10. An Overview of Top Futuristic Technologies

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What Is Futuristic Technology?

Futuristic technology is a very common term used in the field of information and computer technology (ICT). This term refers to the technologies that can change the way people live their daily lives in different domains such as businesses, social activities, governments, research and development, range of other industries and their processes. Those technologies may emerge in different fields such as manufacturing, aeronautics, information technology, electronics and communication, electromechanical engineering, construction and materials, and so on. The most important of all those industries and domains, information and computer technology is the most powerful and futuristic domain where a range of revolutionary things are expected to happen. Thus, it can be said that ICT and other fields of technology powered by the ICT technologies will be the major drivers of the futuristic technology sphere (as is the case even today).

If we look at the automobile and aerodynamic fields of engineering, the ICT is drastically changing the way they work even at the present time. For instance, the most complex and technology-oriented processes in the manufacturing of automobiles or vehicles is the designing and prototyping of the vehicles. The designing and

prototyping of the car models, and their parts is being extensively done in the virtual environments powered by computer software and virtual reality (VR) environments today. Hence, we can expect what will happen after a few years or decades when almost all manufacturing processes will be automated and integrated into one operations room powered by the modern computer and information technologies (i.e., ICT's involvement will increase manifold).

Futuristic technologies are continuously evolving and the applications of those technologies in all major industries are being assessed and figured out. Many industry experts believe that upcoming or futuristic technologies that are going to revolutionize other industries and businesses can impact almost all kinds of existing industries and may bring forth new domains of industries in the future. The most important industries whose existing shape may change or a drastic transformation may occur are mentioned in the following list [255]:

- Computer or chip manufacturing industry
- Automobile and other manufacturing industries
- Transportation and aviation industries
- Medical and healthcare industries
- Bioengineering and medicines industries
- Aeronautics engineering and manufacturing
- Mobile and computer industry
- Telecommunication
- Software development industry
- Agriculture and environment engineering.

If we look at the major upcoming technologies that will impact the above-mentioned list of industries and domains and even other fields that are not mentioned here, we can see a range of upcoming futuristic technologies that are capable of impacting any one or more than one industries substantially. A few of those futuristic technologies are described in the following topic.

Top Futuristic Technologies

A large number of existing technologies that have either emerged in the market or are getting deeper roots in different applications across the industries have been described in separate chapters in this book. In this topic, let us focus on those technologies that are either getting ready to hit the markets or will hit markets in a few years or a couple of decades.

A few of those technologies that will shape the future in different industries are mentioned below:

- 3D Printing Technology
- 6G Technology
- Autonomous Robots
- Artificial Neurons
- Artificial General Intelligence (AGI)
- Mind Uploading
- Driverless Vehicles
- Infrastructure Hacking
- Regenerative Medicine
- Digital Twin (DT) Technology
- Programmable Living Robots
- Human Augmentation
- Intelligent Process Automation (IPA)
- Space Elevator
- Rotating Skyhook
- Light Sail.

If we look at the names of the above-mentioned technologies that are in offing, we can realize that they can revolutionize almost all processes, activities, and industries of human beings on this earth. A large number of present processes, products, and activities will vanish completely and numerous new processes, activities, and industries will emerge in the market place. The ways humans live their lives in the present age will also change drastically or will transform completely into new activities powered by the most advanced and futuristic technologies.

The details of the above-mentioned futuristic technologies are given with full explanation in the following sub-topics.

3D Printing Technology

Three dimensional printing, precisely referred to as 3D printing is a revolutionary technology that will change the shape of our world drastically. It will use different types of materials in a material manufacturer or printer like we add papers in the existing printers. The computer will make a design of the product in three dimensions and the print command will be passed with the design data to the material printer. The printer will choose the material as per design and will print a 3D material based item, which will be added to the products manufactured in the factories. 3D-printed furniture samples are shown in Fig. 10.1.

Fig. 10.1 3D-printed furniture (Flickr)

For instance, you want to build a bolt, you need to create a design and give a command to the printer, which will take the melted iron from the connected furnaces and will print a bolt based on the design developed in the computer. Now, you need to just take that bolt and install on the product where you need that bolt. The automation may even interfere with the taking and installing the bolt to the new product. The bolt may automatically go to the assembly area and then it can be even automatically installed by a robotic hand or machine.

The most important features and characteristics of three dimensional printing are summarized here [256]:

- 3-D printing is also known as additive manufacturing.
- Objects are created from either digital 3D model or CAD (Computer-Aided Design) models.
- The entire process of manufacturing may include numerous stages such as material depositing, solidification, jointing, and others under the control of computer programs.
- The fusion of the material takes place in layers—layer by layer—by using the fused materials such as plastic, powder grains, liquids, and others.
- Earlier in 1980s, the 3D printing was considered useful for prototyping. That is why, it was used to be called as rapid prototyping too.
- Nowadays, it is being considered viable for the industrial production and referred to as additive manufacturing.
- The most advanced process based on 3D printing used in the start of the second decade of twenty-first century is Fused Deposition Model, precisely referred to as FDM, which uses continuous filament of thermoplastic material.
- The term *additive manufacturing* evolved in around 2010 and now, it is getting popular across the industries and manufacturing processes.
- Other alternative terms used instead of *additive manufacturing* include *desktop manufacturing* and *rapid manufacturing*.
- The main manufacturing processes in which the additive manufacturing is being used nowadays include stamping, hydro-forming, and injection modeling.
- The general principles of 3D printing include the following processes:

  – Modeling
  – Printing
  – Finishing.

- A 3D printer can be mono-material printer as well as multi-material printer.
- A range of additive manufacturing processes can be added into seven categories that are listed below:

– Vat photopolymerization
– Material extrusion or particle deposition
– Material jetting
– Powder bed fusion
– Binder jetting
– Sheet lamination
– Directed energy deposition.

