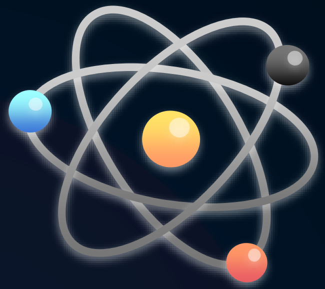
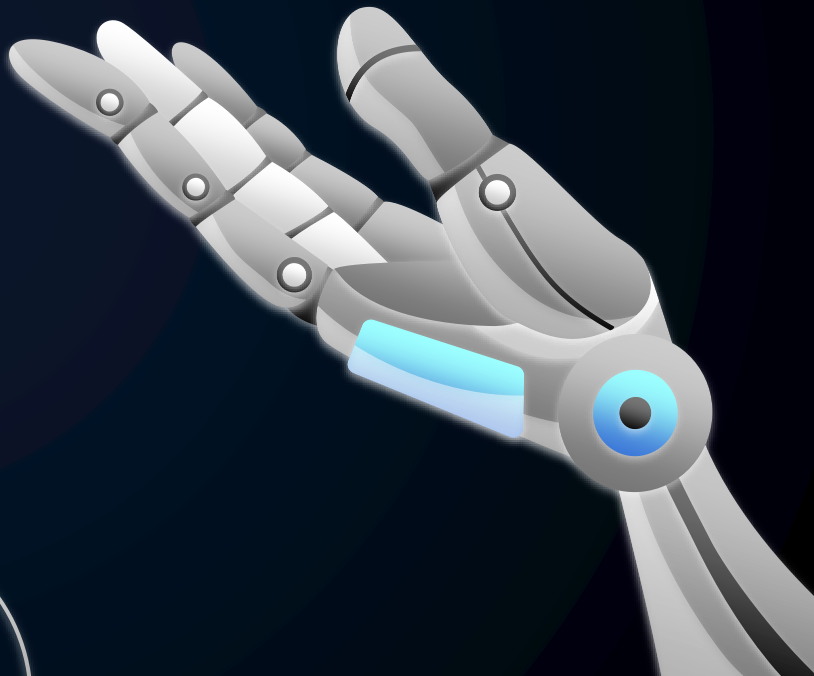
HUMANOID ROBOT



MCTE 4326 (ROBOTIC HARDWARE SYSTEM)



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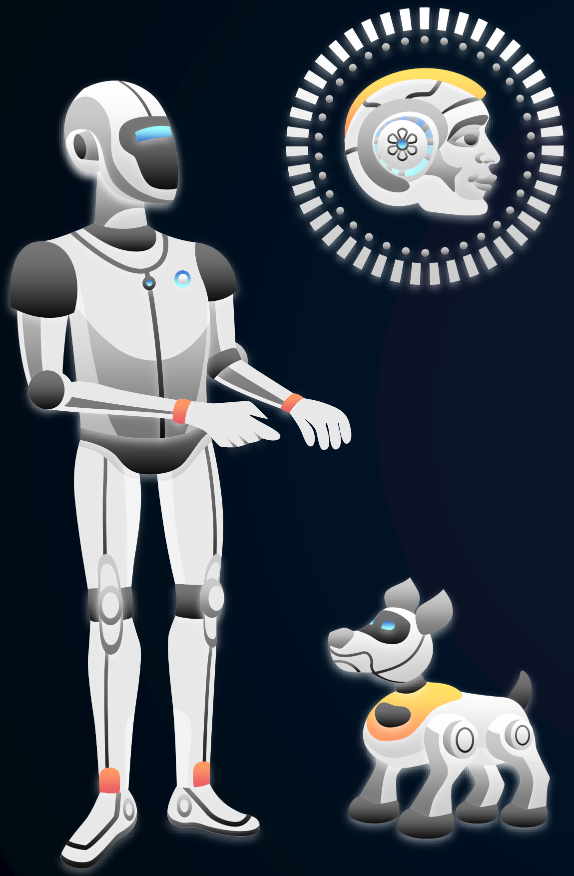
INTRODUCTION



