Chapter seven (7) : Other emerging technologies

The main points to be addressed under these chapter are:-

- ✓ Nanotechnology
- ✓ Biotechnology
- ✓ Block-chain technology
- ✓ Cloud and quantum computing
- ✓ Autonomic computing (AC)
- ✓ Computer vision
- ✓ Embedded systems
- ✓ Cybersecurity and Additive manufacturing (3D Printing)

Nanotechnology

- It is science, engineering, and technology conducted at the nanoscale, which is about 1 to 100 nanometers.
- Nanoscience and nanotechnology are the study and application of extremely small things.
- They can be used across all the other science fields, such as chemistry, biology, physics, materials science, and engineering.
- The ideas and concepts behind nanoscience and nanotechnology started by physicist Richard Feynman at an American Physical Society during December 29, 1959, long before the term nanotechnology was used.

cont. ..

- Over a decade later,the term nanotechnology coined by Professor Norio Taniguchi while his explorations of ultraprecision machining.
- It’s hard to imagine just how small nanotechnology is.
- One nanometer is a billionth of a meter or 10-9 of meters.
- Here are a few illustrative examples:
  - There are 25,400,000 nanometers in an inch
  - A sheet of newspaper is about 100,000 nanometers thick

cont. ..

- Nanoscience and nanotechnology involve the ability to see and to control individual atoms and molecules. Everything on Earth is made up of atoms.
- Nanoscience can defined as the study of phenomena and manipulation of materials at atomic, molecular and macromolecular scales, where properties differ significantly from those at a larger scale.
- Nanotechnologies defined as the design, characterization, production, and application of structures, devices, and systems by controlling shape and size at the nanometer scale.

cont

- The properties of materials can be different at the nanoscale for two main reasons.

i. Nanomaterials have a relatively larger surface area when compared to the same mass of material produced in a larger form. Which can make materials more chemically reactive and affect their strength or electrical properties.

ii. Quantum effects can begin to dominate the behavior of matter at the nanoscale particularly at the lower end which affecting the optical, electrical and magnetic behavior of materials.

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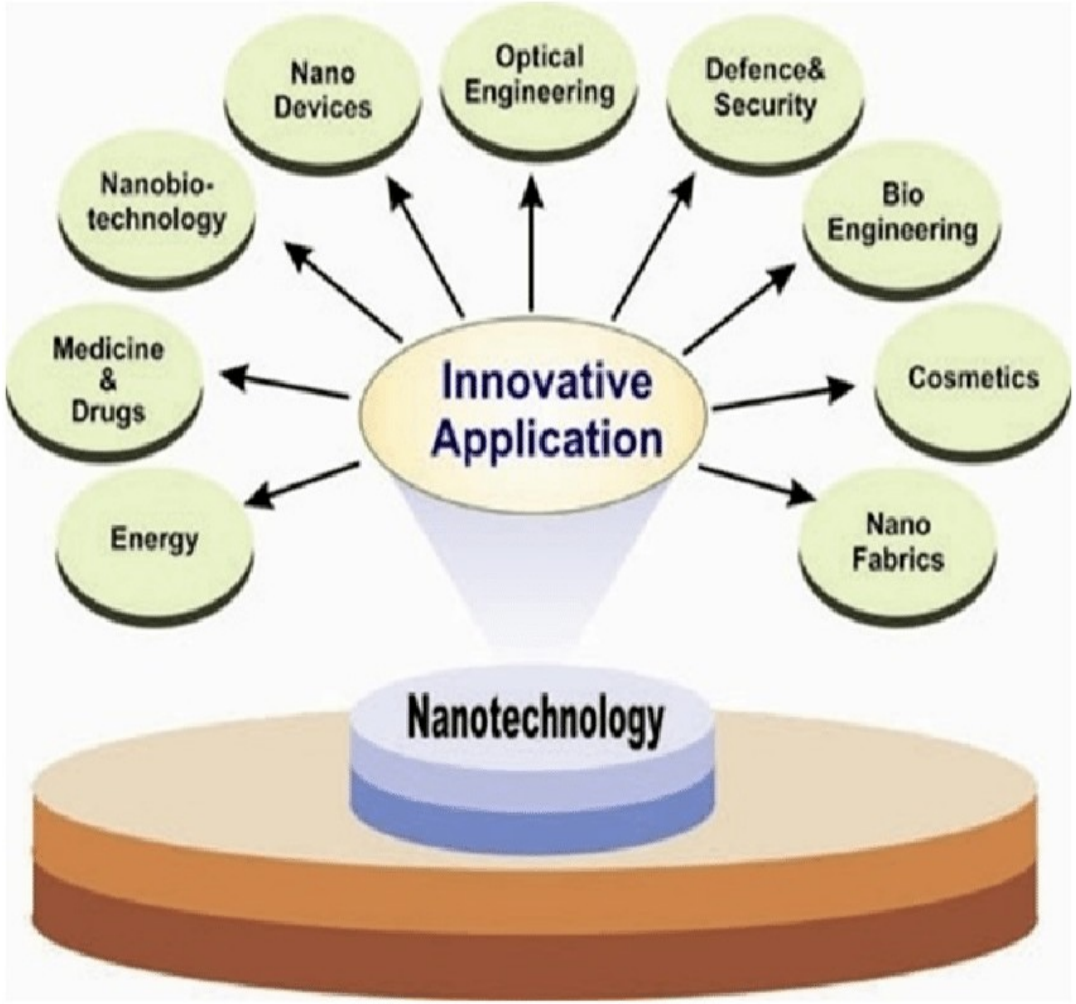