Short History of 3D Printing

The history of 3D printing dates back to 1940s when the idea of three dimensional printing came into the minds of the scientists. The chronicle history of 3D printing is described below:

- **1945**—The concept and process of 3D printing introduced by Murray Leinster.
- **1950**—Raymond Jones published this concept in science fiction magazine with concept of molecular spray under his article "Tools of the Trade".
- **1971**—Liquid Metal Recorder was patented by Johannes Gottwald.
- **1974**—The concept of 3D printing introduced by David Jones in New Scientist journal.
- **1980**—Two additive methods of fabricating 3D plastic models introduced by Hideo Kodama.
- **1984**—Computer Automated Manufacturing Process was patented by Bill Masters.
- **1984**—Alain Le Mehaute and his colleagues filed for patenting stereo-lithography processes.
- **1993**—Powder bed process using custom inkjet print head was invented by Emanuel Sachs at MIT Institute.
- **1995**—Selective Laser Melting process was invented by Fraunhofer Society.
- **2005**—An open-source project named as RepRap started by Adrian Bowyer. Under this project, a 3D printer was built in 2008 and the first replication named as "Darwin" of the newly built printer was achieved.
- **2009**—After the expiration of fused deposition meting (FDM) patent, numerous companies under RepRap open-source project emerged for FDM manufacturing.

- **2010**—Metal working process was accomplished first time. Before this, majority of the processes dealt with the plastics and polymer materials.
- **2016**—First LEAP engine with 3D printed fuel nozzles was manufactured by General Electric for Airbus corporation.
- **2021**—A fully 3D printed prosthetic eye was created and installed in a patient named as Steve Verze in Moorfields Eye Hospital London.

A large number of big companies in the field of manufacturing, healthcare, ICT, and other industries are investing enormously in 3D manufacturing. It is expected that many new processes and applications will emerge in the future marketplace very soon.

Applications of 3D Printing

There is wide range of applications of three dimensional printing in different domains of industries in the present day at a limited scale. But, it is projected that the applications of 3D printing would expand exponentially in all sectors of industries within a short period of time in the near future. The most important industries where 3D printing is being utilized at a certain level include:

- Manufacturing industry
- Fashion industry
- Firearm industry
- Healthcare industry
- Transportation and aviation industry
- Culture heritage industry
- Education and training sectors.

The major applications in those industries are mentioned in the following list:

- Work is going on to create 3D printed food items for astronauts and for the people on earth while maintaining the food texture and taste with the help of three dimensional bio-printers in the USA, Italy, and other countries. The plant-based meat developed in Italy is an example of such food items.
- Different companies like Nike and others are manufacturing clothes, shoes, and other items used in fashion industry with the help of 3D

printing. Software-based systems create customized products for man/woman that are perfect for him/her.

- Numerous printed parts and components are being used in a range of products such as typhoon fighter jet, Airbus airplanes, Swedish supercar, GE aviation engines, US air force, and many other companies and their products.
- Different companies in the US are working on building 3D printed firearms. Those can be customized and used for special purposes.
- 3D printing based human body parts are being created at very small and experimental levels for implantation and other surgeries in healthcare industry.
- 3D-printed metal bridge was first time installed in Amsterdam.
- Numerous applications are being explored in the field of education and training, especially for the Science Technology Engineering and Mathematics (STEM) education systems.
- Numerous companies used 3D printing for manufacturing the PPE (Personal Protective Equipment) kits to cater to an exponential growth of demand during Covid-19 pandemic.

4D Printing

Four dimensional printing, precisely referred to as 4D printing, is an extended version or form of 3D printing, which is capable of printing a 3D object that can be morphed with the help of light, temperature, stress or other influencers with the passage of time. In other words, a 3D object printed through 3D printing technique can change its shape in a predictable manner controlled by the computer software program. The program exposes the 3D objects to different things such as temperature, water, air, electric current, magnetic energy, or any other source to achieve the desired impact on the three dimensionally printed objects.

A 4D printing can be done through single or multi-material to transform into different shapes from 1 and 2D that would strand into 3D shapes through a controlled environment governed by the computer program or software application interfaced with the printers [257]. First time, the word 4D was introduced in TED conference in MIT in 2012 and later on, the first research paper on 4D printing appeared in journal in 2013. The prospects of 4D printing are very high and it has

potential to revolutionize numerous processes and industries in the future.

The notable companies that are using 4D printing for further research and development (R&D) as well as for different applications include [258]:

- Hewlett and Packard
- 3D Systems Corporation
- StrataSys Limited
- Autodesk Inc.

The demand of 4D printing will by huge in the future. According to a projection, the demand for 4D printing will remain over 42.95% after its launch in 1919–20 through 2025.

6G Technology

The sixth-generation technology, precisely referred to as 6G, is a mobile wireless technology that will be the successor of the 5G technology, which is still rolling out in many countries around the world. The 5th generation technology is considered as the most promising mobile data transmission technology that uses millimeter waves in spectrum of 24–50 GHz. The 6th generation cellular wireless network standard will use millimeter waves in range of 30–300 GHz and 300–3000 GHz too. The final development and testing of those bands and associated technologies are under research and experiments. Many companies are investing hugely to develop 6th generation technology faster to become the leader in the market. A few of those major companies that are investing substantially in research and development of 6G technology include [259]:

- Huawei Technologies, China
- Anritsu Corporation, Japan
- KeySight Technologies, USA
- Samsung Group, South Korea
- Ericsson Corporation, Sweden
- Jio Telecommunications, India.

The most important characteristics, features, and capabilities of the sixth-generation cellular technology network standards are listed

below [259, 260]:

- The 6th generation wireless technology offers more throughput and much lesser latency as compared to the 5th generation networks.
- It is more heterogeneous or diverse network.
- The 6G technology supports more advanced ICT technologies such as virtual reality and augmented reality (VR/AR) in real-time environments, Internet of Things (IoT), mobile edge computing, diverse IT service-based business models, short packet communication, quantum computing and others.
- Uses upper spectrum in terahertz range to offer much more speed and data throughput or capacity.
- The 6th generation wireless cellular networks are targeted to offer speed at least 5 times faster than its predecessor 5th generation network. It may range above 100 Gbps.
- It is expected that 6G may support AI supported all programs in real-time environment such as driverless cars and other automated systems powered by artificial intelligence.
- The robust level of security, privacy, and secrecy may be the other most salient features of this technology.
- It may support up to one microsecond latency in different telecom services, which is even of much lower latency than 5G technology.
- This technology is also expected to fully support location awareness and present technology services for all its connected devices and networks.
- The releasing data of the 6th generation technology is set as 2030.
- Some experts and researchers believe that the peak data rate may reach one terabyte in certain ideal conditions or testing conditions.
- This technology is expected to further exploit wireless techniques used in the 5G technology such as beamforming, orthogonal frequency division multiple access (OFDMA), multiple input multiple output (MIMO), and higher sampling rates.
- It is expected to further expand upon the distributed radio access network (RAN) for achieving increased capacity and improving spectrum sharing.
- It is approximated that this technology will use wireless sensing solutions that will help the system to select the frequency band suitable for the given conditions.

