane changes, understeering evaluations, and analogous activities. This simplifies the task of modeling a human driver and reconciles the experimental gap between virtual and real-world tests.

2.7.5. Education

Education 4.0 is an institution that advocates for intelligent and innovative thinking in education. Education 4.0 advocates for a transformative approach to education, primarily through the utilization of technology-driven tools and resources. This indicates that pupils will not acquire the skills to utilize textbooks, pencils, and essay instructors in conventional courses. Education 4.0 enables remote students to use the internet and enroll in courses via diverse open online platforms, video conferencing, or voice calls to engage with more dynamic content relevant to their studies. Your learning may be less than it now is. Education 4.0 emerged as a response to Industry 4.0, significantly enhancing the utilization of internet technology and communication tools. Numerous other sectors are adapting to this shift in business processes by developing Healthcare 4.0, Technology 4.0, and further innovations. The education ecosystem is similarly affected. Education 4.0 is designed for Industry 4.0 and equips skilled professionals for a highly globalized and digital workforce.

2.7.6. Industry

Companies have just commenced the adoption of additive manufacturing, including 3-D printing, primarily for prototyping and producing individual components. Industry 4.0 will facilitate the extensive utilization of additive manufacturing techniques for the production of small quantities of bespoke goods that provide construction benefits, including intricate, lightweight designs. High-performance, decentralized additive manufacturing technologies will minimize transportation distances and inventory levels. Aerospace businesses are utilizing additive manufacturing to implement innovative designs that decrease aircraft weight, hence reducing costs for raw materials like titanium.

2.7.8. Transport

Following the systems of organizations, services, transportation, streets, and gridlock, breaking down street information for methods for transport, fortifying it on top occasions, or changing the course on a case-by-case basis, saves time and exertion on transportation and conveyance organizations by gathering bundles or demands depending on the situation. A solitary zone or address contributes to lessening gridlock and contamination. Download stations can likewise be furnished with gadgets to follow the number of individuals at each station, and transport cards can be connected to a wallet and a cell phone or smartwatch, so the driver is alarmed about the number of individuals prone to be stacked or downloaded at each station, for instance.

2.7.9. Tourism

Virtual and expanded reality can be utilized in the travel industry. Hence, it permits the traveller to live an exciting encounter that reproduces reality as indicated by the historical backdrop of the area and gives insights concerning the area and the ideal approach to getting to the webpage, notwithstanding the administrations and means on the cafés and administrations site, working hours. A guide for visiting inside the website, with alarms. To decide whenever present and the clarification is upheld in a few dialects for the accommodation of the vacationer, with determining the costs of the administrations accessible in those locales, so they don't fall prey to the greedy and the ravenous [19].

2.7.10. Environment

Screen the degree of ecological contamination and average assets, such as water, biodiversity, natural stores, and temperatures, while connecting them all to biological insurance and making a quick awareness of the closest periodical to make a prompt move, if anything, regardless of whether it occurs. It is a fire or an assault. We will discuss the remainder of the areas so the site can apply the IoT and keep up the lasting work with no interference or human mediation, as we said previously [20].

3. SUGGESTED METHODS TO PROTECT THE INTERNET OF THINGS FROM THE USER'S PERSPECTIVE

The client or end purchaser has extraordinary obligations towards his security and guarantees its assurance. Maybe the means and tips underneath will give a few plans for safe use [20]-[24].

- Hardware insurance and advancement of security frameworks for the home organization: refreshing frameworks continually, utilizing fitting firewalls, staying away from phishing destinations, changing the

- secret word much of the time, abstaining from remembering individual data for them, using auxiliary assurance techniques for passwords.
- Choosing notable sellers or organizations to purchase gadgets: you can be confident that these organizations uphold the best assurance frameworks despite the exorbitant cost of buying devices from prominent organizations.
 - Take into account the utilization of private or public mists: you should know the contrast between private and public mists, the holes in every one of them, and the ideal security measure while picking the gadget you need to utilize [25].
 - The utilization of a virtual private organization VPN: a VPN permits a protected association with the internet by making it hard to follow the client, subsequently lessening the danger of entrance.
 - Creating a visitor network for all gadgets associated with the internet: the forces of this organization are restricted, and along these lines, infiltrating it won't be a passage to get to the devices [26].
 - Network-level danger checking: avast smart life is an IoT insurance administration that utilizes artificial brainpower and AI to distinguish and dispense with dangers and keep your home organization secure.
 - Do not connect devices to the internet except when needed.
 - Segregation between the home network and the work network.
 - Stop universal plug and play UPnP, which helps devices recognize each other automatically without confirmation, allowing the hacker to discover devices from outside the local network due to weaknesses in the UPnP protocol.
 - Tracking and evaluating devices, where the user must ensure the protection protocols supported by the device, the ease of modification on them through Patch, and the manufacturer's privacy policy.

4. STRATEGIES FOR INTEGRATING THE USE OF THE IOT IN THE IR4.0

Where different devices are connected to the internet, such as air-conditioners, refrigerators, washing machines, curtains, lamps, and other various devices, as each device has a specific address that communicates with the concerned people, so the lights can turn on automatically as soon as entering the house and close at the time of going out or sleeping, and the refrigerator can send an alert to its owner due to the lack of a specific material by sending a message on a mobile application, and even if a device communicates with another device without human intervention. For example the home refrigerator sends a signal to your phone about the required contents that have been exhausted. Then your phone directly sends a message to the supermarket, which will enable it to send ordering your home automatically without your intervention, and other examples include intelligent transportation solutions to speed up the flow of traffic, which leads to saving fuel consumption, and prioritizing appointments to repair vehicles and save lives.

Also, savvy power frameworks that are more effective in associating inexhaustible assets improve framework unwavering quality and expect clients to devour less diagnostic and prescient observing sensors, sitting tight for support issues and unavailable cases for the time being, as well as setting arrangements for upkeep staff to fix the gear and address local issues. Building information-subordinate organizations in the framework of brilliant urban communities makes it more straightforward for metropolitan gatherings to oversee information for executives, law implementation, and different projects more productively [27]. Add to your home security framework, which permits you to control the locks remotely, and the indoor regulatory framework in the home, cool the house, and open the windows.

5. CONCLUSION

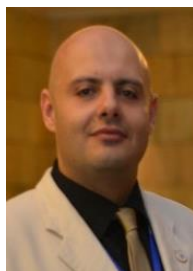
The IR4.0 is crucial for our nations because it will serve as the foundation of the economy in the future because oil will no longer carry the same economic weight as it does now. If a swift strategy is not implemented to effectively enter the IR4.0, the economies of nations that produce oil could experience a shock. Although some developed countries have already started to move towards adopting technology, especially the Gulf countries, we have not yet entered the stage of technological innovation effectively. This requires new skills, an advanced curriculum, and a different educational culture.




Adopting the IR4.0 is important for reasons other than only the economy. Nevertheless, it would lessen the civilizational divide between developed and advanced industrial nations that developed countries frequently inhabit. On the other hand, if the fourth revolution is not pushed through with force, the gap between civilizations will widen dramatically in the future. When genetics-based AI techniques are able to identify and treat diseases before they manifest, for instance, this means that the average lifespan of a person in technological countries will reach, according to estimates, 150 years, and the lifespan of a person in developing countries will remain between 60 and 70). This alone is a dangerous indication of the widening civilizational divide if the matter is not taken seriously.

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