Applications of Nanotechnology

Textile/fabrics/non-wovens	Energy	Cosmetics
• surface-processed textiles • smart clothes	• fuel cells • solar cells • batteries • capacitors	• sun protection • lipsticks • skin creams • tooth paste
Food and drinks	**Household**	**Sports /outdoor**
• package materials • storage life sensors • additives • clarification of fruit juices	• ceramic coatings for irons • odors catalyst • cleaner for glass, ceramic, floor, windows	• ski wax • antifogging of glasses/goggles • antifouling coatings for ships/boats • reinforced tennis rackets and balls

Table 5: Overview on applications of nanomaterial based products in different areas

Biotechnology

- It is technology based on biology - biotechnology harnesses cellular and biomolecular processes to develop technologies and products that help improve our lives and the health of our planet.
- Brewing and baking bread are examples of processes that fall within the concept of biotechnology which is the traditionalone.
- One example of modern biotechnology is genetic engineering (the process of transferring individual genes between organisms or modifying the genes in an organism to remove or add a desired trait or characteristic.)
- Biotechnology covers many different disciplines (genetics, biochemistry, molecular biology, Medicine, agriculture, industrial etc.)

cont. ..

Application of biotechnology

- ✓ Agriculture (Green Biotechnology):- contributed a lot to modify the genes of the organism known as Genetically Modified Organisms such as Crops, Animals, Plants, Fungi, Bacteria, etc.
- ✓ Medicine (Medicinal Biotechnology):- helps in the formation of genetically modified insulin known as humulin and also in treatment of a large number of diabetes patients. It also given rise to a technique known as gene therapy
- ✓ Aquaculture Fisheries:- improving the quality and quantity of fishes. They breed them selfs by gonadotropin-releasing hormone.
- ✓ Environment (Environmental biotechnology):- used in waste treatment and pollution prevention.

Blockchain technology

- Originally blockchain is a growing list of records, called blocks, that are linked using cryptography.
- Each block contains a cryptography hash of the previous block, a timestamp, and transaction data (generally represented as a Merkle tree).
- Blockchain is a time-stamped series of immutable records of data that is managed by a cluster of computers not owned by any single entity.
- . Each of these blocks of data (i.e. block) is secured and bound to each other using cryptographic principles (i.e. chain).

cont. ..

- “Blocks” on the blockchain are made up of digital pieces of information. Specifically, they have three parts:

i. Blocks store information about transactions like the date, time, and dollar amount.

ii. Blocks store information about who is participating in transactions.

iii. Blocks store information that distinguishes them from other blocks.

- When a block stores new data it is added to the blockchain.
- Blockchain, as its name suggests, consists of multiple blocks strung together.

cont. ..

- In order for a block to be added to the blockchain, however, four things must happen:

i. A transaction must occur.

ii. That transaction must be verified.

iii. That transaction must be stored in a block.

iv. That block must be given a hash.:- once all of a block’s transactions have been verified, it must be given a unique, identifying code called a hash. Once hashed, the block can be added to the blockchain

cont. ..

- By design, a blockchain is resistant to modification of the data.
- It is "an open, distributed ledger that can record transactions between two parties efficiently and in a verifiable and permanent way".
- The blockchain network has no central authority; it is the very definition of a democratized system. Since it is a shared and immutable ledger, the information in it is open for anyone and everyone to see.

❖Assginment : Discuss the History of Blockchain in details?

cont. ..

- A blockchain carries no transaction cost but it carries the infrastructure cost.
- The blockchain is a simple yet ingenious way of passing information from A to B in a fully automated and safe manner. The main activities performed are:-
  - ✓ One party to a transaction initiates the process by creating a block.
  - ✓ This block is verified by thousands, perhaps millions of computers distributed around the net.
  - ✓ The verified block is added to a chain, which is stored across the net, creating not just a unique record, but a unique record with a unique history.
- Falsifying a single record would mean falsifying the entire chain in millions of instances.

cont. ..