Why is 6G Technology Needed?

Advancement in technology is the most fundamental component of modern businesses to create higher level of efficiency, reduction in cost, and improvement in daily business processes, and enhancement of service and product quality in the world. To achieve all those goals, a continual improvement in the technologies should be done (for all technologies). In modern world, the ICT has huge impact on all business processes and activities across the industries and sectors. Thus, the enhancement in the ICT technology is the most fundamental domain of research and development (R&D) for the improvement of all processes and activities in all industries. The demand for the number of connected devices and data bandwidth is increasing exponentially with every passing day. The present day technologies are not efficient enough to cater to that huge demand in the future. Therefore, a substantial investment in research and development is very necessary for the growth of the businesses and industries in the world.

The main reasons why our industries and businesses need the 6th generation technology are mentioned below [260]:

- **The convergence of technology**—There are numerous technologies that exist in the present-day wireless communication networks. The 5th generation technology is trying to coexist within heterogeneous environment and pave the way for larger convergence, which will be achieved through the power of 6th generation technology.
- **Incorporation of high performance computing (HPC)**—The existing technologies still lack in incorporating the high performance computing and quantum computing services, which are very fast and need high bandwidths and data channels for communicating with the similar kinds of devices on highly broader super-highways of data. The huge demand for low latency and faster speeds can be fulfilled through 6th generation wireless technology.
- **Internet of Things (IoT) network**—The number of IP-enabled devices are expanding exponentially, which would need huge bandwidth and high-capacity network connection for communication. The present day technologies will not be able to provide the required data after a few years or a decade. Therefore, a

newer technology like the 6th generation technology is highly needed.
- **Mobile Edge computing**—The implementation of edge computing and mobile edge computing in a connected networks of billions of IoT-enabled devices would need huge data with very low latency. To make them capable of communicating in the real-time environment, the filtration and local provision of data are highly needed to avert any congestion in the network. This can be solved through edge computing systems and in the future, through mobile edge computing networks. Those networks require greater processing and bandwidth for real-time processing of the requests of billions of devices and other entities in the connected network. This can only be catered to with the help of newer technologies like the 6G technology and beyond.

Scope and Challenges of 6G Technology

The future scope of 6G technology is expected to be very bright in the light of modern technology trends and emerging technologies. A few highly data-bandwidth demanding services and technologies that will rule the future of the ICT businesses to provide support to the other industries include the following:

- Data centers
- Virtualization programmable networks
- Internet of Things (IoT)
- Quantum computing and high performance computing (HPC)
- Edge computing.

All of the above-mentioned domains of technologies and services are still not getting enough bandwidth to cater the emerging demands. Thus, the future of more powerful, low-latency, high-speed, and larger-capacity technology like the 6th generation cellular wireless network will be very bright and encouraging across the industries.

Every other technology or progress in any field brings a few challenges along with it. Hence, the 6th generation is also expected to face some very uphill challenges such as:

- Interconnection of a gigantic network of poles or towers that may bring complication related to public health, security, and cost factors.

- A challenge may be the security and threat detection in a huge network of diverse networks, especially separated through different edge devices, local wireless points and other nodes that provide local security.
- Implication in coordination between the core computing and edge computing that have to distribute certain processing levels and decisions at their own levels.
- Emergence of Nano-core that will deal with the processing of artificial intelligence (AI), high performance computing (HPC), and quantum computing.
- Such huge networks with huge volumes of network generated data will become another important challenge for the next generation networks of wireless technologies such as 6G. For the management of that big data, data analytics power will be required. At the same time, the legal and regulatory issues will also emerge as a big challenge for the service operators.
- Governments and industries may face numerous other challenges in maintaining a range of activities such as law enforcement and social credit systems, health monitoring, air-quality and environment monitoring, monitoring sensory interfaces, which are the core components of the IoT-powered networks.
- And many others as the technology evolves

Autonomous Robots

Autonomous robots are intelligent machines that can perform tasks without any intervention of human being. They can perform the tasks based on the intelligence they possess through computer-vision training data sets. The autonomous robots are being used in different industries across the world. A few examples include the food serving robots, automated guided vehicles used in factories, flying robots or drones used for the surveillance purpose and may other domains such construction, environment monitoring, and so on [261, 262].

The main features, characteristics, and applications of an autonomous robot are mentioned below:

- It acts autonomously in the line of its learning through previous data fed into the software of the machine.

- No control or intervention of human in its core functions. A few critical maintenance or other functions may be in the control of engineers.
- The examples of autonomous robots include industrial robotic arms, self-driving cars, space probes, and flying robots.
- Normally designed to perform repetitive, dull, dirty, and dangerous tasks that are not favorable for a human to perform.
- The other areas where the autonomous robots are used in the present-day include e-commerce, warehousing, logistics, manufacturing, data centers, biotechnology, etc.

Main Components of Autonomous Robots

An autonomous robot works independently without any human help or human intervention; so, it requires the capabilities of thinking, perception, sensing, and decision making before taking an action through arms or other parts physically. Hence, the major components of an autonomous robot can be divided into logical and physical ones. The physical components may vary significantly in terms of its shape, size, and designs but the logical components of an autonomous robot will remain very much common. The most important logical components of an autonomous robot can be divided into three types as mentioned below:

- Perception
- Decision
- Actuation.

