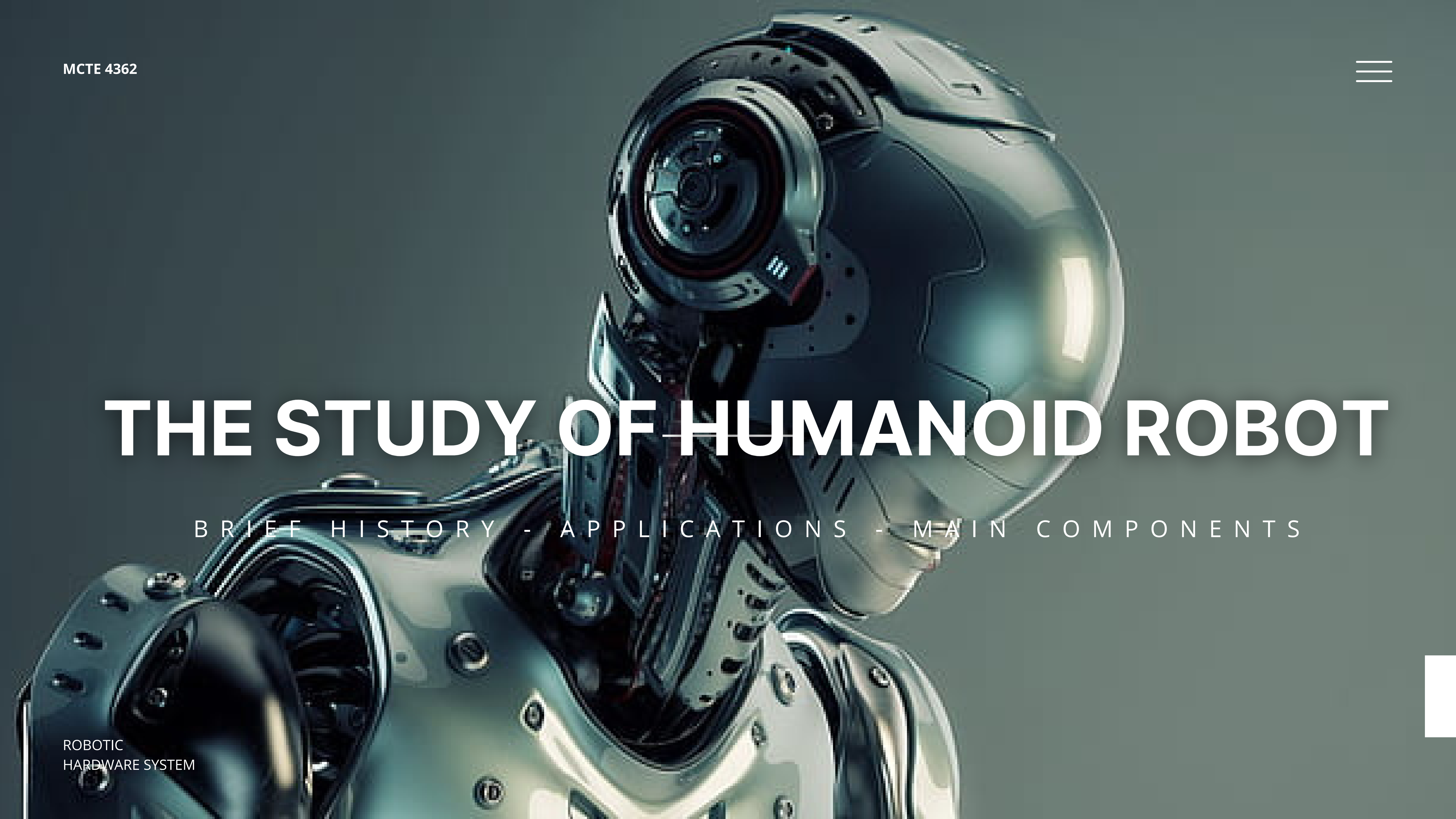


MCTE 4362

THE STUDY OF HUMANOID ROBOT

BRIEF HISTORY - APPLICATIONS - MAIN COMPONENTS

ROBOTIC
HARDWARE SYSTEM

WHAT IS HUMANOID ROBOT?

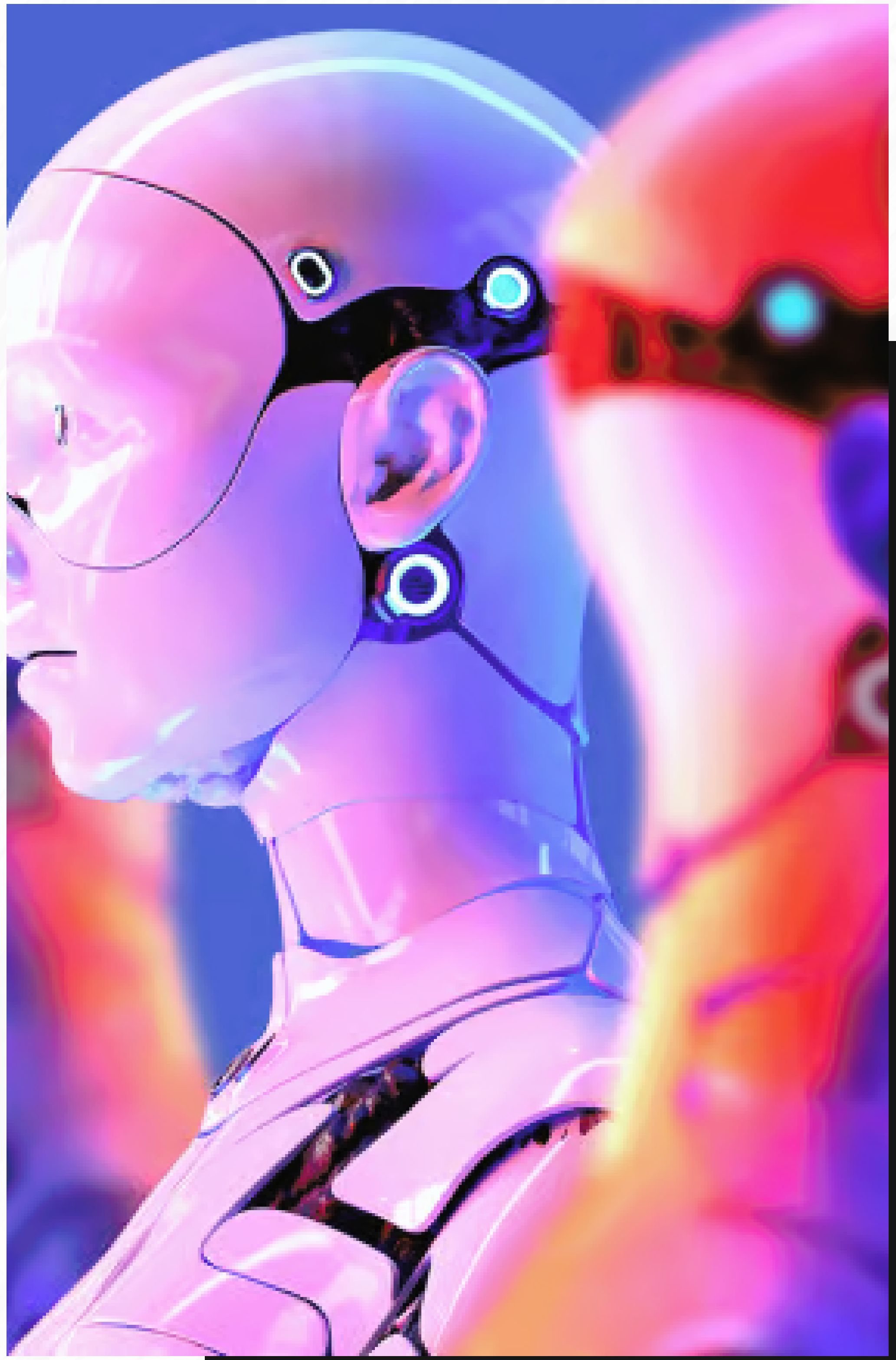
A humanoid robot is a type of robot that is designed to resemble the human body in terms of its physical appearance and capabilities. These robots typically have a head, torso, arms, and legs, and they aim to mimic human movements and behaviors to some extent. The goal of humanoid robotics is to create machines that can interact with humans and navigate human environments more effectively.