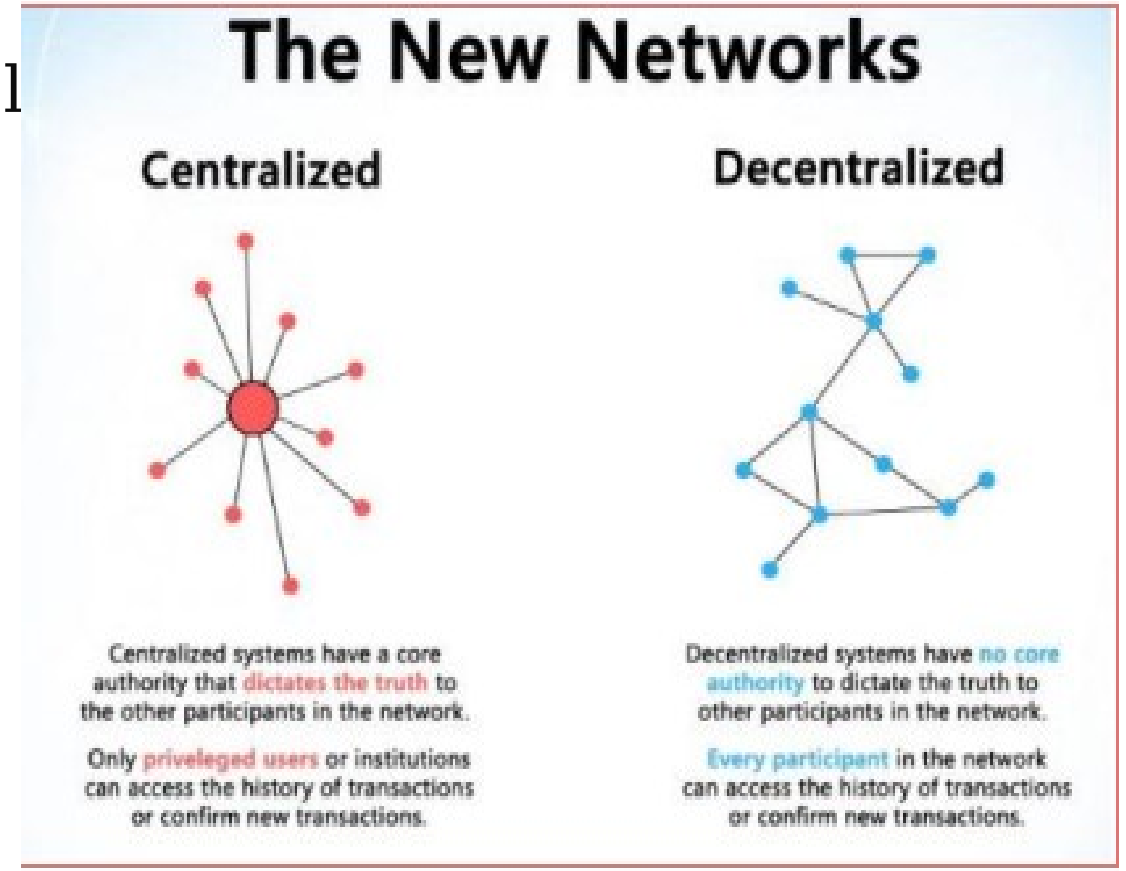
Three Pillars of Blockchain

Technology

- The three main properties of Bl

i. Decentralization :-

- ✓ The information is not stored by one single entity
- ✓ Everyone in the network owns the information
- ✓ if you wanted to interact with your friend then you can do so directly without going through a third party.
- ✓ That was the main ideology behind Bitcoins.



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ii. Transparency:- is hiddeing person's identity via complex cryptography and represented only by their public address. So, if you were to look up a person's transaction history, you will not see "Bob sent 1 BTC" instead you will see "1MF1bhsFLkBzzz9vpFYEmvwT2TbyCt7NZJ sent 1 BTC". while the person's real identity is secure, you will still see all the transactions that were done by their public address

iii. Immutability:- means that once something has been entered into the blockchain, it cannot be tampered with. The reason why the blockchain gets this property is that of the cryptographic hash function. **hashing** means taking an input string of any length and giving out an output of a fixed length by using hashing algorithm (Bitcoin uses SHA-256).

cont.

- No matter how big or small your input is, the output will always have a fixed 256-bits length. Concider the following example.