The perception part of autonomous component deals with the senses. For example, humans are capable of sensing different internal and external environment through five senses such as seeing, touching, smelling, listening, and tasting. Those senses help us make decisions based on the senses through our cognition that we learned through our experience in our life. On the other hand, autonomous robots would take two types of inputs known as perception such as:

- Proprioception
- Exteroception.

Proprioception deals with the internal sensing such as heating, force, batteries, charges, power, and other similar kinds of senses. While, exteroception deals with the sensing of the external environment such as sound, touch, light, smell, and many other objects. Both parts of the sensing are done through different sensors installed on the robots such as camera, bump sensors, torque-force sensors, spectrometers, thermometer, radar, and many other types of sensors.

The second important component of an autonomous robot is decision making. The decision making in autonomous robots is done through an artificial neural system powered by the computer algorithms. That decision making is done on the basis of the input that it gets in the surrounding and compares that with the authority limitations and assigned tasks or programs. The decision making process in human is done on the basis of gut feelings or brain's neural systems that would decide the situations encountered to make the most suitable decision (as deems to be). The human decision making can also be classified into two categories—gut feelings/brain decisions and the other one is the natural reflexes which just act fast on the basis of input without getting command from brain on the basis of its previous ready-made decisions such as blinking of eye, sensing of extremely hot environment, and similar types of things in high speed environments.

The third important component of autonomous robot is actuation, which is similar to muscle action performed by human body at the time when instructions are received from the brain after it makes the decision. The actuation in autonomous robots is done through different actuators that perform motion in different parts of the robots similar to the muscle movements performed by the muscles in human body. The actuators are formed through different equipment such as motors, hydraulics, electromagnets, and others.

Main Applications of Autonomous Mobile Robots (AMRs)

Autonomous mobile robots, precisely referred to as AMRs, are the most task-oriented self-operating and self-maintaining machines that can perform their respective tasks without any intervention or support from human beings. They are capable enough to tackle different issues such as obstacles and continue performing the designated tasks by overcoming those hindrances as much as possible. This is the reason

that AMRs are being used in a large number of industries and different applications. The most common industries in which the most sophisticated AMRs can be used to achieve the most automated ecosystem include the following:

- Logistics industry
- Ecommerce and retail industry
- Manufacturing industry
- Warehousing industry
- Data centers management
- Biotech engineering
- Healthcare industry
- Research and development (R&D).

The most common applications in those industries are those that are very repetitive, dull, hazardous, risky, dirty, and odd jobs. The repetitive jobs can easily be performed by the autonomous robots such as taking one part from one tray to inset into a machine frame repetitively. A human can get bored and may not keep his/her focus on such repetitive job but a robot can perform it perfectly. Similarly, there are other jobs suitable for such robots, which are risky and dirty such as passing nearby running motors, furnaces, and other similar kinds of machines where human error can lead to risk to life of a human worker.

There are two major types of navigations performed by the autonomous robots in our modern industries:

- Indoor navigation
- Outdoor navigation.

The indoor navigation is much easier as compared to the outdoor navigation because indoor environment is limited and can be easily made understood to the AI-enabled machine through different training datasets in the modern machine learning applications. But, the external or outdoor environment changes significantly and machines cannot be fully trained for all types of objects, situations, and environments that encounter the navigation of autonomous robots. The indoor navigation can be made possible through a few sensors such as sonar sensing, CAD floor plans, camera, and other objects to make it understand the environment within limited premises. The outdoor navigation requires

much sophisticated tools and learning algorithms and huge datasets to consume for building experience-based learning. An autonomous robot for outdoor navigation needs to deal with a range of issues such as:

- Huge disparities in surface densities
- Weather conditions and exigencies
- Three dimensional terrain to counter with
- Instability in the sensed environment
- And much more.

The prospective domains in the future where the autonomous robots will be consumed or deployed the most include:

- Space probes
- Military applications
- Automobiles
- Research and development (R&D).

The research and development work is going on in all major domains of industries, especially in space, defense, military, R&D, and other fields to make the most of the potential of autonomous robots.

Artificial Neurons

Artificial neurons are another very emerging and futuristic technology that will change the shape of automation and mechanization of all types of business processes with the help of robots, computer added programs, and other modern equipment and software platforms. Artificial neurons act similar to the biological neurons functioning in human brain. In human brain, the input data comes through multiple sources such as five senses and the gut feelings, which is considered as the sixth feeling, and then, all the inputs are processed to make a decision and pass the results to the next level if the neuron calculates that the weight of the output is such that it should be sent to the upper level or nodes or neurons.

The artificial neurons also resemble the biological neurons in structure, data processing, data input, and passing the output to the next level based on its weight. An artificial neural network consists of the following parts:

- Neurons or nodes

- Connections.

The neuron is a node that receives the data from multiple sources and processes it through certain logical algorithm(s) to generate the output, which is in the shape of weight or a voltage value. If that voltage value is above the threshold value (as set), the value is forwarded by the node to the next layer of neural network. If not, it is not forwarded to the next layer. There are two types of neurons in terms of their capabilities such as:

- Convergence neuron
- Divergence neuron.

The convergence is the capability of one neuron to collect input data from multiple neurons in the neural network. The divergence of a neuron is the ability of one single neuron to communicate with multiple neurons in the neural networks. The decision making in artificial neuron is done through activation function, which is built in the system and it runs on the basis of an algorithm. The algorithms of activation functions can either be linear or non-linear to decide the value in such a way that if it crosses the threshold value, it will be sent to the next layer and if not above the threshold value, it will not be forwarded. This process of deciding whether to send or not (the output value) to higher layer is known as "bias" in artificial intelligence or neural networks.

The main features and characteristics of a neuron are summarized below [262, 264]:

- Neurons are modeled similar to the structure of biological neurons.
- The assigned values are based on the importance of the input signal; it can be both positive and negative.
- The neuron's activation function works on the basis of hidden layer calculations to forward the result to output or not.
- The use of multi-layer perception or hidden layers in the future will help transform the ways people work, live, and act in the future.
- The advanced training methods to the artificial neurons or neutral network systems can help neurons understand and decide about the most complex environments and situations that may result in the most sophisticated automation in numerous industries, processes, and activities globally.