Humanoid robots often incorporate advanced sensors, actuators, and artificial intelligence algorithms to enable them to perceive and interpret their surroundings, make decisions, and carry out tasks. They may have cameras, microphones, touch sensors, and other sensors to gather information from the environment. Actuators such as motors and joints allow the robot to move its limbs and body in a manner similar to humans.

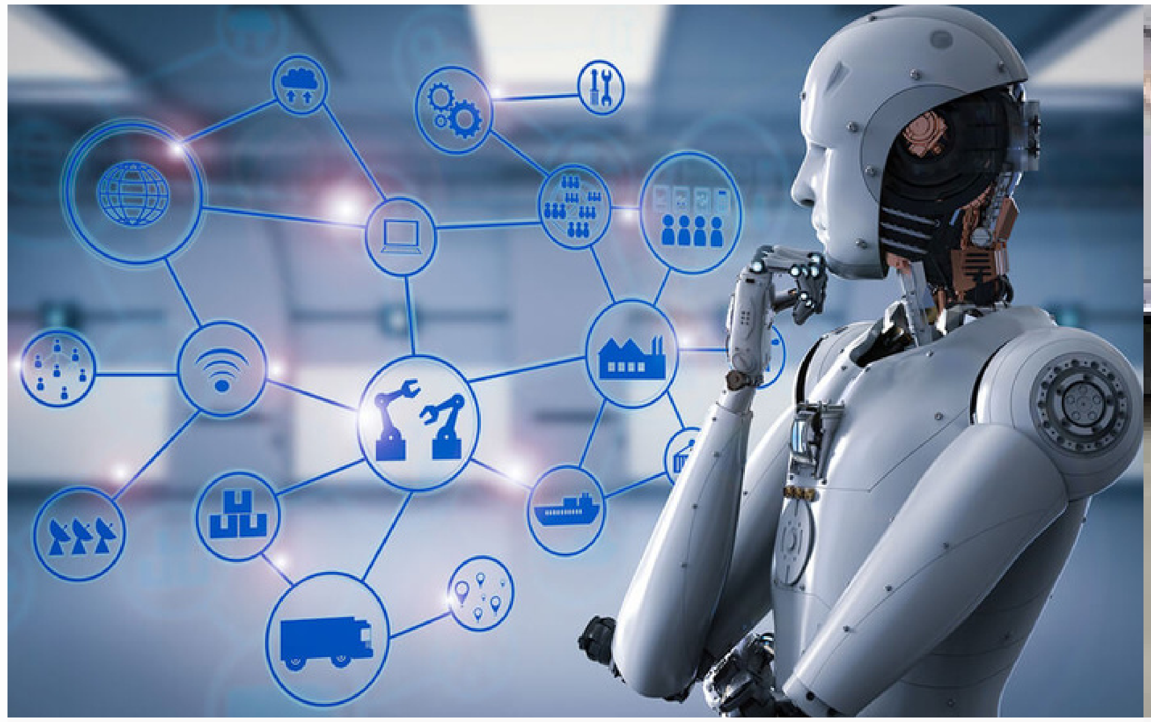
Humanoid robots can be used in various applications, including research, entertainment, education, healthcare, and assistance. They can perform tasks such as interacting with humans, navigating through complex environments, manipulating objects, and even providing companionship. While there have been significant advancements in humanoid robot technology, creating robots that perfectly replicate human abilities and appearance is still a challenging task.

BRIEF HISTORY OF HUMANOID ROBOT

1. Early Robotic Advancements: The 20th century brought significant advancements in robotics. In 1921, Czech writer Karel Čapek coined the term "robot" in his play "R.U.R. (Rossum's Universal Robots)." The word "robot" originated from the Czech word "robota," meaning forced labor. This play popularized the idea of humanoid robots in mainstream culture.
2. WABOT-1: In 1973, WABOT-1, developed by researchers at Waseda University in Japan, became one of the earliest functional humanoid robots. It could walk, grip objects, and even play simple melodies on a keyboard.
3. ASIMO: Honda's ASIMO, introduced in 2000, is one of the most recognizable humanoid robots to date. ASIMO showcased impressive capabilities, including walking, running, climbing stairs, recognizing objects, and interacting with humans.
4. Humanoid Robots in Research and Industry: Since the early 2000s, humanoid robots have gained prominence in research and industrial settings. Various projects and competitions, such as DARPA Robotics Challenge and RoboCup, have spurred advancements in humanoid robot technology, focusing on capabilities like mobility, dexterity, perception, and human-robot interaction.
5. Current Developments: Presently, humanoid robots continue to evolve. Advanced robotics companies, research institutions, and tech giants are investing in humanoid robotics, exploring areas such as social interaction, natural language processing, emotion recognition, and autonomous decision-making.