INPUT	HASH
Hi	3639EFCD08ABB273B1619E82E78C29A7DF02C1051B1820E99FC395DCAA3326B8
Welcome to blockgeeks. Glad to have you here.	53A53FC9E2A03F9B6E66D84BA701574CD9CF5F01FB498C41731881BCDC68A7C8

- This becomes critical when you are dealing with a huge amount of data and transactions. So instead of remembering the input data which could be huge, you can just remember the hash and keep track.

cont. ..

How Blockchain Works

- Picture a spreadsheet that is duplicated thousands of times across a network of computers.
- Then imagine that this network is designed to regularly update this spreadsheet and you have a basic understanding of the blockchain.
- Information held on a blockchain exists as a shared and continually reconciled database. The blockchain database isn’t stored in any single location, meaning the records it keeps are truly public and easily verifiable. No centralized version of this information exists for a hacker to corrupt.

cont. ..

- The reason why the blockchain has gained so much admiration is that:

✓ It is not owned by a single entity, hence it is decentralized

✓ The data is cryptographically stored inside

✓ The blockchain is immutable, so no one can tamper with the data that is inside the blockchain

✓ The blockchain is transparent so one can track the data if they want.

cont. ..

<u>Why do people use the peer-to-peer network?</u>

- One of the main uses of the peer-to-peer network is file sharing, also called torrenting.If you are to use a client-server model for downloading, then it is usually extremely slow and entirely dependent on the health of the server. Plus, as we said, it is prone to censorship.
- In a peer-to-peer system, there is no central authority, and hence if even one of the peers in the network goes out of the race, you still have more peers to download from.
- It is not subject to the idealistic standards of a central system.

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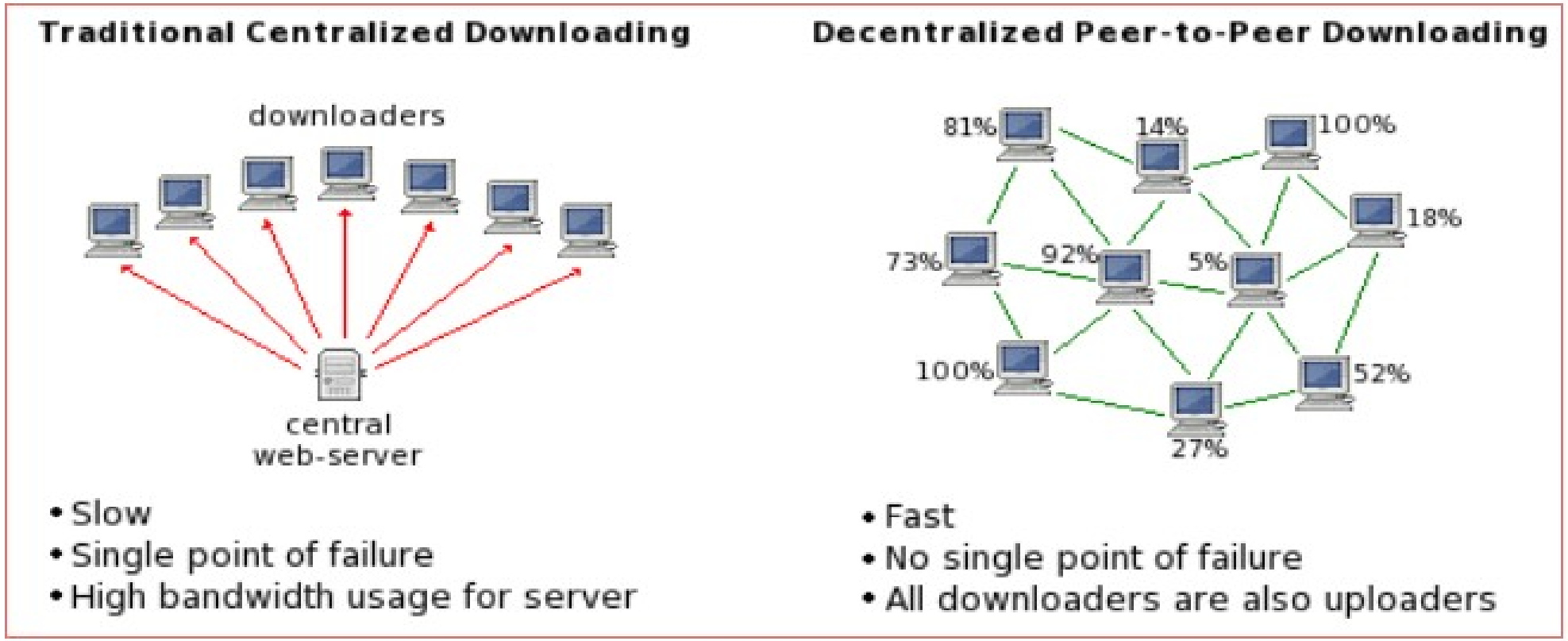
- Comparison between Traditional Centralized Downloading and Decentralized Peer-to-Peer Downloading.