- The artificial or synthetic neurons are made up of silicon chips to process the input data through complex middle layer to generate an output.
- The process of learning about the environment in neurons is known as deep learning, which decides the outcome on the basis of importance of the input data.

As expected, the future of neural networks or artificial neuron technology is very bright in all domains of industries to achieve high level of automation, which is the future of highly connected world powered by multi-billion device networks.

Artificial General Intelligence (AGI)

Artificial intelligence (AI) is a very vast and futuristic technology, which is just evolving. The potential of artificial intelligence has not yet been fully achieved. In terms of levels of artificial intelligence capabilities, it can be divided into three generalized categories such as:

- Artificial narrow intelligence (ANI)
- Artificial general intelligence (AGI)
- Artificial super intelligence (ASI).

The modern world has not achieved the full capabilities of the first category of artificial intelligence known as artificial narrow intelligence. The most sophisticated artificial intelligent systems like IBM Watson falls in the category of narrow intelligence. The definition of artificial general intelligence is not standard but may experts define it as the level of artificial intelligence that matches the decision making capabilities of machines equal to human brains [265].

The artificial general intelligence (AGI) is also referred to as deep artificial intelligence, which is equal to the thinking, understanding, learning, and applying the intelligence to solve the complex problems in the way human brain thinks and updates the learned experience for the future applications so that the advancement or growth of mind/intelligence would continue. There are several companies such as Microsoft, OpenAI, Fujitsu, and many others, who are investing hugely in the research and development to achieve the AGI level of intelligence to change the world drastically.

Let us summarize the key features and characteristics of artificial general intelligence (AGI) that have not yet been materialized in the world [266].

- It is mid-level artificial intelligence that is defined as par to human intelligence.
- Still science fiction stuff; not materialized yet.
- It can handle abstract thinking, maintain background knowledge, use common sense capability, transfer the learning, and predict/find effects and causes of an event and much more.
- Machines would be capable of creating and correcting human work such as code, writings, and other similar kinds of tasks.
- Understanding human language and responding with the different types of languages by using the power of natural language processing (NLP) will also be a big characteristic of artificial general intelligence (AGI) machines.
- Navigation with the help of global positioning system (GPS) and motorized fine skills to carry out activities like human does will also become parts of the feature list of advanced AGI machines of the future.
- The other major activities that it can perform will include:
  - Utilizing different sets of knowledge
  - Handling numerous types of learning skills and learning algorithms
  - Creating the structures for almost all kinds of tasks that a human can perform
  - Dealing with metacognition and using it effectively
  - Understanding symbols and signs like humans do
  - Understanding of beliefs, ideologies, sentiments, and others.

As mentioned earlier, the AGI capabilities have not yet been realized. Many experts are skeptical of achieving such capabilities through machines and some scientists believe that it can be achieved by the end of the third decade of twenty-first century. One of the best scientists Stephen Hawking warned the humans not to create such level of artificial intelligence because it will be severely dangerous for the existence of human being. Even if that may not be exactly like what humans do for their understanding and action in a given context, the

problem is that such machines can also err or there could be other issues like bugs in the code, mechanical failure or wrong electrical signal to machine parts, etc. that can create dangerous or hazardous situations.

Artificial Super Intelligence (ASI)

Artificial Super Intelligence, precisely referred to as ASI, is the most advanced form of artificial intelligence, which will supersede the capabilities and power of the most genius brains on the earth. This is just a science fiction or imaginary idea that will be developed in the future (as is the expectation or objective of the research community). The machines that possess the ASI-level power would be able to beat the most powerful brains available on the earth in numerous domains such as creativity, problem solving, decision making, approximation, and many other domains of human activities.

To have clearer understanding of the concept of artificial super intelligence (ASI), let us explore it in terms of different levels of artificial intelligence. All machines and software-based systems that can perform intelligent activities powered by the artificial intelligence (AI) fall in the first category or level of artificial intelligence, which is commonly referred to as weak artificial intelligence. The examples of weak intelligence based machines and software applications include driverless vehicles, expert systems, virtual assistants, and many other (today's) advanced AI applications.

The second level of artificial intelligence defined in the domain of modern information and computer technology (ICT) field is referred to as strong artificial intelligence, precisely "Strong AI". This is a software-based machine system whose capabilities and intelligence would be equal to that of a common human being. It can think, understand, make decisions, and accomplish approximations and self-adjustments, and many other functions performed by the present-day human brain. This level of intelligence is under research and development (R&D) and has not been fully materialized in the world as yet. May experts and scientists believe that it is near-to-impossible to create the intelligent systems of this level but efforts can be given in this direction.

The artificial super intelligence is the most advanced category of all other intelligent categories such as weak-AI and strong-AI. This is about

the software-based intelligence systems that can surpass in all brain related activities that a human brain can perform such as thinking, decision-making, scientific creativity, social behavior adjustment, experienced-based wisdom, learning-based wisdom, approximation, adjustments in line with the surrounding conditions and sentiment readings of the people who interact with those machines.

The most important capabilities, features, and characteristics of ASI futuristic technology are summarized in the following list [267]:

- It is a fictitious concept of artificial intelligence that is based on imaginary suppositions.
- The software systems that surpass the capabilities of human brains is called artificial super intelligence (ASI).
- It is also referred to as "singularity" in the technological world and some scientists and experts refer to it as hypothetical artificial intelligence.
- If the concept is materialized, the ASI machines would think about abstraction and make interpretation of unclear things that the most genius human brains will not be able to think or crack (i.e., the hidden concepts).
- ASI-powered machines will be capable of not only reading of human emotions but also can evoke human emotions, ideologies, beliefs, and other abstract concepts.
- There are many philosophers and domain specialists that believe that the advent of the artificial super intelligence may lead to very risky and devastating situation for humans and other natural things on the earth or in the universe.

Mind Uploading

Mind uploading is another very futuristic and fictitious concept in the field of artificial intelligence (AI) and information technology (IT) that can transform the way people live not only on the earth but in some other parts of the universe too. The proposers of the idea of mind uploading believe that this process can be achieved by the mid of the twenty-first century when the artificial super intelligence or singularity will hit the markets.