APPLICATIONS OF HUMANOID ROBOT



RESEARCH AND DEVELOPMENT

umanoid robots are valuable tools for scientific research. They can be used to study human locomotion, balance, and behavior, helping scientists better understand human anatomy and movement.

HEALTHCARE AND REHABILITATION

Humanoid robots have the potential to assist in healthcare settings. They can provide support to patients, assist with physical therapy exercises, and perform repetitive tasks.

ASSISTANCE FOR THE ELDERLY AND DISABLED

Humanoid robots can aid elderly individuals and those with disabilities by assisting with daily tasks, such as fetching items, opening doors, and operating appliances.

APPLICATIONS OF HUMANOID ROBOT

EDUCATION AND ENTERTAINMENT

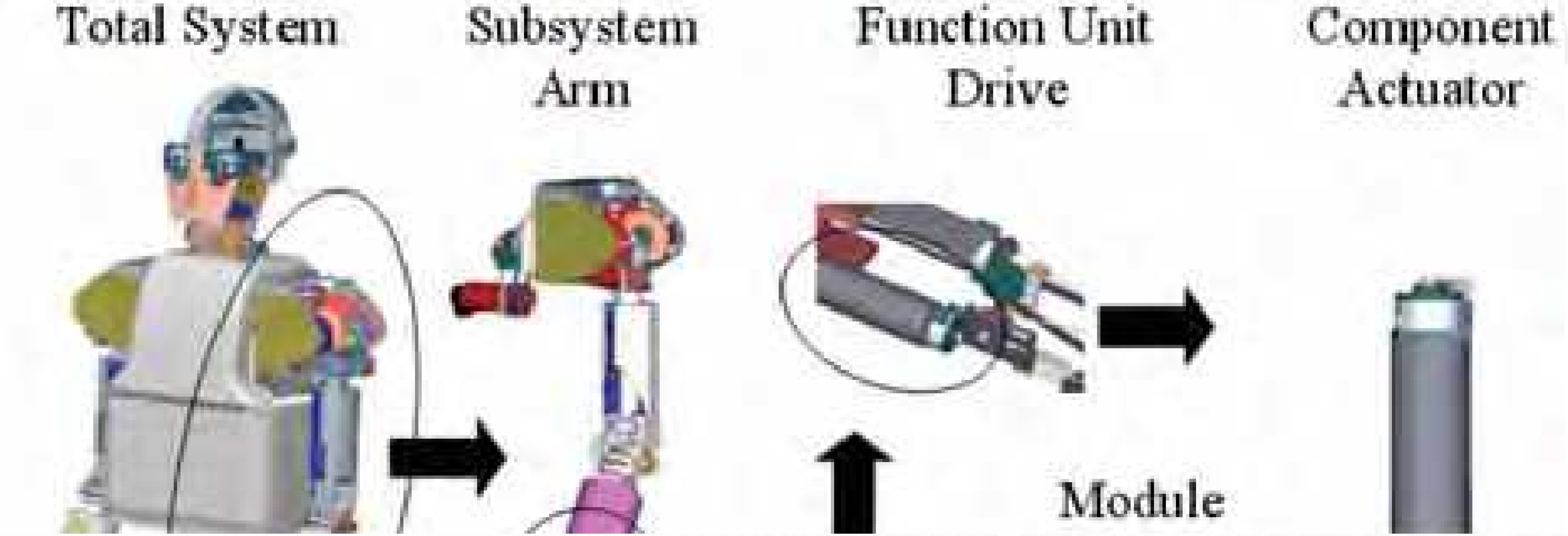
Humanoid robots can be used in educational settings to engage and teach students. They can deliver lessons, interact with children in a playful manner, and provide personalized tutoring.

CUSTOMER SERVICE AND HOSPITALITY

In sectors like hospitality and retail, humanoid robots can interact with customers, answer questions, provide directions, and assist with various services.

SOCIAL COMPANIONSHIP

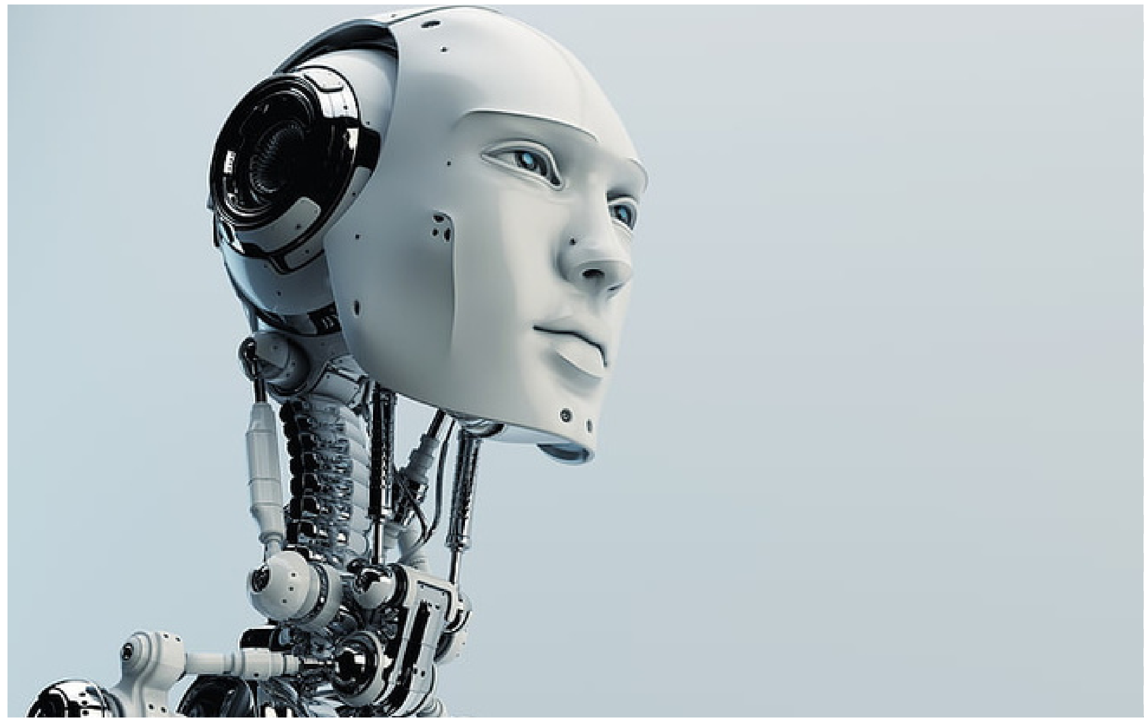
Humanoid robots designed for companionship can provide emotional support, entertainment, and social interaction for individuals who may be lonely or in need of companionship.