Application of blockchain

- Some of the application areas of blockchain are:-

✓ In the sharing economy

✓ Crowdfunding

✓ Governance

✓ Supply chain auditing

✓ File storage

Cloud and quantum computing

- Cloud computing :- is a means of networking remote servers that are hosted on the Internet. Rather than storing and processing data on a local server, or a PC's hard drive, one of the following three types of cloud infrastructure is used.

i. public cloud:- Here a third-party provider manages the servers, applications, and storage much like a public utility. Anyone can subscribe to the provider’s cloud service, which is usually operated through their own data center.

ii. private cloud:- which is typically used by a business or organization.

iii. hybrid cloud:- Here private clouds are connected to public clouds, allowing data and applications to be shared between them. It includes multiple service providers .

cont. ..

- a hybrid offers a business more flexibility and more computing capacity for a business application when the need for its spikes.
- Hybrids also enable applications to keep sensitive client data in a private cloud but connect to end-user software in a public cloud.
- Cloud computing services can focus on infrastructure, web development or a cloud-based app.
- . Infrastructure as a Service (IaaS) gives you management of the whole deal: servers, web development tools, applications.
- Platform as a Service (PaaS) offers a complete web development environment, without the worry of the hardware that runs it.

cont. ..

- Finally, Software as a Service (SaaS) allows access to cloud-based apps, usually through a web browser interface.
- It's only in the last 10 years (around since 2000.) that major players like IBM, Amazon, and Google have offered commercially viable, high-capacity networks.

Advantages of cloud computing

- ✓ **Cheap computing power.**
- ✓ **Cloud providers have vast resources of computing power at their fingertips.**
- ✓ **Allows you and multiple users to access your data from any location**
- ✓ **A business processes its data more efficiently, increasing productivity.**
- ✓ **Maintenance is much cheaper, often free, so reliability is rarely a worry.**
- ✓ **Allows CEOs to focus on running their business.**

Quantum computing

- Quantum computers truly do represent the next generation of computing.
- Unlike classic computers, they derive their computing power by harnessing the power of quantum physics.
- Give clients access to a quantum computer over the internet, and you have quantum cloud computing.
- Currently, the only organization which provides a quantum computer in the cloud is IBM. They allow free access to anyone who wishes to use their 5-qubit machine. Qubit is short for a sequence of quantum bits.
- With a quantum computer, the data is stored in qubits.

cont. ..

- Thanks to the mechanics of quantum physics, where subatomic particles obey their own laws, a qubit can exist in two states at the same time. This phenomenon is called superposition. So, a qubit can have a value of 1, 0, or some value between.
- Quantum computer theory was first rooted in the 1980s and only now are the first rudimentary machines being constructed.
- Quantum computing could help in the discovery of new drugs, by unlocking the complex structure of chemical molecules. Other uses include financial trading, risk management, and supply chain optimization.

Autonomic computing (AC)

- Autonomic computing (AC) is an approach to address the complexity and evolution problems in software systems.
- It is a self-managing computing model named after, and patterned on, the human body's autonomic nervous system.
- An autonomic computing system would control the functioning of computer applications and systems without input from the user, in the same way, that the autonomic nervous system regulates body systems without conscious input from the individual.
- The goal of autonomic computing is to create systems that run themselves, capable of high-level functioning while keeping the system's complexity invisible to the user.

Characteristics of Autonomic Systems

- Self-Awareness: An autonomic application/system “knows itself” and is aware of its state and its behaviors.
- Self-Configuring: An autonomic application/system should be able to configure and reconfigure itself under varying and unpredictable conditions.
- Self-Optimizing: An autonomic application/system should be able to detect suboptimal behaviors and optimize itself to improve its execution.
- Self-Healing: An autonomic application/system should be able to detect and recover from potential problems and continue to function smoothly.
- Self-Protecting: An autonomic application/system should be capable of detecting and protecting its resources from both internal and external attacks and maintaining overall system security and integrity.