According to the mind-uploading concept, the entire state of a human mind is scanned and transferred to the computer digitally so

that the uploaded mind file can be installed or restored in any other body. This is called whole brain emulation—all emotions, creativities, skills, innovation, thoughts, experience and everything—into digital data or executable file and uploaded to the computer machine, which can be used for restoring, transferring, and installing in other bodies. Cyber channels can also be used to transfer the full digital mind!

The digital computer then runs the simulation of information processing of the brain in such a way that it will respond perfectly like the human mind does with all sentiments, emotions and other abstract concepts. This concept mind uploading (or, brain uploading) can be materialized by developing a range of tools and programs such as:

- Brain Computer Interfaces (BCI)
- Connectomics
- Information extractions.

The role of brain-computer interfaces is very pivotal in realizing the concept of super intelligence in artificial realm and brain/mind uploading systems. The mind uploading can be accomplished through two main methods.

- Copy the brain and upload to the digital computer. It is also called as constructive mind uploading or simple mind uploading. In this type of uploading, the brain is scanned for the information and features, then the information of the biological brain is mapped and finally, it is stored or copied to upload to the computers or any specific computational device used for this particular brain uploading task. In this process, it is possible that the biological brain may not be able to survive due to numerous processes of copying and pasting activities and sometimes, some major components may be destroyed for copying different parts of the brain. The entire copied and uploaded brain will survive in the virtual reality and simulated world.
- Copy the brain and delete brain through gradual replacement of neurons. This process is also referred to as gradual destructive mind uploading. In this process, the entire brain of human is deleted and replaced with the computer program that emulates the entire brain. After that process, the entire body of the human will remain under the control of the software program that was emulated and transferred to the human body through different interfaces.

The most important aspects, features, characteristics, and capabilities of brain/mind uploading include [268, 269]:

- The most important technologies that can pave the faster way for the mind uploading include superintelligence, brain-computer interfaces, virtual reality, information extraction from minds, and so on.
- During the process of scanning, mapping, copying, and uploading, a few parts of the brains or entire biological brain may get destroyed intentionally or may not survive due to the complex processes of copying, pasting or uploading.
- The copied brain can be installed or connected through BCIs to a humanoid robot, cybernetic, or biological body controlled through computer programs.
- This technology is also viewed as digital immortality because the brain does not die but it can change the body from one human to another or to a robotic body.
- It uses different technologies and techniques such as serial sectioning, computational complexity, brain imaging, brain simulation, brain scanning, brain mapping, and others.
- Some supporters of the brain uploading idea believe that it can be realized by the year, 2045 while the others believe that it may take much longer and may get materialized in the last decades of this century.
- The creation of cochlear (implant) is the first successful step-forward in building brain-machine interface (BMI) or BCI, which is designed to stimulate the brain cochlear nerve electronically to restore sense of sound that is hard to be heard.
- A large number of researchers and companies are investing in the development of modern BCIs for restoring the motor skills for restoration of brain damage due to stroke or accidents.
- For this process, powerful computers are needed; if the quantum computing materializes as per projections, then mind uploading can become reality much sooner than expected.

Driverless Vehicles

Driverless vehicles have already hit the market in many countries on trial as well as commercial basis. The full-fledged usage of driverless vehicles would change numerous human activities, business processes,

and government rules significantly. Once the driverless vehicle ecosystem takes roots, so many other emerging technologies would grow for the improvement of this system. The use of drivers would reduce significantly through more automation in the automobile and transportation industries. The shape of logics and supply chain would also change drastically.

The vehicles that can run between two destinations with the help of cameras, sensors, and artificial intelligence AI-powered software without any intervention of human is known as driverless vehicle. There numerous other terms used for this particular matter such as autonomous cars, self-driving vehicles, and robotic cars.

The main features, capabilities, and characteristics of vehicular automation through driverless car system are summarized below [270]:

- According to the standards developed by the Society of Automotive Engineers, precisely known as SAI, there are six levels of vehicular automation or autonomy such as:

  - **Level 0**—No automation
  - **Level 1**—Shared control or hands on with the automated systems
  - **Level 2**—It is called as the hands-off automation of car driving
  - **Level 3**—In this level of automobile automation, the eyes are taken off but human assistance may be required
  - **Level 4**—In this category, the eyes are taken off and mostly, it is not expected that a human would be required to intervene
  - **Level 5**—Steering wheel optional.

- The most common sensors used in autonomous cars include radar, GPS, Sonar, inertial measurement units, thermographic cameras, and others
- The driverless cars are expected to hit the market at larger scale in the late 2020s and early 2030s of this century.

With autonomous cars getting strong grounds, the artificial intelligence and machine learning will have a strong shot in the arm for more investment in machine learning applications in the future, which will lead to more advancement in futuristic technologies.

Infrastructure Hacking

The infrastructure hacking is not a futuristic technology but a futuristic risk or challenge to the modern world. It is being used as the weapon of the war in the new format of hybrid war. Highly sophisticated tools are being used by the hackers to take control of the core infrastructure of a country such as water supply systems, drainage systems, electricity grid systems, dam control systems, traffic control systems and many others. To counter those threats, highly futuristic technologies will keep emerging so that the emerging threats can be mitigated.

Regenerative Medicine

Regenerative medicine is another highly futuristic technology that will change our lives significantly and can open up new dimensions of human and animal lives. The regenerative medicine is a process of healthcare therapy powered by the futuristic technologies to replace or generate new cells, tissues, and organs in human body so that the damaged or teared organs or tissues can be generated within the body systems. For instance, in our body, there are numerous such processes that regenerate the tissues when they are damaged such as skin, bone, or muscles—the body regenerate those parts by developing new tissues. But, this process is not common in all cases. For example, if your heart is damaged, it does not regenerate or your brain is damaged, it is not redeveloped. Thus, the scientists and researcher are exploring the options through the potentials of technologies to create a therapy based in the regenerative medicines that can build new tissues, molecules, cells, or even organs.