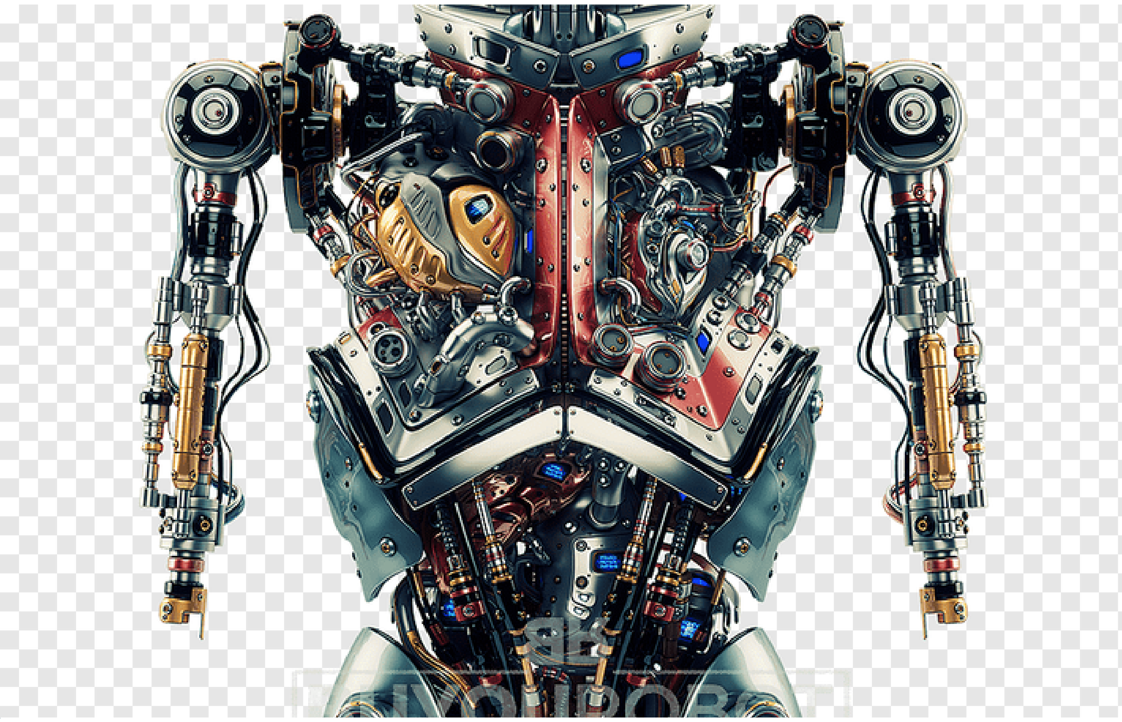


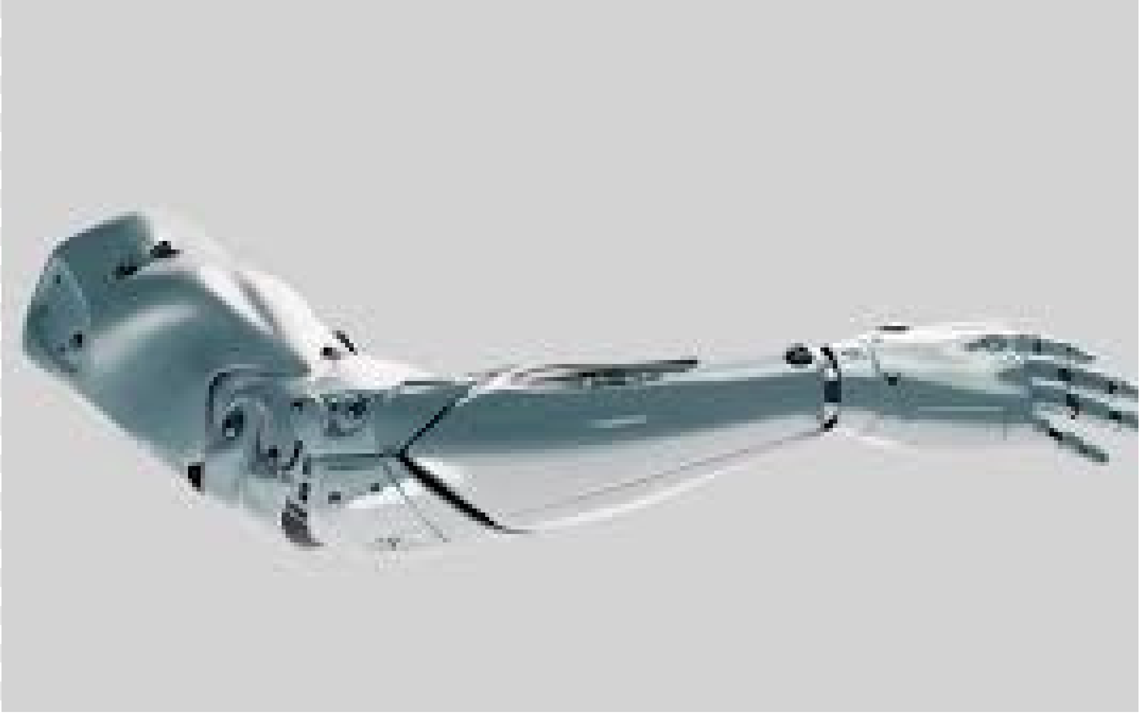
MAIN COMPONENTS OF HUMANOID ROBOT

FRAME

The frame design of humanoid robots is a balance between replicating human capabilities and achieving practical functionality for specific tasks. It aims to provide a structure that enables natural and efficient movements while accommodating the necessary sensors, actuators, and control systems. The overall goal is to create a robot that can interact with its environment and perform tasks in a manner similar to humans.







Head

The head usually contains sensors such as cameras, microphones, or depth sensors for perception and interaction with the environment. It may have articulated joints to allow for movements like nodding or turning.

