HUMANOID

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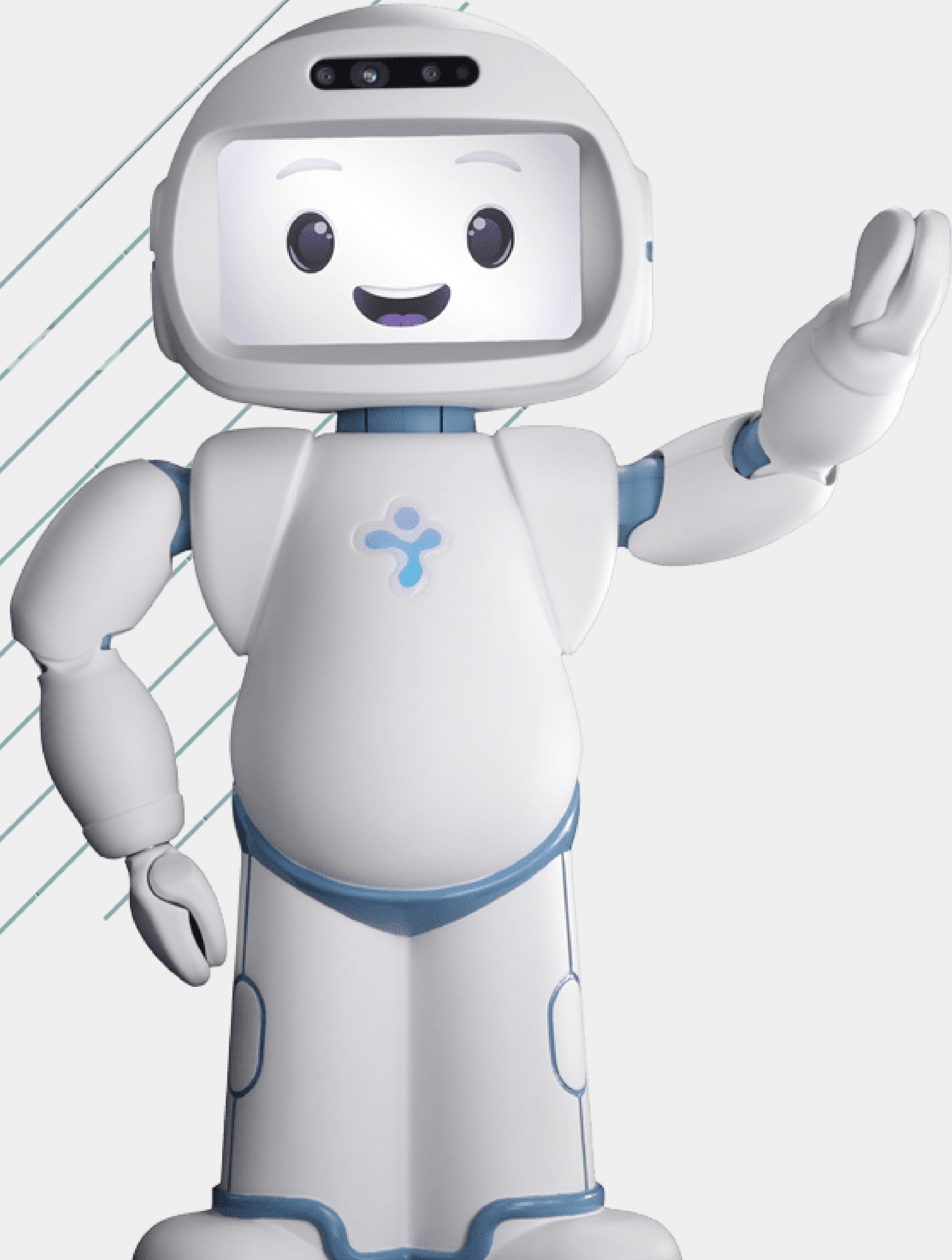

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2. Type of Humanoid Robot
3. Main Components
4. Advantages
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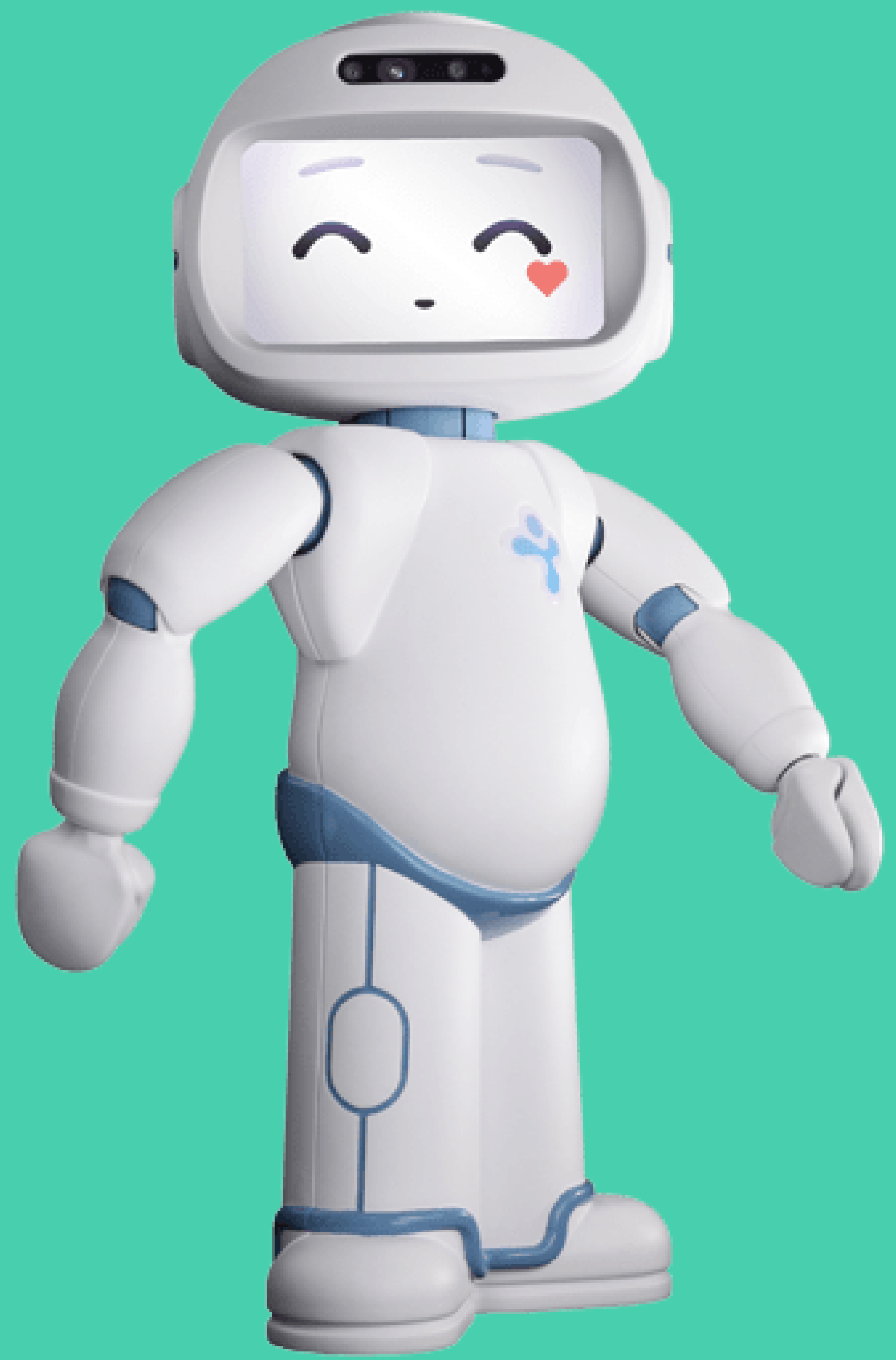
6. Conclusion