The main features, capabilities, and characteristics of regenerative medicine are [271]:

- Replacing, rebooting, or rejuvenating the damaged tissues due to diseases, aging, accidents, or other things with the help of modern technologies (it is known as regenerative medicine therapy).
- Regenerative medicine does not involve the surgery or replacement of a human organ with another human organ as it happens in present-day medical procedures. This is a type of medical procedure in which the damaged parts would repair automatically at different biological levels.

- It deals with three level of regeneration—molecular, cellular, and tissue level generations.
- Many of the therapies concerning this domain of healthcare are under research and development, though a few such works as stem cell therapy and other small therapies are under limited use in modern medication.
- A few major types of regenerative medicine therapies include:
  - Immunomodulation therapy and artificial organs developed in laboratories
  - Tissue engineering and biomaterial therapies by transplanting lab-generated tissues
  - Progenitor cell therapies for blood, bone marrow, fat, muscle cells and others.

The impact of regenerative medicine powered by 3D printing and many other futuristic technologies will be very high on the life expectancy, immortality (If at all, in any form—as imagined. In reality, impossible for human beings as they are created.), and other factors that are not in control of the humans nowadays.

Digital Twin (DT) Technology

Digital Twin, precisely known as DT, is a concept of a new technology in which the physical object, assets, or even a process is presented into a virtual world through software program. This technology helps the industries save the prototyping cost and operational failures of products and processes significantly. There are three core components of digital twin technology that form a complete framework of digital twin technology such as:

- Physical product or object
- Digital product or object
- Connection between physical and digital objects.

The connection is mostly the information or data that flows between them to simulate a physical product or a process to produce the data that can be analyzed and used to make decisions about the physical products or processes. The digital data flows from physical world—object or process—to the virtual world—simulated digital

environment. The processed and valuable information flows from the virtual environment to the physical environment for suitable decisions based on the information processes through the most cutting-edge technologies such as big data, artificial-intelligence-based software analytics, and other advanced tools as well as technologies.

There are certain types of this model-based designing technology that are mentioned in the following list:

- Digital twin prototype (DTP)
- Digital twin instance (DTI)
- Digital twin aggregate (DTA).

Moreover, in terms of integration levels, the digital twin technology can be further categorized into the following types:

- Digital model (DM)
- Digital twin (DT)
- Digital shadow (DS).

The other main characteristic and features of digital twin technology are summarized in the following list [272]:

- The core characteristics of this technology is the connectivity between multiple physical entities, which may be the processes, functions, physical objects, and others with the help of a range of sensors that send data to the virtual environment. The virtual environment provides access to the concerned entities to get the suitable information received after collection of data that is processed through the integrated software.
- It allows the homogenization of data and information under a unified ecosystem.
- This is highly programmable and smart environment in which the model can easily be modified and corrected with the help of software program modification.
- Digital twin technology provides you with the detailed digital traces of the events and activities so that you can easily trace the events and reasons of any kinds of malfunctioning in the physical environment with complete details.
- It is known for its modularity characteristics in which this technology fully supports the modular designs of the products and processes.

Thus, it is much easier to scale up, scale down, modify, and perform other processes.
- It uses different stack of technologies such as 3D modeling, Internet of Things (IoT), virtual reality (VR), augment reality (AR), and many others.
- This technology can be used in future planning of the cities and towns, development of smart cities, industrial manufacturing, construction industry, automobile, healthcare, and many other industries.
- The concept of digital twin technology was introduced publically in 2002 by Michael Grieves.

The advancement of this technology will be very useful for virtualization of a range of processes and physical objects in the future to change the shape of the industries significantly.

Programmable Living Robots

Programmable living robot is a concept in which an artificial robot will be formed from organic material that can perform different activities as programmed in it. It can be like a human, or any other living thing that is under control of programmed software applications that would instruct the machine to perform certain functions and activities. This concept is still a fictitious one but a great breakthrough was achieved in 2020 when a self-replicating robot was made from stem cells taken from the embryo and heart of clawed African frog. The newly created robot is named as Xenobot due the origin of the robot from the clawed frog of Africa whose biological name is Xenopus Laevis [273, 274].

This development is being considered as the way to creating living robots based on the software program that may function like a living thing under the control of software program. The creation of programmable living robots is the conceptual advancement of regenerative medicine and mind uploading concepts. The combination of both concepts will bring revolution in scientific world and will transform the entire world into a new world with majority of the processes, activities, thoughts, and concepts drastically changed.

The other main characteristics, features, and capabilities of modern discovery of Xenobot self-replicating robot include:

- It was made from organic tissues under the supervision of AI program
- The newly created robot can live for weeks without any food
- It can move and swim in the given environment, which can be programmed as per requirements in the field of medicines or any other applications
- The programmable living robot can collect different stem cells to replicate its body and characteristics, which is an amazing thing of this robot
- These robots can be programmed to carry out numerous activities in human medicine such as programming cancer cells, cleansing of clogged arteries, repairing of birth defects, and regeneration of tissues after any kinds of trauma
- The replication of Xenobot was based on the kinematic self-replication, which is one of the concepts proposed by mathematician John Neumann in 1940.

The advancement of programmable living robot technology will open up new arena for a range of industries to use it in transforming numerous processes, activities, functions and even capabilities of existing objects and things.

Human Augmentation

Human augmentation is a new concept of technology stack that can enhance the natural limits of human capabilities, efficiencies, and characteristics by implementing a range of techniques powered by many modern technologies such as [275]:

- Artificial intelligence
- Robotics
- Bionics and prosthesis
- Brain computer interfaces
- Genetic editing
- Nootropics.

The human augmentation technology is also referred to as Human 2.0 in certain domains. This new concept aims to revolutionize the world as well as change the entire humankind and many other living things. This concept has a goal to break numerous boundaries based on

religion, principles, ideologies, beliefs, and much more in the future. It is a fact that many such ideas are coined in the field but only few see the reality.