Torso

The torso houses the main control system, which includes the robot's processing unit, power supply, and other electronic components. It often consists of interconnected segments that provide flexibility and allow for bending or twisting motions..

Arms

Humanoid robots typically have two arms, each consisting of an upper arm, forearm, and hand. The arms often have multiple joints that enable a wide range of movements, such as reaching, grasping, and manipulating objects. The hands may include fingers or grippers for fine motor control..

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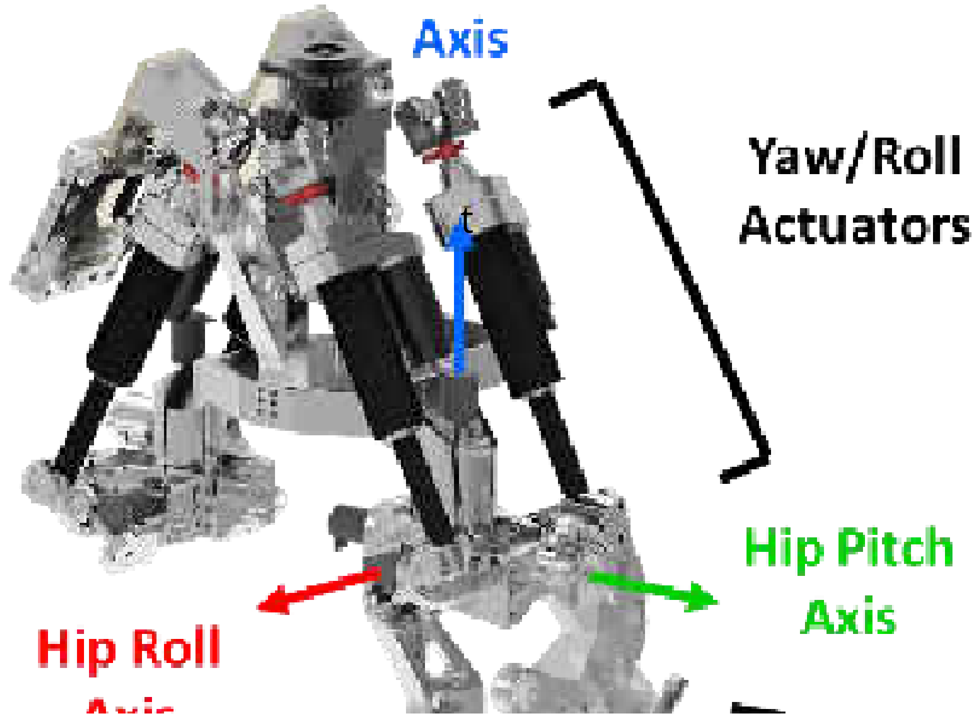


Legs

THumanoid robots usually have two legs, each with multiple joints, designed to replicate human leg movements. The legs enable walking, running, and other locomotion capabilities. The feet may have sensors for balance and navigation.

Joint and Actuators

The frame incorporates various joints and actuators, such as motors or hydraulic systems, to provide movement to the robot's limbs. These joints allow for flexibility and control over the robot's motions.

Materials

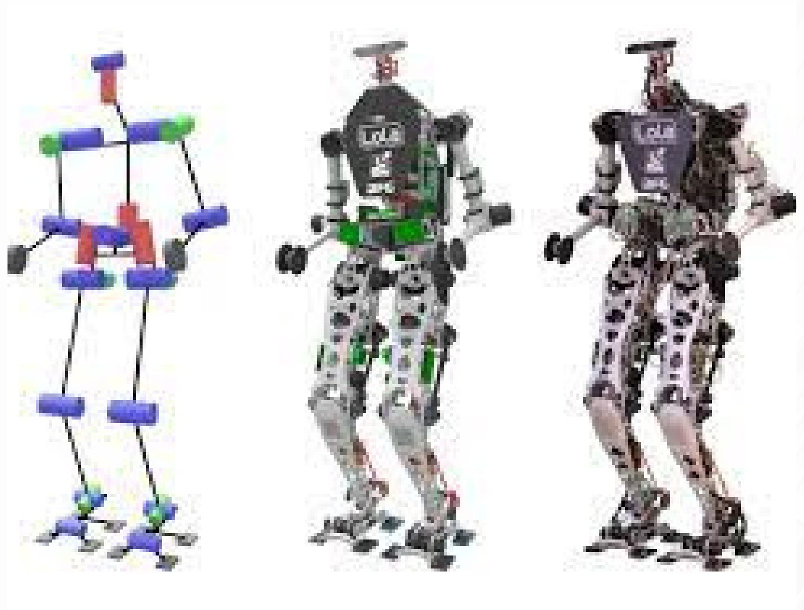
Humanoid robot frames are often constructed using lightweight materials like aluminum, carbon fiber, or plastic composites. These materials help reduce the robot's weight while maintaining strength and durability.

PROPULSION SYSTEM

The choice of propulsion system depends on factors such as the robot's intended use, desired mobility, terrain requirements, and energy efficiency. Researchers and developers continuously explore new propulsion techniques to improve the agility, stability, and versatility of humanoid robots.

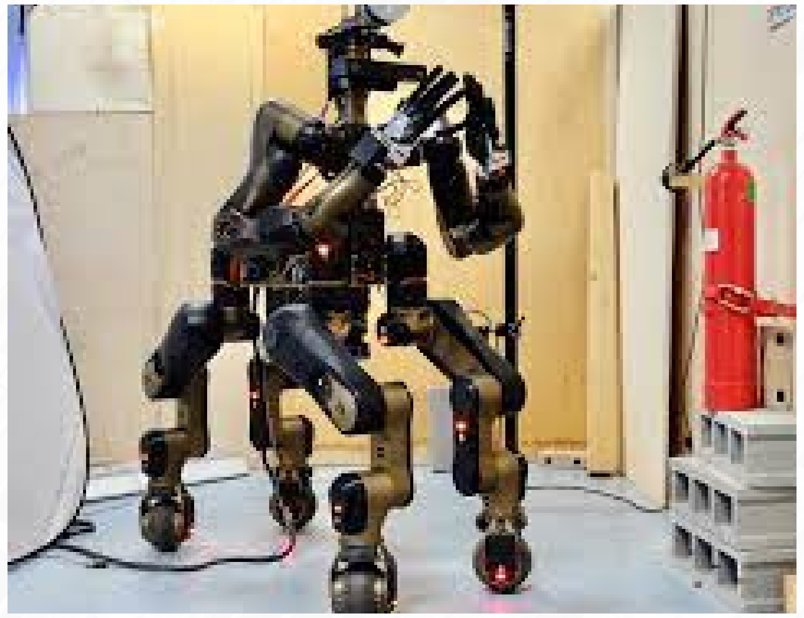
Wheeled Mobility

These robots can move by rolling or driving their wheels, similar to traditional mobile robots. The wheels can be attached to the feet or integrated into the legs of the robot..