1

Introduction & History

INTRODUCTION

A humanoid robot is a machine designed to resemble the human body in terms of its structure, movement, and interaction capabilities. These robots often have a head, torso, two arms, and two legs, mirroring the basic physical characteristics of humans. They are equipped with sensors, actuators, and artificial intelligence, allowing them to perceive and interact with the environment in ways similar to humans.



HISTORY

1495

Leonardo da Vinci designs a humanoid automaton called the "Robot Knight." While it was never built, da Vinci's sketches and notes depict a mechanical knight capable of performing various human-like movements.

1738

Jacques de Vaucanson creates "The Flute Player," an automated humanoid figure that could play the flute. It is considered one of the earliest examples of a humanoid robot.

1921

Czech writer Karel Čapek coins the term "robot" in his play "R.U.R. (Rossum's Universal Robots)." While the play does not feature humanoid robots, it popularizes the term and introduces the concept of artificial beings.

HISTORY

1948

WABOT-1, developed by researchers at Waseda University in Japan, becomes the first full-scale humanoid robot. It could walk, move its arms, and recognize objects using external sensors.

1970

Shakey the Robot, developed at Stanford Research Institute (SRI), becomes the first mobile humanoid robot. It had a computer onboard and was capable of perceiving its environment through sensors.

1986

Honda develops the P3 humanoid robot, which is the first to have a walking gait that resembles human walking. The P3 was a significant step forward in humanoid robot locomotion.

HISTORY

1997

Honda introduces the P2 humanoid robot, which is able to walk, climb stairs, and maintain balance. It was an improved version of the P1 robot, which had been developed in 1993.

2000

Honda unveils ASIMO (Advanced Step in Innovative Mobility), a highly advanced humanoid robot capable of autonomous navigation, running, climbing stairs, and interacting with people. ASIMO became a well-known and influential humanoid robot.

2002

Sony introduces the humanoid robot QRIO (Quest for Curiosity), which could walk, dance, and recognize faces. QRIO was designed to be a companion robot and featured expressive movements.

HISTORY

2010

Boston Dynamics unveils PETMAN, a humanoid robot designed for testing chemical protection clothing. PETMAN is capable of walking, squatting, and performing various dynamic movements.

2013

Atlas, developed by Boston Dynamics, is a humanoid robot that can walk on uneven terrain, balance itself, and use its hands for simple tasks. It was designed for search and rescue operations.

2016

Sophia, a humanoid robot developed by Hanson Robotics, gains international attention. Sophia is capable of natural language processing, facial recognition, and holding conversations. It became known for its human-like appearance and expressive features.

HISTORY

2020

Boston Dynamics unveils PETMAN, a humanoid robot designed for testing chemical protection clothing. PETMAN is capable of walking, squatting, and performing various dynamic movements.

2

Application of Humanoid Robot

APPLICATIONS

Research and Development

Humanoid robots are used in research and development to explore human-like movements, behaviours, and interactions. Examples include ASIMO by Honda and HRP-4C by the National Institute of Advanced Industrial Science and Technology (AIST).

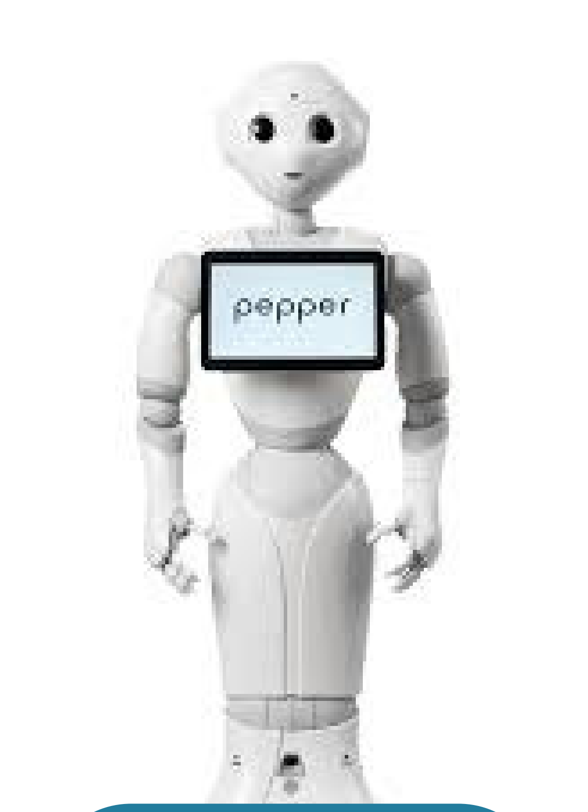
ASIMO

HRP-4C

APPLICATIONS

Healthcare Assistance

Humanoid robots can assist in healthcare settings by providing companionship to the elderly, assisting with daily tasks, and monitoring patients. Pepper, developed by SoftBank Robotics, is a popular humanoid robot used in healthcare settings.



PEPPER

APPLICATIONS

Education and Entertainment

Humanoid robots can be used in educational institutions to teach various subjects or as interactive companions for children. NAO, developed by SoftBank Robotics, is widely used in schools and universities for educational purposes.