INTRODUCTION

- Humanoid robots resemble and imitate human form and behavior.
- They have a head, torso, arms, and legs like humans.
- Humanoid robots aim to replicate human movements and interactions.
- They use advanced technologies like AI, sensors, and actuators.
- They are used in research, entertainment, and practical applications.
- Humanoid robots aid research in locomotion, cognition, and behavior.
- They entertain by performing in shows and interacting with audiences.
- They assist in caregiving for the elderly or people with disabilities.
- They perform dexterous tasks in industrial settings.
- Humanoid robots enhance human-robot collaboration.

TOP 5 HUMANOID ROBOT

NADINE

GEMINOID GK

JUNCO CHIHIRA

JIA JIA

SOPHIA

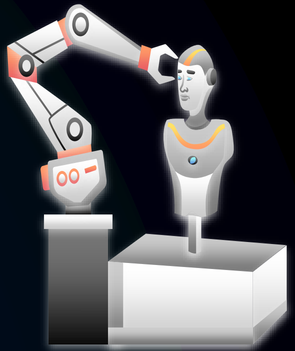
HUMANOID
ADVANTAGES & DISADVANTAGES

ADVANTAGES	DISADVANTAGES
Resemble and imitate human form and behavior	Complex design and manufacturing processes
Can perform tasks in a more human-like manner	Higher cost compared to other robot designs
Allow for better interaction and communication with humans	Limited mobility and agility compared to specialized robots
Can navigate and operate in environments designed for humans	Vulnerable to damage or malfunction due to complex mechanisms
Have potential applications in research, entertainment, caregiving, and industries	Require advanced AI and sensor systems for effective functioning
Enhance human-robot collaboration in various domains	Ethical considerations regarding human-like appearance and interactions

02

HISTORY & APPLICATIONS

TIMELINE HISTORY



1921

Term "robot" was coined by Czech playwright Karel Čapek in his play "R.U.R.," derived from the Czech word "robota," meaning forced labor

1948

William Grey Walter built the first electronic autonomous humanoid robot called "Elmer"

1970

WABOT-1, developed by researchers at Waseda University in Japan, became the first full-scale autonomous humanoid robot

1986

Honda introduced P2, a prototype humanoid robot with improved stability and walking capabilities.

1997

Honda unveiled its most famous humanoid robot, ASIMO (Advanced Step in Innovative Mobility), showcasing advancements in walking, running, and interacting with its environment

2000

Toyota, Boston Dynamics, and SoftBank Robotics, began developing and introducing their own humanoid robots

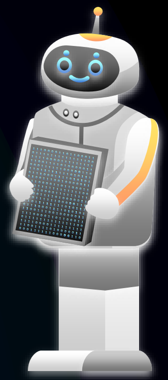
2016

Hanson Robotics introduced Sophia, a humanoid robot capable of social interactions and facial expressions

Current

Continued research and development have led to advancements in artificial intelligence, sensor technology, and human-robot interaction

APPLICATIONS



RESEARCH AND DEVELOPMENT

- Used in scientific research to study human locomotion, cognition, and behavior
- Contribute to advancements in robotics, psychology, neuroscience, and related fields

SOCIAL INTERACTION AND COMPANIONSHIP

- Have potential applications in social interactions, providing companionship, and assisting individuals with emotional support
- Can engage in conversations, display facial expressions, and mimic human gestures

ENTERTAINMENT AND PERFORMANCE

- Employed in entertainment industries, including theme parks, exhibitions, and shows
- Can perform choreographed routines, interact with audiences, and provide engaging experiences

CAREGIVING AND ASSISTANCE

- Assist in caregiving tasks, particularly for the elderly or individuals with disabilities
- Can support daily activities, monitor health conditions, and provide reminders or assistance in a home or healthcare setting

APPLICATIONS

EDUCATION AND TRAINING

- Can be utilized in educational settings to facilitate learning experiences
- Can act as tutors, teaching basic concepts or skills, or serve as practice partners in various disciplines