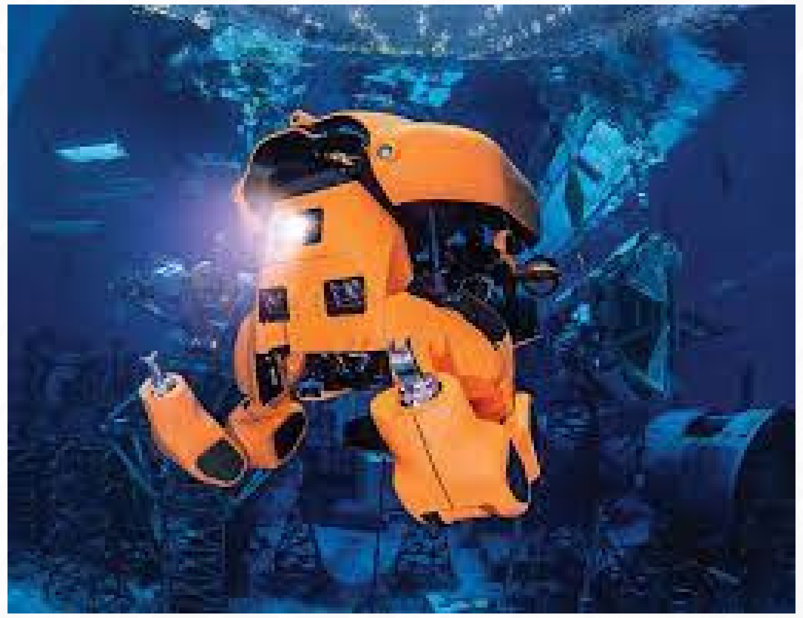
Legged Locomotion

- Bipedal Walking
- Quadrupepal Walking
- Dynamic Walking



Hybrid Locomotion

Hybrid locomotion combines multiple modes of propulsion to enhance the capabilities of humanoid robots