NAO

APPLICATIONS

Customer Service

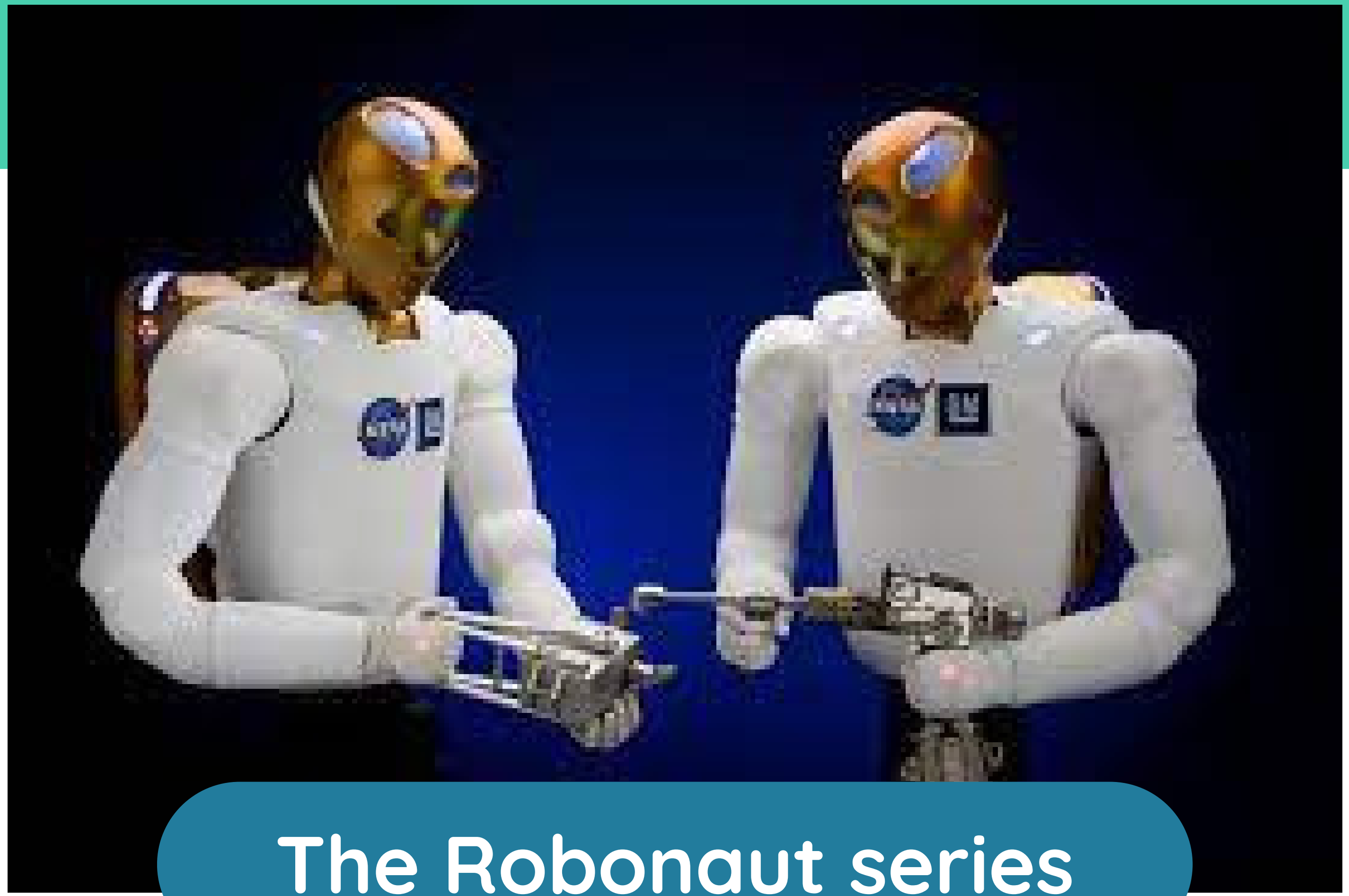
Humanoid robots are employed in customer service roles, providing information, guiding visitors, and assisting in retail environments. Tally, developed by Simbe Robotics, is a humanoid robot used for inventory auditing in retail stores.

TALLY

APPLICATIONS

Social Assistance

Humanoid robots can assist individuals with disabilities or limited mobility by performing tasks such as fetching objects, opening doors, or providing physical support. The Robonaut series, developed by NASA and General Motors, is an example of a humanoid robot designed for assistance in space and on Earth.



The Robonaut series

APPLICATIONS

Disaster Response

Humanoid robots can be utilized in search and rescue operations, exploring hazardous environments, and providing aid in disaster-stricken areas. Atlas, developed by Boston Dynamics, has been tested for such purposes.