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- Context-Aware: An autonomic application/system should be aware of its execution environment and be able to react to changes in the environment.
- Open: An autonomic application/system must function in a heterogeneous world and should be portable across multiple hardware and software architectures. Consequently, it must be built on standard and open protocols and interfaces.
- Anticipatory: An autonomic application/system should be able to anticipate to the extent possible, its needs and behaviors and

Computer vision

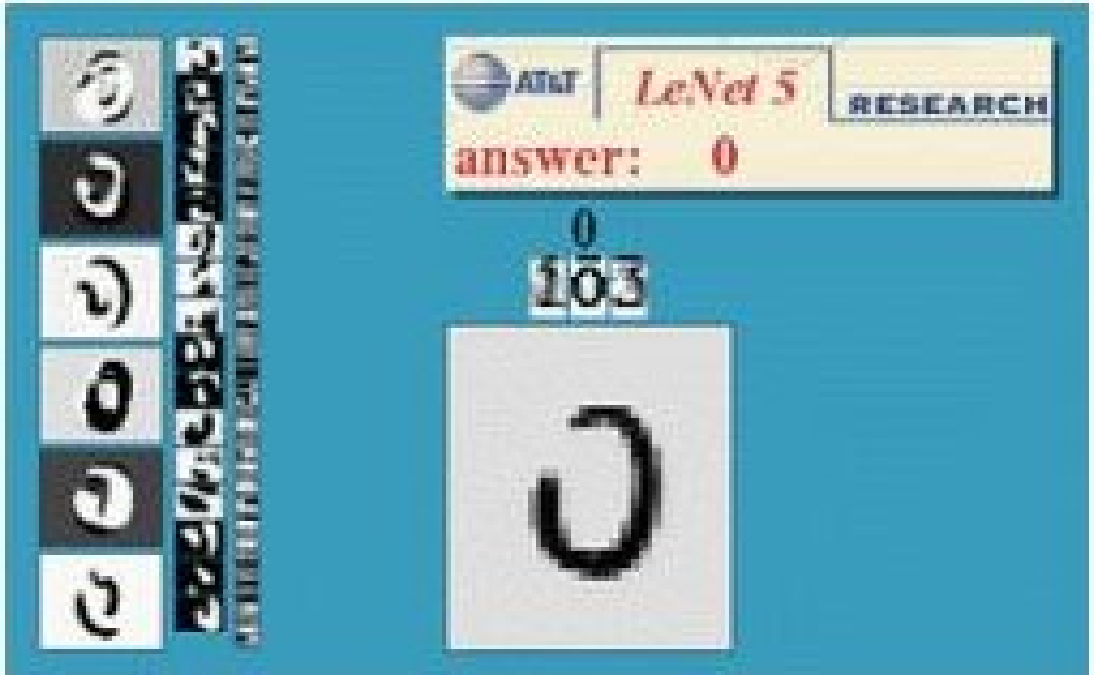
- It is an interdisciplinary scientific field that deals with how computers can be made to gain a highlevel understanding of digital images or videos. From the perspective of engineering, it seeks to automate tasks that the human visual system can do.
- Computer vision tasks include methods for acquiring, processing, analyzing and understanding digital images, and extraction of high-dimensional data from the real world in order to produce numerical or symbolic information, e.g. in the forms of decisions.
- Computer vision is building algorithms that can understand the content of images and use it for other applications.

How computer vision works

1. Acquiring an image: Images, even large sets, can be acquired in real-time through video, photos or 3D technology for analysis.
2. Processing the image: Deep learning models automate much of this process, but the models are often trained by first being fed thousands of labeled or pre-identified images.
3. Understanding the image: The final step is the interpretative step, where an object is identified or classified

Applications of computer vision

- Optical character recognition (OCR): reading handwritten postal codes on letters and automatic number plate recognition (ANPR);



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- Machine inspection: rapid parts inspection for quality assurance using stereo vision with specialized illumination to measure tolerances on aircraft wings or auto body parts or looking for defects in steel castings using X-ray vision;

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- Retail: object recognition for automated checkout lanes.

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- Medical imaging: registering pre-operative and intra-operative imagery or performing long-term studies of people's brain morphology as they age:

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- Automotive safety: detecting unexpected obstacles such as pedestrians on the street, under conditions where active vision techniques su