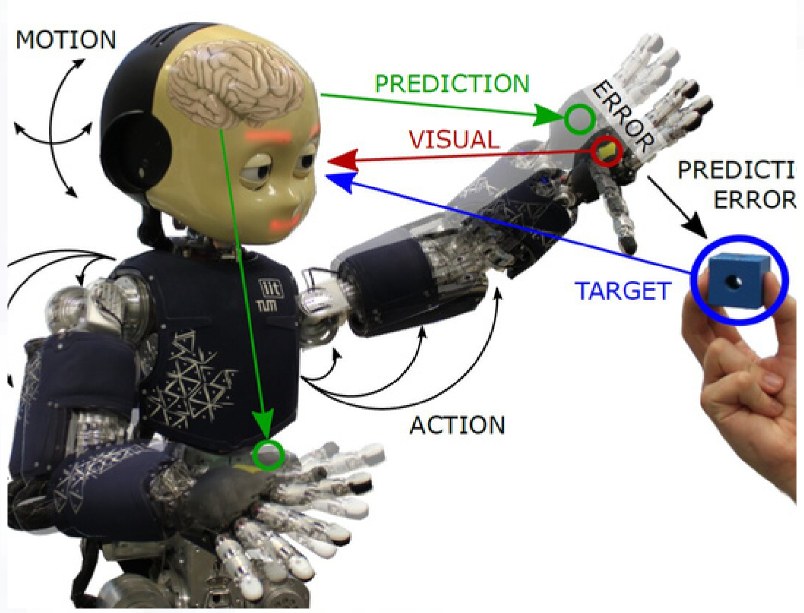


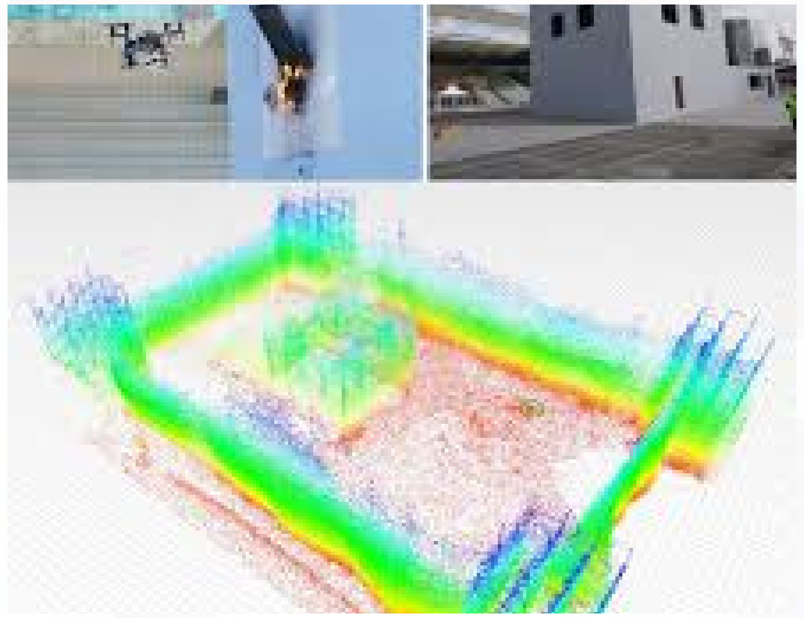
Specialized Propulsion

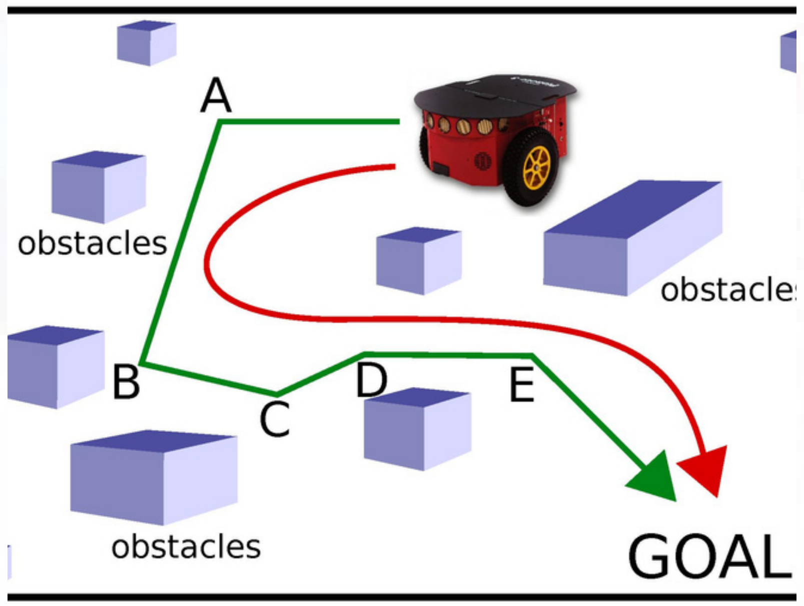
In some cases, humanoid robots may have specialized propulsion systems based on their intended applications.

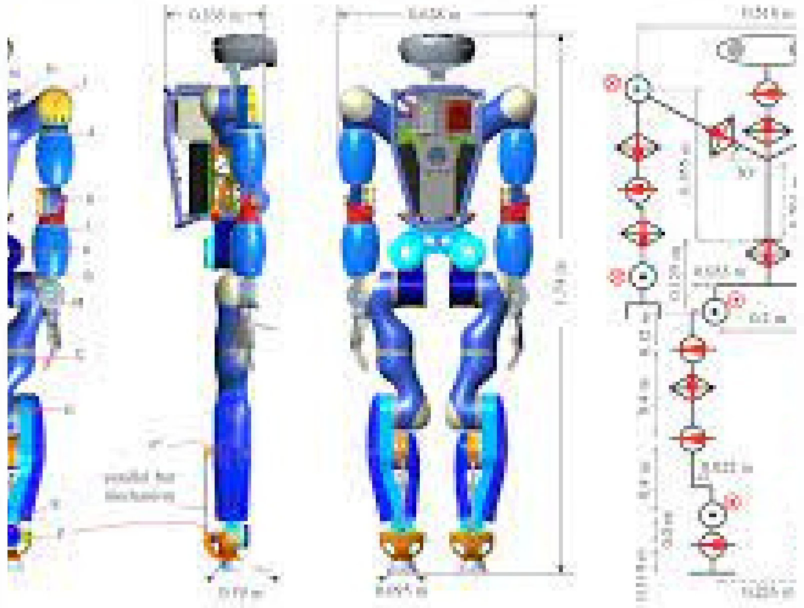
NAVIGATION & CONTROL SYSTEM

The navigation and control system of humanoid robots involves a combination of software algorithms, hardware components, and sensor integration to enable perception, decision-making, and motor control. These systems are continually evolving as researchers and engineers strive to improve the capabilities and autonomy of humanoid robots.









Perception Sensors

Sensors may include cameras, depth sensors (such as LiDAR or depth cameras), infrared sensors, and tactile sensors. These sensors provide information about the robot's environment.

Localization and Mapping

To navigate effectively, humanoid robots need to determine their own position and create a map of the environment. Techniques such as Simultaneous Localization and Mapping (SLAM) are commonly employed to estimate the robot's location and simultaneously build a map using sensor data.

Path Planning and Obstacle Avoidance

Humanoid robots need to plan their movements and navigate around obstacles to reach their desired destinations. Path planning algorithms are used to generate feasible paths from the robot's current location to its target location while avoiding obstacles.

Control and Motion Planning

Humanoid robots have complex kinematic structures with numerous degrees of freedom. Control algorithms and motion planning techniques are used to generate joint trajectories and coordinate the movements of the robot's limbs for tasks such as walking, reaching, grasping, and other desired actions.

NAVIGATION & CONTROL SYSTEM

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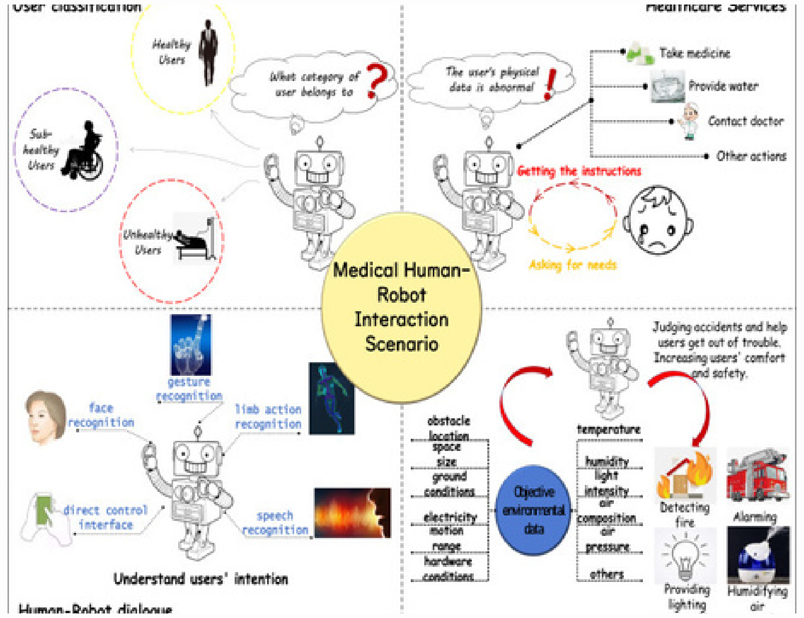
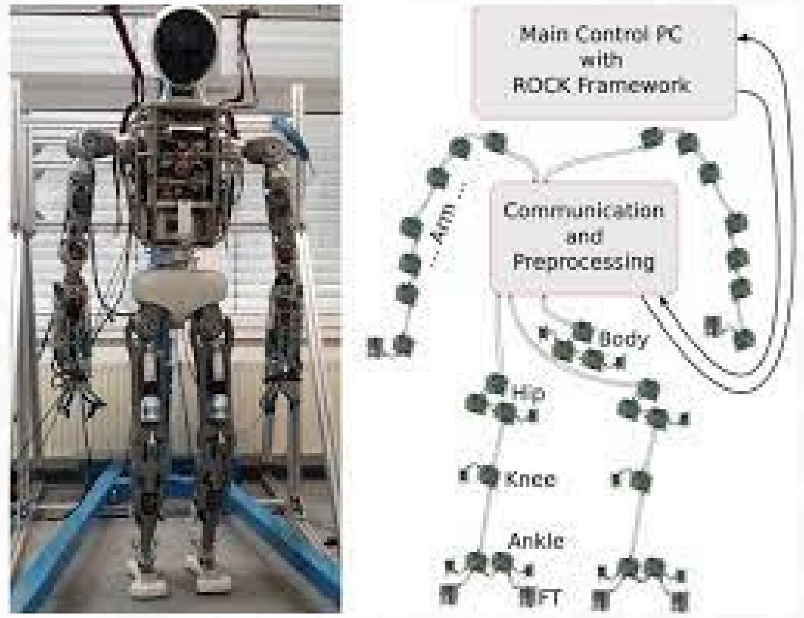