ATLAS

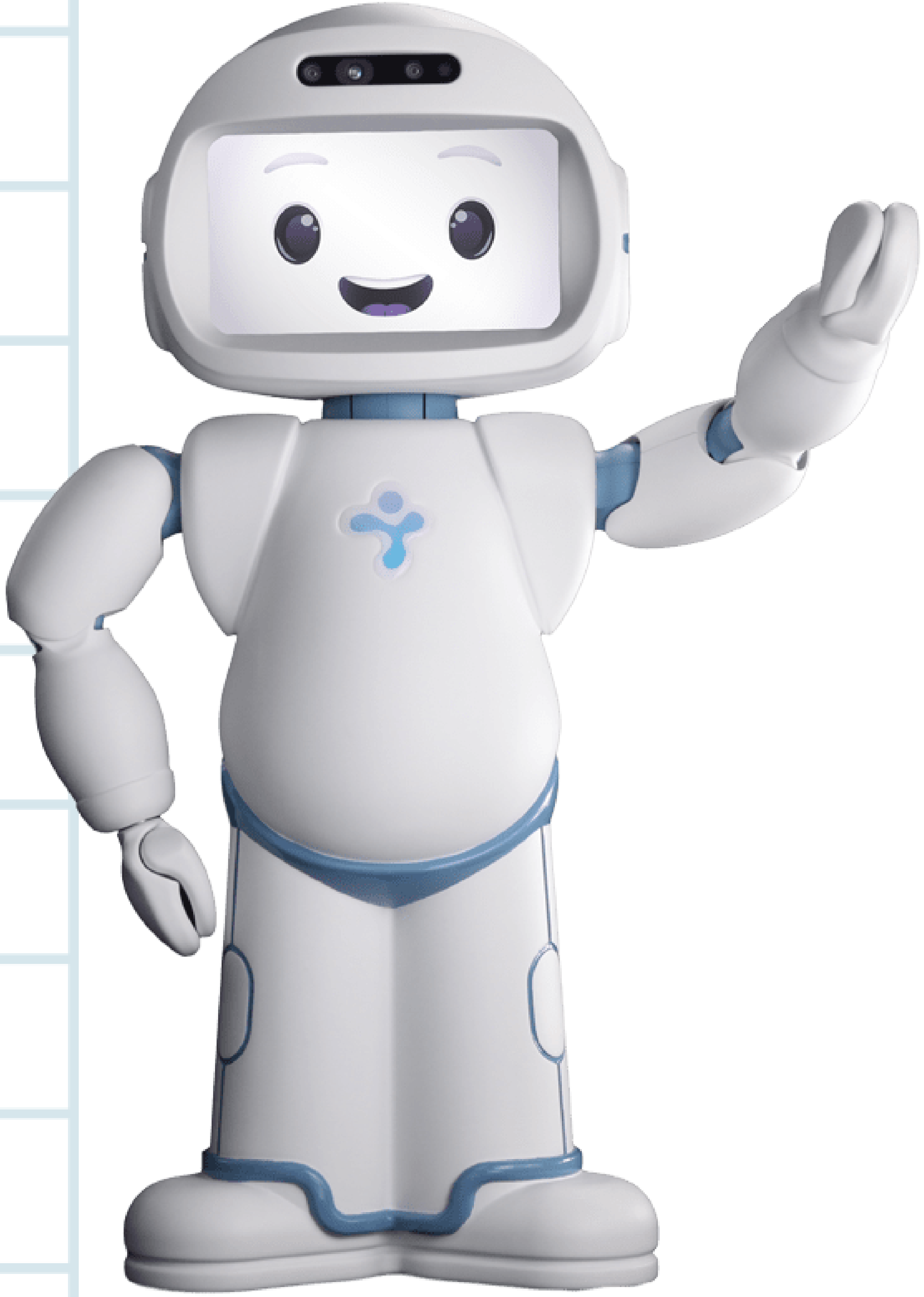
3

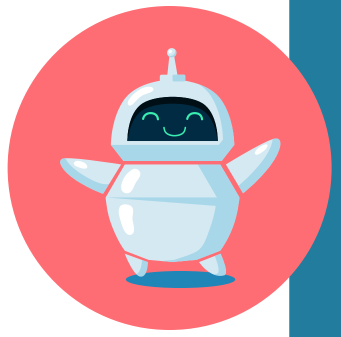
Main Components

Body Design . Locomotion . Navigation . Data Collection . Communication . Power Management