Intelligent Process Automation (IPA)

Process automation is an older concept prevailing in all industries and sectors of businesses. The automation started with the robotic or motorized automation in which a tasks-based activity was automated with the help of a motor or moving machine. With the passage of time, the programmable automation came into existence in which more complex activities were automated with the help of pre-programmed sets of instructions. There are four major types of automations used in the industries that are listed below [276]:

- Fixed automation or hard automation
- Programmable automation
- Flexible automation
- Integrated automation.

The intelligent process automation, precisely referred to as IPA, is an advanced version of automation that may fall in integrated automation but it is fully powered by the artificial intelligence and machine learning. This automation will work automatically by self-learning, understanding the condition, and making suitable decisions for actions. Thus, the intelligent process automation is highly advanced form of automation that has not yet been materialized at full scale in the commercial uses but research is going on to integrate the following technologies through software and hardware integration and deployment such as [277]:

- Machine learning (ML)
- Artificial intelligence (AI)
- Robotic Process Automation (RPA)
- Integrated software platforms.

In intelligent process automation, the robotic tools can be instructed flexibly through intelligent software applications that are trained for the environment to understand and make decisions and issue command to the robotic tools to act based on the decision that

intelligent software makes. With the materialization of intelligent process automation in all domains of industries, the industries will get fully transformed into a new shape.

Space Elevator

Space elevator is a science fictitious concept which describes that an elevator can be built between planets and space or between the planets. This space elevator will provide the means for transportation between space and planet. The main objective of this elevator concept can be the launching of satellites and other space missions through it at a very low cost. There are certain issues that the researchers are trying to solve. The most important one of them is the material that is able to withstand such a huge weight and counter weight. The latest research by a Google team is focusing on the carbon nanotube (CNT), which is the strongest material under development. The structure of this proposed space elevator would consist of the following parts [278]:

- Base station
- Cable
- Climber
- Powering climber
- Counter weight.

Once this technology is realized, a huge transformation in extra-terrestrial communication and other processes will take place.

Rotating Skyhook

Rotating skyhook is a physical concept of a rope that can list the objects from the earth to the space for transportation purposes. The concept emerged in the mid of the twentieth century. The latest idea is that there would be a long tether on one-side and a small tether for counter weight on the other side. The longer tether would be attached to a rotating strong satellite and dropped to the earth-side. The small tether would be directed to the space for providing counter weight. Any object that is supposed to travel to the space such as spacecraft is attached to the long tether and flung out of the earth's gravitation force to provide a very economical carrier for travelling to space through this structure [289].

This structure is just in the research phase now. There are numerous challenges and issues pertaining to tether material, physical principles, structure operational issues, and much more. Once this concept of building a rotating skyhook is developed, the space industry will be revolutionized and numerous opportunities and arena will open up.

Light Sail

Light sail is a method of propulsion for spacecraft, which has recently been realized in the propulsion of space crafts. This method is designed to use the radiation pressure exerted by the sunlight on a huge mirror. This method is also known with other names in the field such as photon sail and solar sail. Electric sail and magnetic sail are other proposed forms of propulsion for the spacecraft to be launched in the future.

The first experiment of the use of this technology was done in 2010 when IKAROS spacecraft used this method of propulsion for testing purposes. According to the physical principle, when solar light falls on the mirror, it exerts pressure, which can be used for propelling thrust for navigational objects in the space [280]. The main successful missions of this revolutionary spacecraft propulsion system include the following:

- LightSail 1 Launched Atlas V rocket
- LightSail 2 Mission by The Planetary Society.

Sample Questions and Answers

Q1. What will be impact of ICT on automobile and aerodynamic fields of engineering in the near future?
A1. If we look at the automobile and aerodynamic fields of engineering, the ICT is drastically changing the way they work even at the present time. For instance, the most complex and technology-oriented processes in the manufacturing of automobiles or vehicles is the

designing and prototyping of the vehicles. The designing and prototyping of the car models, and their parts is being extensively done in the virtual environments powered by computer software and virtual reality (VR) environments today. Hence, we can expect what will happen after a few years or decades when almost all manufacturing processes will be automated and integrated into one operations room powered by the modern computer and information technologies (i.e., ICT's involvement will increase manifold).

Q2. What is 4D Printing?
A2. Four dimensional printing, precisely referred to as 4D printing, is an extended version or form of 3D printing, which is capable of printing a 3D object that can be morphed with the help of light, temperature, stress or other influencers with the passage of time. In other words, a 3D object printed through 3D printing technique can change its shape in a predictable manner controlled by the computer software program. The program exposes the 3D objects to different things such as temperature, water, air, electric current, magnetic energy, or any other source to achieve the desired impact on the three dimensionally printed objects.

Q3. What is the key concept of mind uploading?
A3. Mind uploading is a very futuristic and fictitious concept in the field of artificial intelligence (AI) and information technology (IT) that can transform the way people live not only on the earth but in some other parts of the universe too. The proposers of the idea of mind uploading believe that this process can be achieved by the mid of the twenty-first century when the artificial super intelligence or singularity will hit the markets.

Q4. Define Digital Twin.
A4. Digital Twin, precisely known as DT, is a concept of a new technology in which the physical object, assets, or even a process is presented into a virtual world through software program. This technology helps the industries save the prototyping cost and operational failures of products and processes significantly. There are three core components of digital twin technology that form a complete framework of digital twin technology such as:

- Physical product or object
- Digital product or object
- Connection between physical and digital objects.

Q5. What is Space elevator? What is the main objective of this?
A5. Space elevator is a science fictitious concept which describes that an elevator can be built between planets and space or between the planets. This space elevator will provide the means for transportation between space and planet. The main objective of this elevator concept can be the launching of satellites and other space missions through it at a very low cost.

Test Questions

1.
   How can Futuristic Technology be defined?

2.
   Which are the top Futuristic Technologies?

3.
   How did 3D printing begin?

4.
   What are the applications of 3D printing?

5.
   In what ways does 6G technology differ from other technologies?

6.
   What is the need for 6G technology?

7.
   What is a data center?

8.
   What is an autonomous robot?

9.
   What are autonomous mobile robots (AMRs)?

10.
    In what sense are Artificial Neurons useful?

11.
    What are AGI and ASI?

12.
    Why is Digital Twin (DT) technology Important?