Feedback and Sensor Fusion

Humanoid robots continuously monitor their actions and the environment through feedback from sensors. Sensor fusion techniques combine information from multiple sensors to improve perception accuracy and enable robust decision-making.

Human-Robot Interaction

Humanoid robots often require interfaces for communication and interaction with humans. Natural language processing algorithms, gesture recognition, and speech synthesis systems can be integrated to facilitate human-robot interaction and enable the robot to understand and respond to commands and queries..



Central Control Unit

The control system of a humanoid robot typically includes a central processing unit or controller that orchestrates the various components of the navigation and control system

DATA COLLECTION OF HUMANOID ROBOT

Humanoid robots collect data from various sensors to perceive their environment, make informed decisions, and interact with humans and objects. The specific data collected and the types of data can vary depending on the robot's design, capabilities, and intended applications.

DATA TYPE COLLECTED

- **Visual Data:** Humanoid robots often employ cameras or vision sensors to capture visual data about their surroundings.
- **Depth Data:** Depth sensors, such as LiDAR or depth cameras, provide information about the distances to objects in the robot's environment. This data helps the robot understand the 3D structure of the surroundings, estimate distances, and perform tasks like object recognition and obstacle avoidance.
- **Tactile Data:** Humanoid robots may be equipped with tactile sensors on their fingers, hands, or body. These sensors enable the robot to sense and measure forces, pressures, or vibrations when interacting with objects or humans.
- **Audio Data:** Microphones or audio sensors allow humanoid robots to capture audio data, including speech, environmental sounds, or specific cues for sound localization. A
- **Joint and Motor Data:** Humanoid robots have joints and actuators that enable movement of their limbs and body. Encoders or sensors associated with these joints collect data related to joint positions, velocities, and torques.
- **Environmental Data:** Humanoid robots can collect data about their environment, such as temperature, humidity, or ambient light levels. Environmental data can be used to adapt the robot's behavior, optimize energy consumption, or respond to specific environmental conditions.
- **Interaction Data:** When humanoid robots interact with humans or objects, they collect interaction data. This can include data about gestures, touch interactions, voice commands, or responses to social cues.

DATA TRANSMISSION

The choice of data transmission method depends on factors such as the required data rate, latency, range, power consumption, and the specific application of the humanoid robot. A combination of wired and wireless communication methods is often used to enable flexible and efficient data exchange between the robot and external devices or networks.

Wireless Communication

Wi-Fi: Humanoid robots can connect to local area networks (LAN) or the internet using Wi-Fi.

Bluetooth: Bluetooth technology allows humanoid robots to establish short-range wireless connections with compatible devices.

Zigbee: Zigbee is a low-power, short-range wireless communication protocol often used in robotics

RFID: Radio-frequency identification (RFID) technology enables the wireless transmission of data between a humanoid robot and RFID tags or readers.

Wired Connections

Humanoid robots often utilize wired connections for data transmission. These connections may include Ethernet cables, USB cables, or other proprietary connectors. Wired connections offer reliable and high-speed data transfer, making them suitable for tasks that require real-time communication or large data exchange.

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Remote Control

In some cases, humanoid robots can be remotely controlled by human operators. Data transmission occurs through specialized control interfaces or teleoperation systems, allowing operators to send commands and receive feedback from the robot. This is useful for tasks that require human supervision or complex decision-making.

Onboard Storage

Humanoid robots may have onboard storage capabilities, such as solid-state drives or memory cards, to store and retrieve data. This can include sensor data, log files, or learned models. Onboard storage allows the robot to store and process data locally, reducing the need for constant data transmission.

POWER MANAGEMENT

1. **Power Sources:** Humanoid robots typically rely on one or more power sources to provide electrical energy. These power sources can include:
- **Batteries**: Rechargeable batteries, such as lithium-ion or lithium-polymer batteries, are commonly used in humanoid robots. They offer portability and enable the robot to operate without being tethered to a power outlet.
- **External Power:** In some cases, humanoid robots may be designed to operate using external power sources, such as being plugged into an electrical outlet or connected to a power supply unit. This approach eliminates the need for battery recharging but limits the robot's mobility.
2. **Power Distribution:** Humanoid robots have multiple subsystems and components that require different voltage levels and power demands. Power management systems distribute power from the main power source to the subsystems, ensuring that each component receives the appropriate voltage and current.
3. **Power Monitoring:** Power management systems often include monitoring capabilities to track power consumption and detect anomalies. Current sensors and voltage monitoring circuits can provide feedback on the energy usage of individual components or subsystems.
4. **Power Optimization:** Power management strategies aim to optimize energy usage and maximize the robot's operational time. This involves implementing power-saving techniques, such as:
- **Sleep Modes:** Components or subsystems can be put into low-power sleep or idle modes when not actively required.
- **Dynamic Voltage and Frequency Scaling (DVFS):** DVFS adjusts the voltage and frequency of the processor or other components based on workload demands.
- **Task Scheduling and Resource Allocation:** Intelligent task scheduling algorithms can optimize power consumption by grouping tasks and allocating resources efficiently. This ensures that the robot operates in the most power-efficient manner.
5. **Energy Harvesting:** Some humanoid robots explore energy harvesting techniques to supplement their power supply. This involves converting ambient energy sources, such as solar power, vibration, or heat, into usable electrical energy.
- **Charging and Recharging:** In the case of battery-powered humanoid robots, power management includes charging and recharging strategies. Charging systems are designed to safely and efficiently recharge the robot's batteries.

THANK YOU

1. "Robots will play an increasingly important role in our lives in the coming years. They will go from being novelties to being fixtures." - Colin Angle