BODY DESIGN

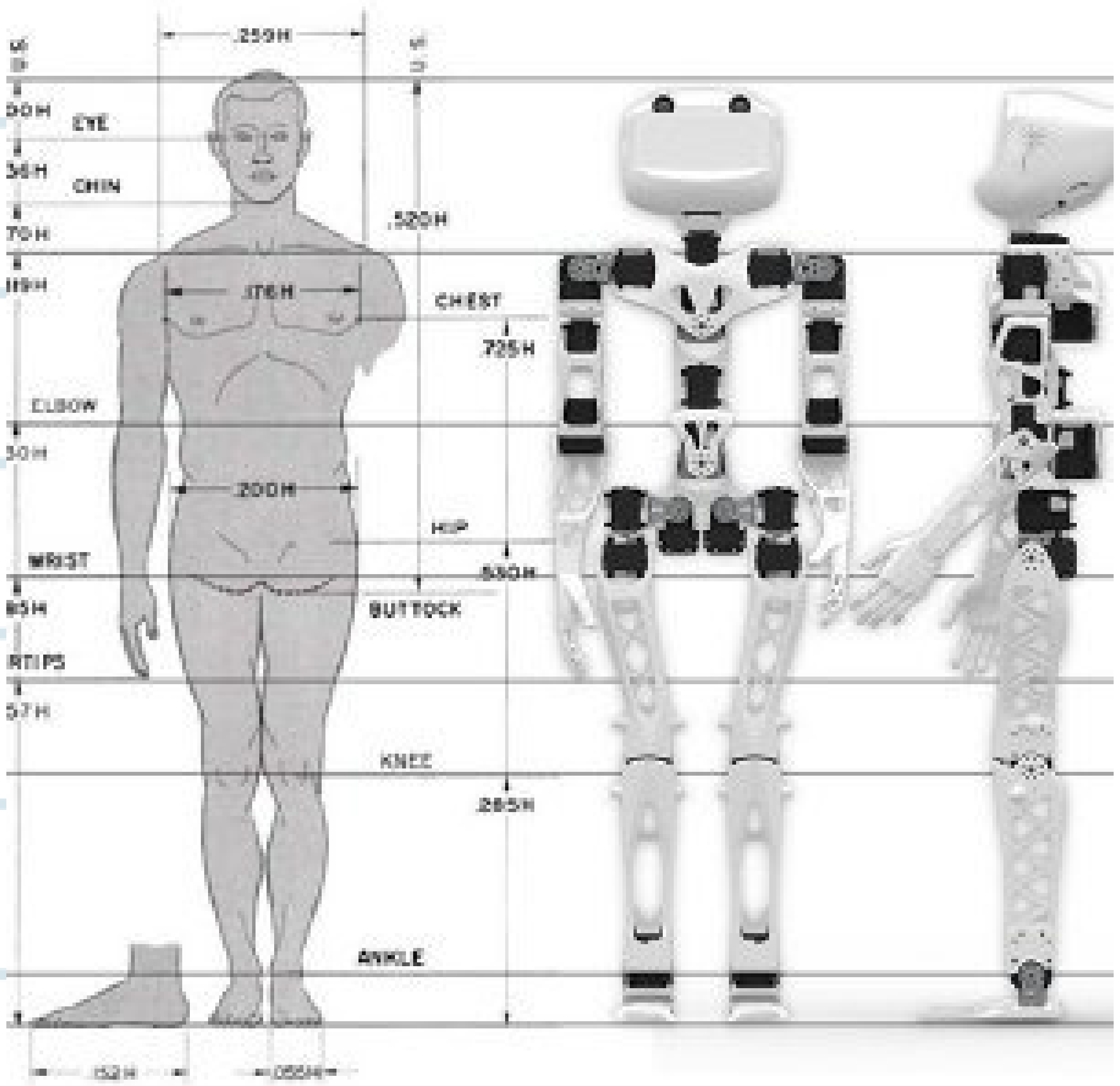
BODY DESIGN

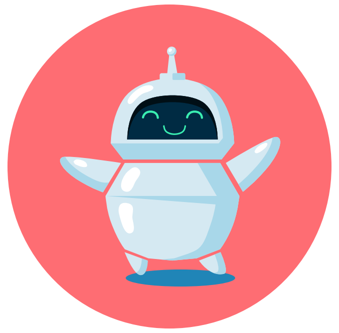


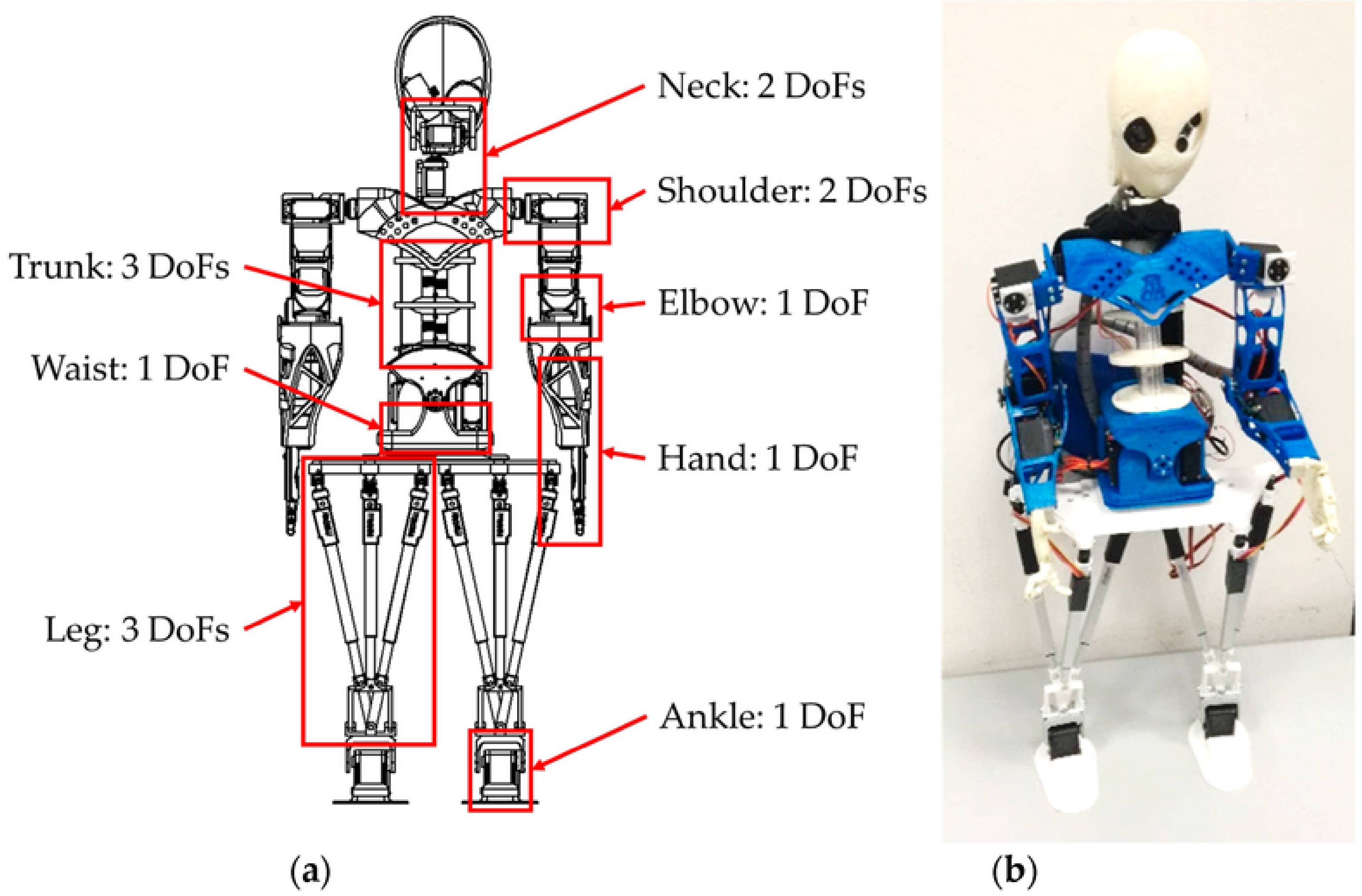


The body design of humanoid robots typically aims to replicate the general form and capabilities of the human body. While there can be variations in specific designs, here are some common features and components found in humanoid robot bodies

BODY DESIGN







Human Propotion used in the humanoid design

BODY DESIGN

Other design of humanoid robots

LOCOMOTION

BODY DESIGN

Bipedal Walking

ADVANTAGES

- Natural and intuitive
- Accessibility.
- Energy efficiency.

DISADVANTAGES

- Stability challenges
- Slower speed.
- Higher computational requirements.

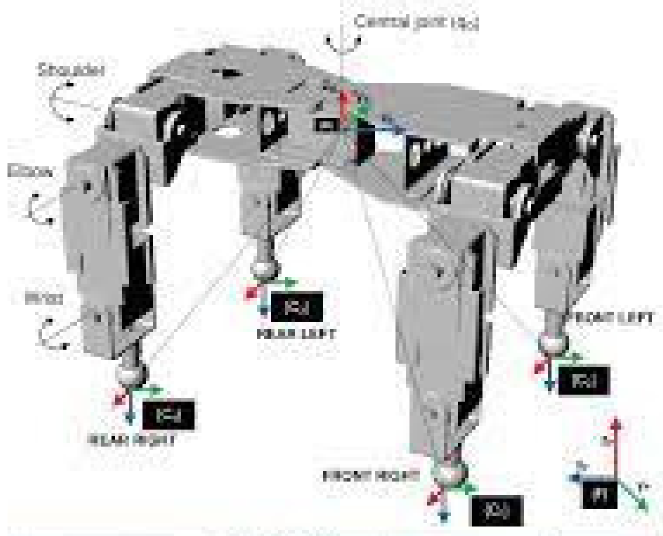
Bipedal walking refers to the locomotion of humanoid robots using two legs. It closely resembles human walking, with the robot alternating steps between its left and right legs.

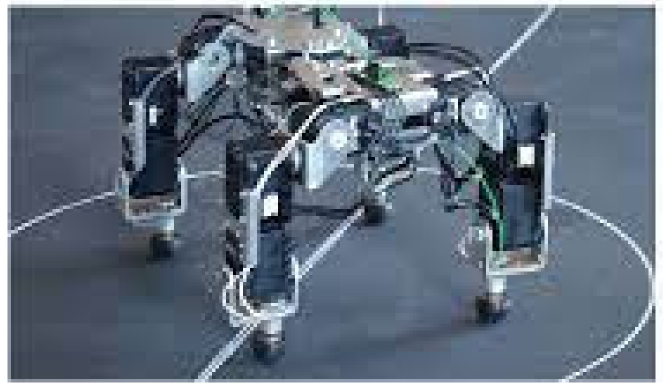
BODY DESIGN

Quadrupedal Walking

ADVANTAGES

- Stability and load-bearing capacity
- Agility and manoeuvrability.
- Redundancy and fault tolerance.





DISADVANTAGES

- Less human-like appearance
- Limited access to a human-centric environment.
- Potential mechanical complexity.

Quadrupedal locomotion involves the use of four legs for walking. Quadrupedal robots mimic animals such as dogs or horses in their movements. This locomotion offers advantages such as stability, load-bearing capacity, and agility.

BODY DESIGN

Wheeled Locomotion

ADVANTAGES

- Efficiency and speed
- Stability.
- Accessibility.

DISADVANTAGES

- Limited terrain adaptability
- Reduced manoeuvrability.
- Restricted interaction.

Wheeled locomotion involves the use of wheels for robot movement. Wheeled robots can have one or more wheels, and they can achieve efficient and fast locomotion.

NAVIGATION & CONTROL

NAVIGATION

Sensors

use a combination of sensors such as cameras, depth sensors (e.g., LiDAR, depth cameras), infrared sensors, and tactile sensors.

Motion Control

Motion control is responsible for generating and executing the necessary motor commands to achieve the desired navigation behavior. It involves coordinating the robot's limbs, joints, and actuators to follow the planned path.