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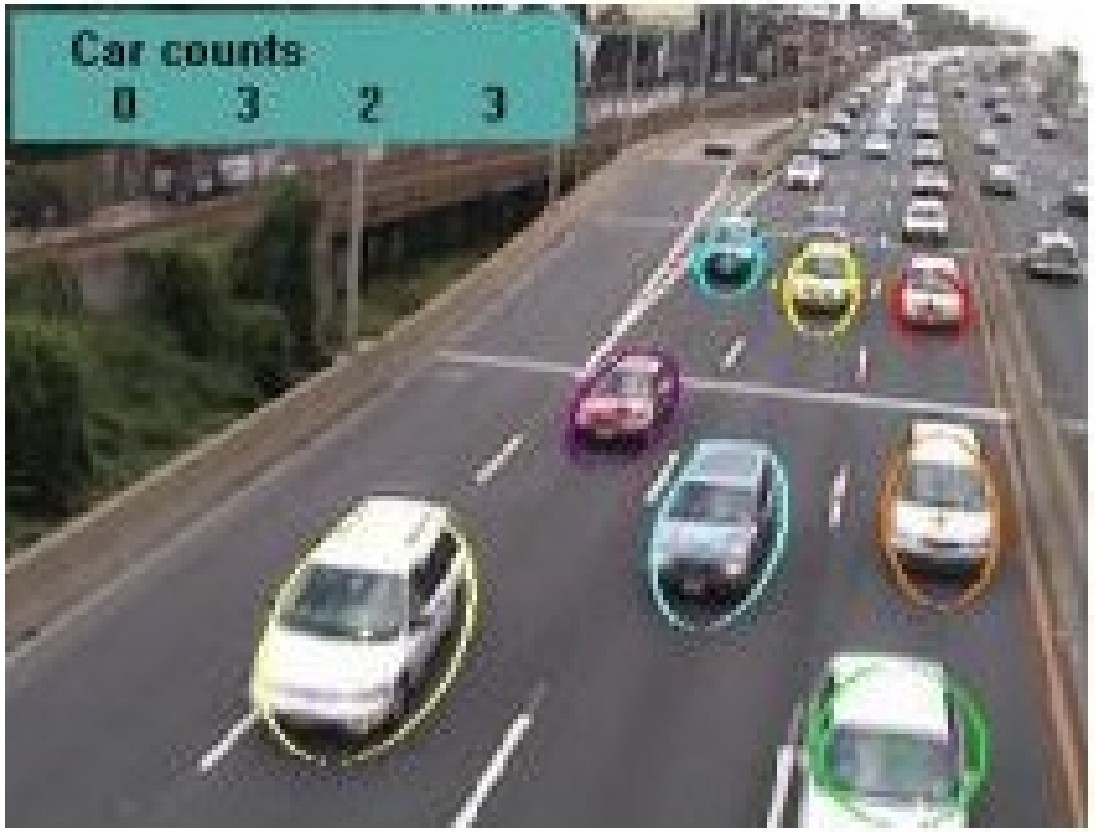
- Surveillance: monitoring for intruders, analyzing highway traffic and monitoring pools for drowning victims;



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- Fingerprint recognition and biometrics: for automatic access authentication as well as forensic applications.

Embedded systems

- It is a controller with a dedicated function within a larger mechanical or electrical system, often with real-time computing constraints.
- It is embedded as part of a complete device often including hardware and mechanical parts.
- Embedded systems control many devices in common use today.
- Ninety-eight percent of all microprocessors manufactured are used in embedded systems.

Advantages and disadvantages of embedded system

- Advantages of Embedded
  - Easily Customizable
  - Low power consumption
  - Low cost
  - Enhanced performance
- Disadvantages of Embedded systems
  - High development effort
  - Larger time to market