Localization

Localization determines the robot's position and orientation within its environment. To achieve localization, humanoid robots often use techniques like Simultaneous Localization and Mapping (SLAM).

Mapping

Mapping involves creating a representation of the environment that the humanoid robot can use for navigation. Mapping can be done using occupancy grids, point clouds, or other data structures.

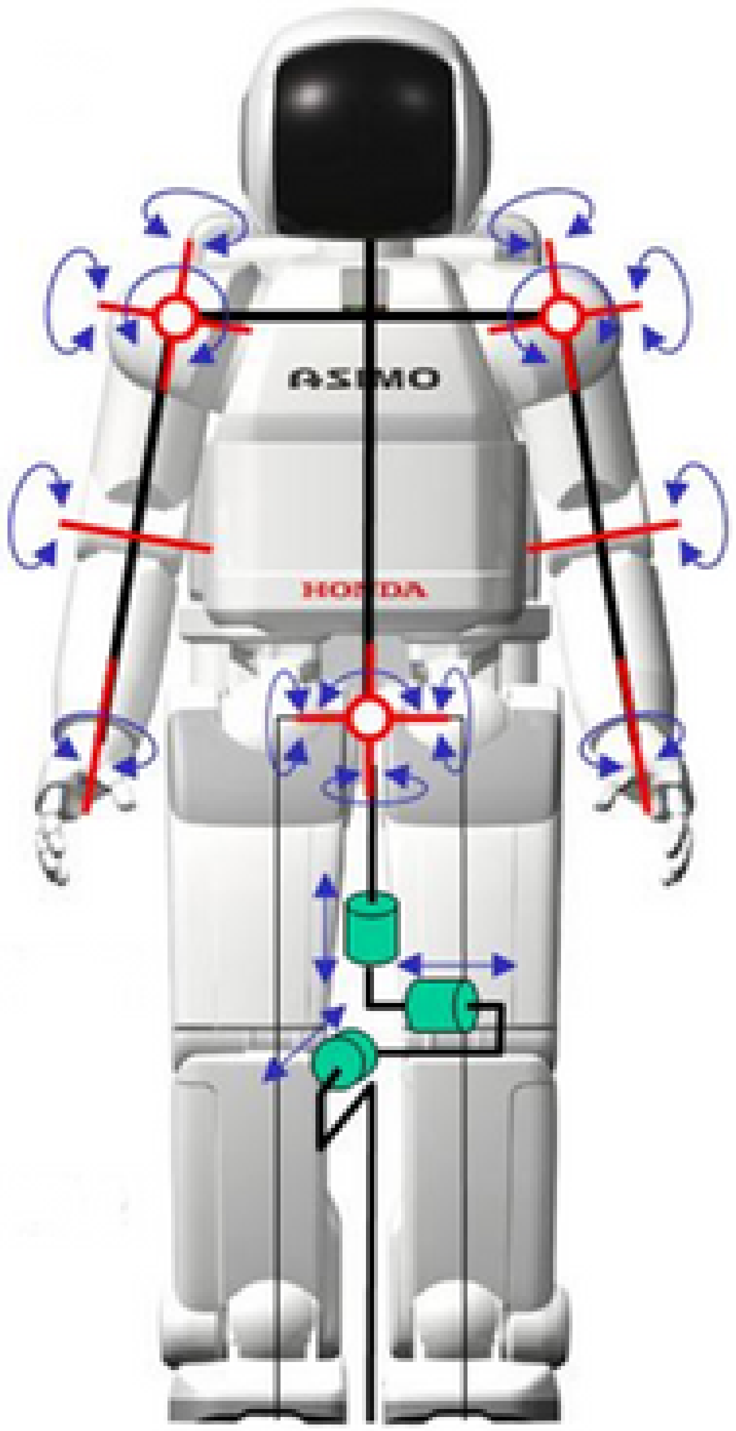
Path Planning

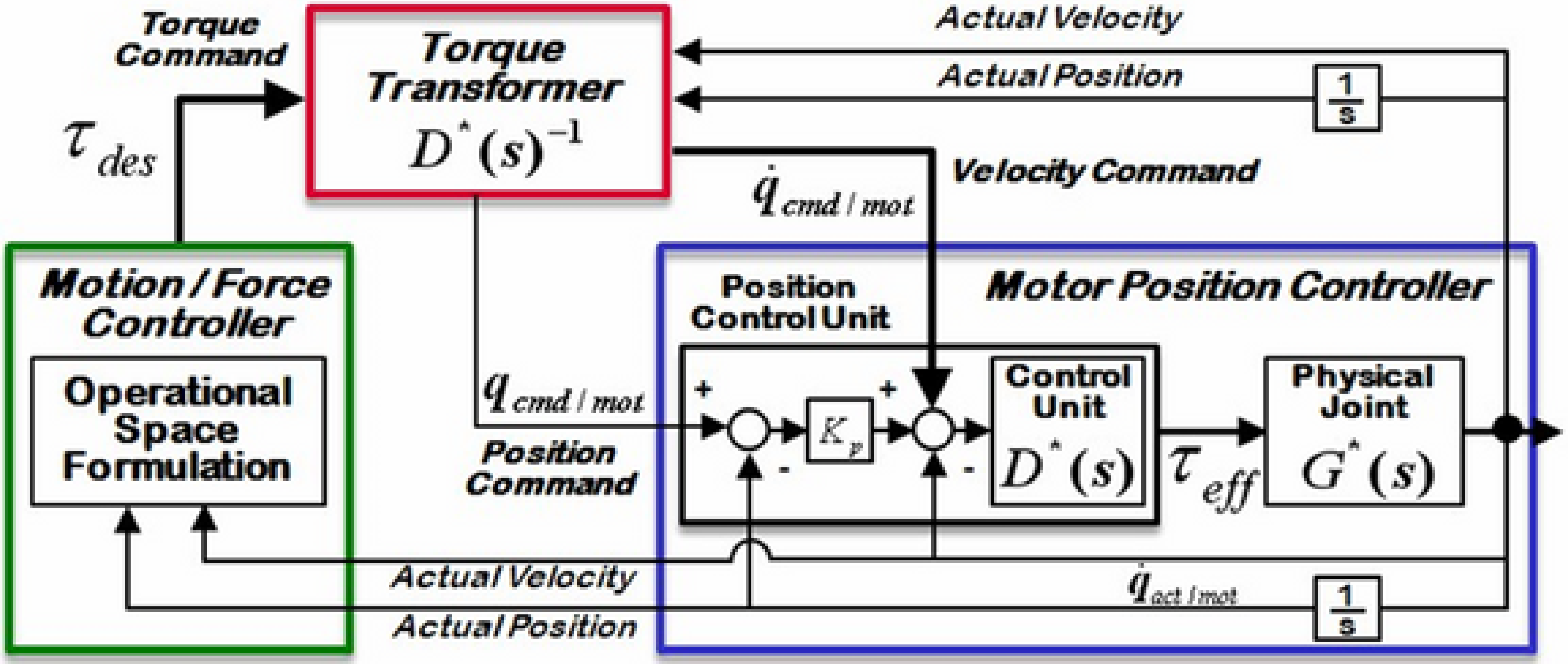
Path planning involves determining a safe and optimal path for the robot to follow from its current location to a desired destination. It takes into account the mapped environment, obstacles, and the robot's capabilities.

Obstacle Avoidance

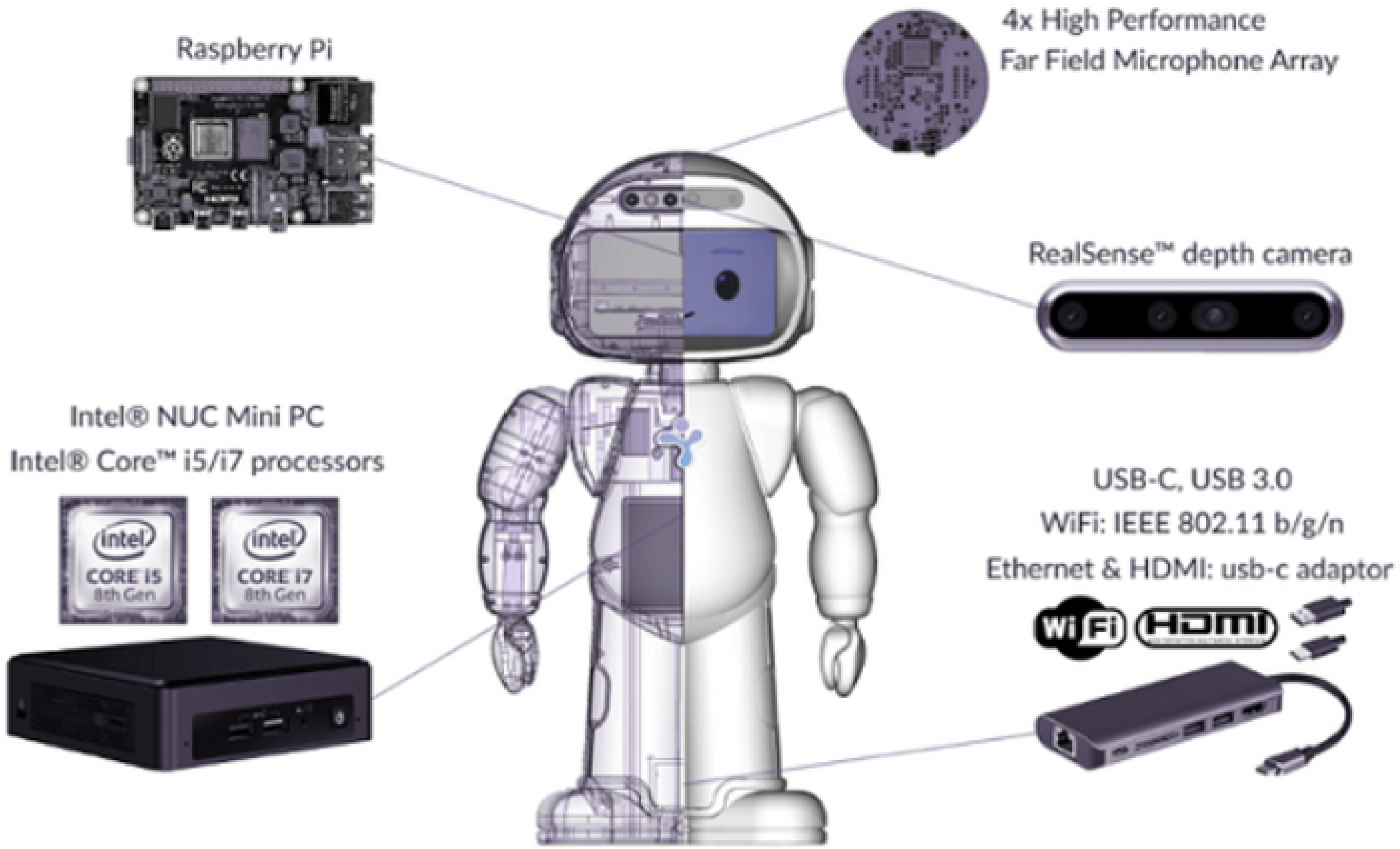
Obstacle avoidance ensures that the robot can navigate without colliding with obstacles. It requires real-time perception and decision-making to identify obstacles and plan alternative paths.