Basic Structure of an Embedded System

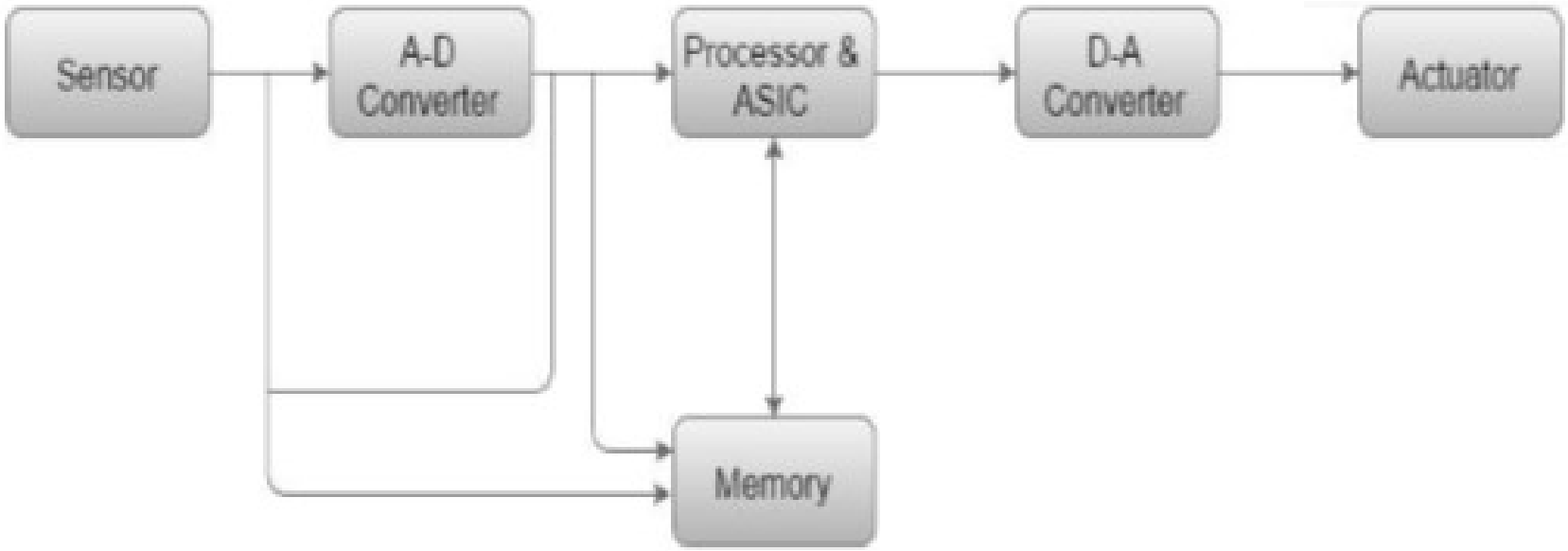

Fig ….Basic structure of an embedded system

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- Sensor − It measures the physical quantity and converts it to an electrical signal which can be read by an observer or by any electronic instrument like an A2D converter.
- A-D Converter − An analog-to-digital converter converts the analog signal sent by the sensor into a digital signal.
- Processor & ASICs − Processors process the data to measure the output and store it to the memory.
- D-A Converter − A digital-to-analog converter converts the digital data fed by the processor to analog data.
- Actuator − An actuator compares the output given by the D-A Converter to the actual (expected) output stored in it and stores the approved output.

Cybersecurity

- It is the protection of computer systems from the theft of or damage to their hardware, software, or electronic data, as well as from the disruption or misdirection of the services they provide.
- Cybersecurity is often confused with information security but it focuses on protecting computer systems from unauthorized access or being otherwise damaged or made inaccessible.
- The term cybercrime is used to describe an unlawful activity in which computer or computing devices such as smartphones, tablets, Personal Digital Assistants (PDAs), etc.

Cybersecurity measures

- Staff awareness training
- Application security
- Network security
- Leadership commitment.
- Password management

Types of cybersecurity threats

- Ransomware: - It is a type of malicious software. It is designed to extort money by blocking access to files or the computer system until the ransom is paid. Paying the ransom does not guarantee that the files will be recovered or the system restored.
- Malware:- itis a type of software designed to gain unauthorized access or to cause damage to a computer.
- Social engineering: - it is a tactic that adversaries use to trick you into revealing sensitive information. They can solicit a monetary payment or gain access to your confidential data.

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- Phishing: - it is the practice of sending fraudulent emails that resemble emails from reputable sources. The aim is to steal sensitive data like credit card numbers and login information. It’s the most common type of cyber-attack.
  - You can help protect yourself through education or a technology solution that filters malicious emails.

Benefits of cybersecurity

- Business protection against malware, ransomware, phishing, and social engineering.
- Protection for data and networks.
- Prevention of unauthorized users.
- Improves recovery time after a breach.
- Protection for end-users.
- Improved confidence in the product for both developers and customers.

Cybersecurity vendors

- Vendors in cybersecurity fields will typically use endpoint, network and advanced threat protection security as well as data loss prevention.
- Three commonly known cybersecurity vendors include
  - Cisco
  - McAfee
  - and Trend Micro

Additive manufacturing (3D Printing)

- The American Society for Testing and Materials (ASTM)-“Additive manufacturing, also known as 3D printing, uses computer-aided design to build objects layer by layer.”
- Wikipedia- “Today, the precision, repeatability, and material range has increased to the point that 3D printing is considered as industrial production technology, with the name of additive manufacturing.”
- Author Deve Turbide puts it simply, suggesting that additive manufacturing is “the industrial version of 3D printing”

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- **What’s the difference between 3D printing and Additive Manufacturing ?**
  - Actually, 3D printing and Additive Manufacturing are synonyms. There is no difference between 3D printing and Additive Manufacturing, as those terms both designate the process of creating an object by addition of material.
  - They are referring to the exact same processes: layer based manufacturing techniques. These appellations can be used interchangeably.

3D Printing

- It is often associated with filament-based plastic printers, which are the pride and joy of many a hobbyist and selfdescribed maker. But there are also binder jet printers, laser metal 3D printers, as well as glass and clay 3D printers

Additive Manufacturing

- “Additive manufacturing” (AM) is a big-picture term more at home in the boardroom than the factory floor or garage.
- It is less about the 3D printer itself, and more about the manufacturing process transformed by 3D printing.
- Additive manufacturing (AM) describes types of advanced manufacturing that are used to create three-dimensional structures out of plastics, metals, polymers and other materials that can be sprayed through a nozzle or aggregated in a vat.