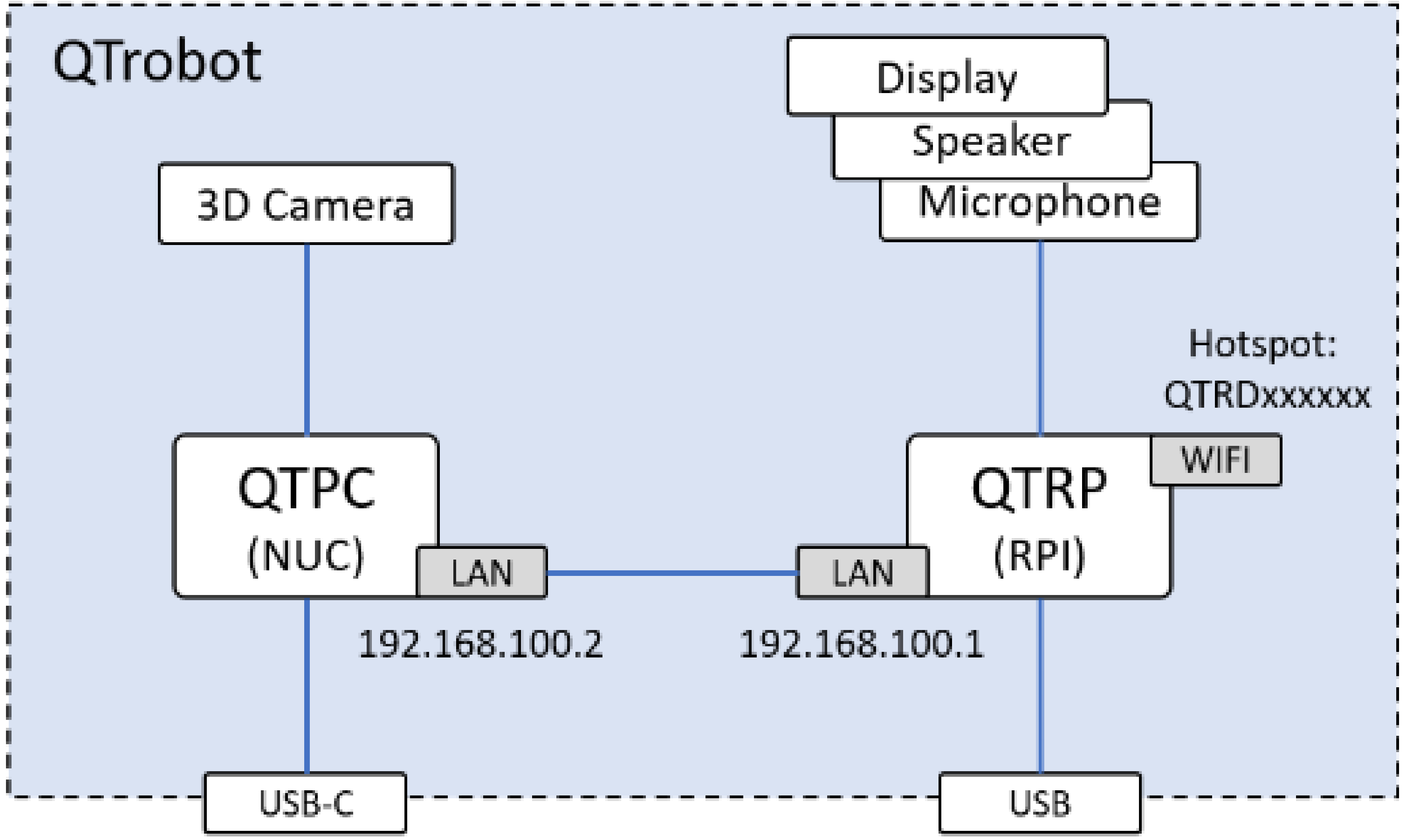
CONTROL SYSTEM





CONTROL SYSTEM





System Architecture of QTrobot

DATA COLLECTION

DATA COLLECTION

Visual Data Collection

Function: Humanoid robots often use cameras or vision sensors to collect visual data from their surroundings. This data provides information about objects, people, landmarks, and visual cues.

Depth Sensing

Function: Depth sensors, such as LiDAR or depth cameras, provide depth information about the environment, allowing humanoid robots to perceive the distance to objects and the structure of the surroundings.

Tactile Sensing

Function: Tactile sensors located on the robot's body or fingertips capture information about contact forces, pressure, and texture when interacting with objects or surfaces.

DATA COLLECTION

Inertial Sensing

Function: Inertial sensors, including accelerometers and gyroscopes, measure the robot's acceleration, angular velocity, and orientation.

Audio Data Collection

Function: Microphones or audio sensors capture sound and auditory information from the environment, including speech, ambient noise, and other audio cues.

Environmental Sensors

Function: Environmental sensors, such as temperature sensors, humidity sensors, or gas sensors, monitor the physical properties of the surroundings.

DATA TRANSMISSION

DATA TRANSMISSION

Wired Communication

Function: Wired communication involves the use of physical cables or connections to transfer data between the humanoid robot and external devices or systems.

Wireless Communication

Function: Wireless communication allows data transmission between the humanoid robot and other devices or systems without the need for physical connections.

Wi-Fi

Function: Wi-Fi (Wireless Fidelity) is a popular wireless communication technology that enables data transmission over short to medium distances using radio waves.

DATA TRANSMISSION

Bluetooth

Function: Bluetooth is a wireless technology designed for short-range communication between devices.

Radio Frequency (RF)

Function: Radio Frequency communication uses radio waves to transmit data over longer distances than Bluetooth or Wi-Fi.

Ethernet

Function: Ethernet is a wired communication technology that enables high-speed data transfer over local area networks (LANs).

POWER MANAGEMENT

POWER MANAGEMENT

Power Source Selection	Power source selection involves the ability to switch between different power sources, such as batteries, external power supplies, or energy harvesting systems.
Battery Monitoring and Control	Battery monitoring and control systems continuously monitor the status of the robot's batteries, including voltage, current, and temperature.
Power Allocation and Distribution	Power allocation and distribution systems manage the distribution of power to different components and subsystems within the humanoid robot.

POWER MANAGEMENT

Power Saving Modes	Power saving modes enable the robot to reduce power consumption during periods of inactivity or when certain components are not required.
Energy Harvesting	Energy harvesting involves capturing and utilizing energy from the environment, such as solar power, kinetic energy, or thermal energy.
Dynamic Power Management	Dynamic power management systems adapt power usage based on real-time demands, task requirements, and system conditions.

4

Advantages

ADVANTAGES

01

Versatility

Humanoid robots are designed to mimic human capabilities, allowing them to navigate and interact with human environments. Their ability to use human-like tools and manipulate objects with their hands makes them adaptable to various tasks.

02

Human Interaction

Humanoid robots are designed to mimic human capabilities, allowing them to navigate and interact with human environments. Their ability to use human-like tools and manipulate objects with their hands makes them adaptable to various tasks.

ADVANTAGES

03

Human-Like Assistance

Humanoid robots have the potential to provide personalized assistance and support to humans. They can help with tasks such as caregiving, household chores, and healthcare monitoring, offering companionship and assistance to individuals in need.

04

Dexterity and Manipulation

With their human-like arms and hands, humanoid robots can perform intricate tasks requiring dexterity and manipulation. This makes them suitable for activities like assembling small components, operating machinery, or handling delicate objects.

ADVANTAGES

05

Research and Development

Humanoid robots serve as valuable tools for studying human movement, cognition, and behavior. They enable researchers to explore complex human-related concepts and develop new technologies and interventions.

5

Limitations

LIMITATIONS

01

Cost and Complexity

Designing, building, and maintaining humanoid robots can be costly and complex. The advanced engineering, sophisticated control systems, and high-quality materials required for their construction can make them financially out of reach for many applications.

02

Mobility and Stability

Achieving stable and agile locomotion in humanoid robots is challenging. Balancing on two legs and replicating the complexity of human walking is difficult, and many humanoid robots have limited mobility compared to humans.

LIMITATIONS

03

Power and Energy Consumption

Humanoid robots often require substantial power, leading to significant energy consumption. The need for a continuous power supply limits their mobility and autonomy, and finding efficient power solutions remains a challenge.

04

Sensing and Perception

While humanoid robots have sensors to perceive the environment, their sensing capabilities are still limited compared to humans. They may struggle with complex sensory tasks, fine-grained object recognition, and understanding intricate human behaviours.

LMITATIONS

05

Mechanical Limitations

Humanoid robots are subject to mechanical limitations such as joint range of motion, speed, and strength. Despite advancements, their physical capabilities are often inferior to humans, restricting their ability to perform certain tasks effectively.

6

Conclusion

In conclusion, humanoid robots represent a remarkable fusion of robotics and human-like characteristics. They have made significant progress in terms of design, locomotion, perception, and interaction capabilities. While still facing challenges, such as stability and power management, humanoid robots hold great potential in various domains.With ongoing advancements, we can anticipate exciting applications and further integration of humanoid robots into our daily routines, ultimately reshaping the way we live and interact with technology.

THANK YOU