REHABILITATION AND THERAPY

- Have potential applications in rehabilitation and therapy, aiding individuals in physical or cognitive recovery
- Can assist with exercises, provide motivation, or offer interactive therapy sessions

HUMAN-ROBOT COLLABORATION

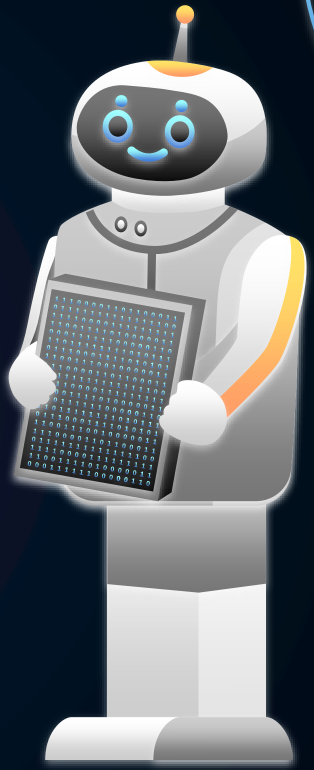
- Have the potential to work alongside humans in collaborative tasks
- Can assist with physically demanding tasks, share workload, and enhance overall productivity in various industries

03

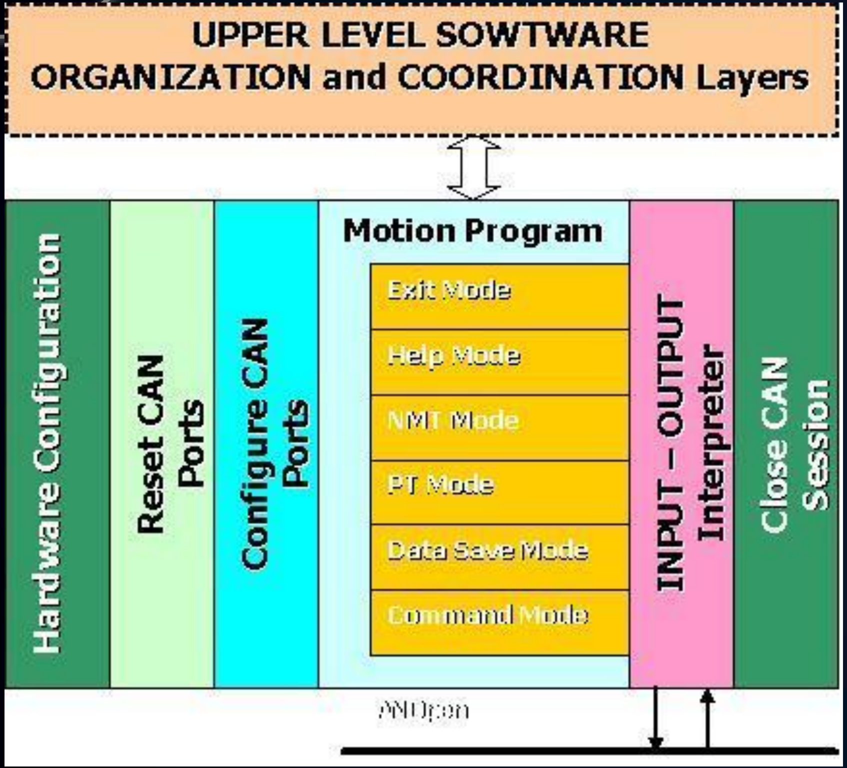
HUMANOID MAIN COMPONENTS

MAIN COMPONENTS

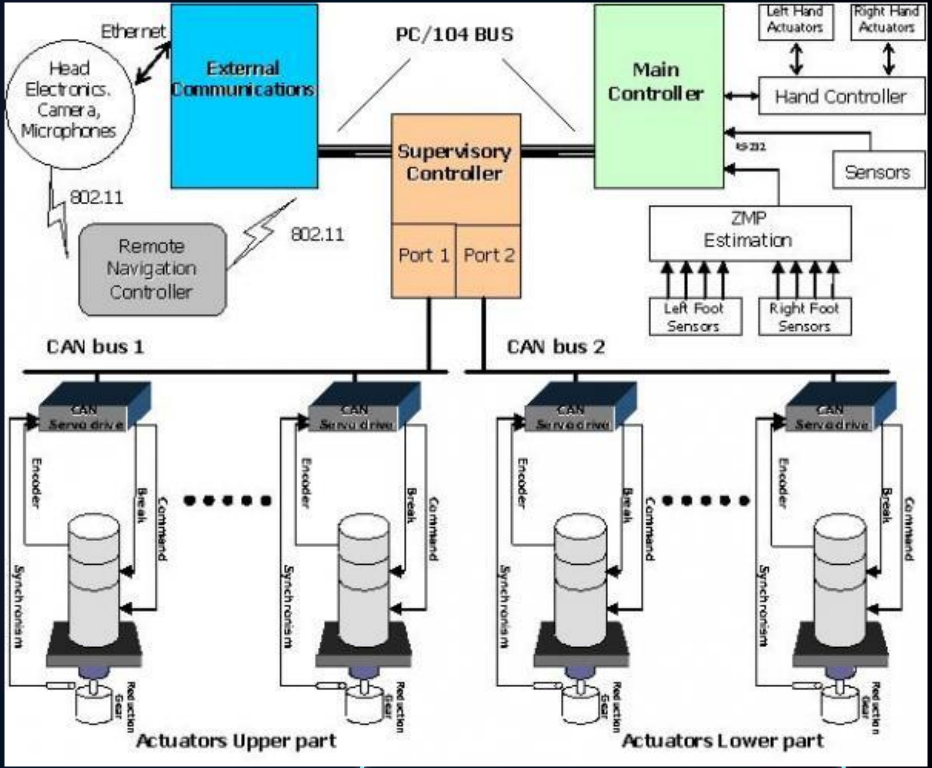
1. Body Design
2. Propulsion System (Actuators/Locomotion)
3. Navigation System & Control
4. Data Collection
5. Data Transmission
6. Power Management



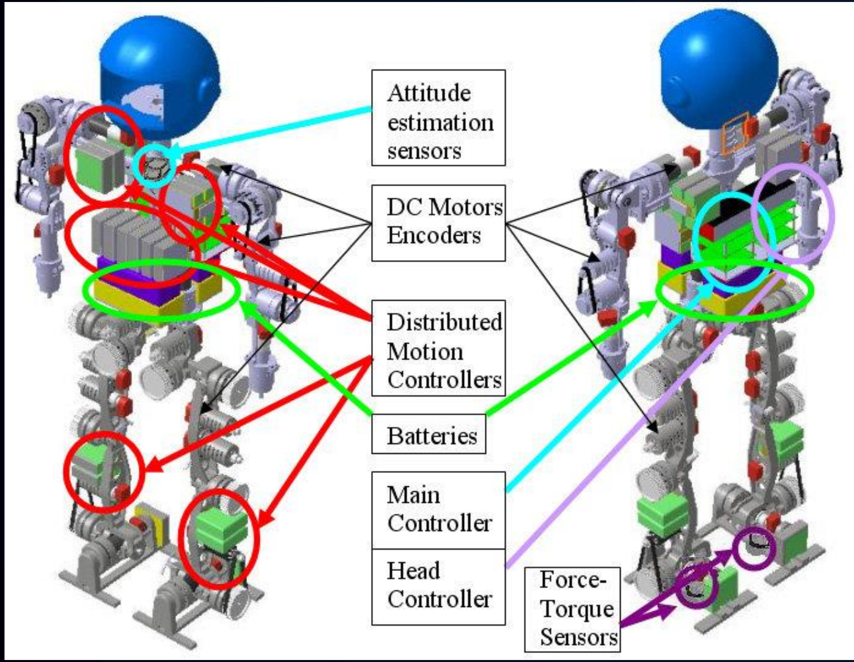
HARDWARE ARCHITECTURE

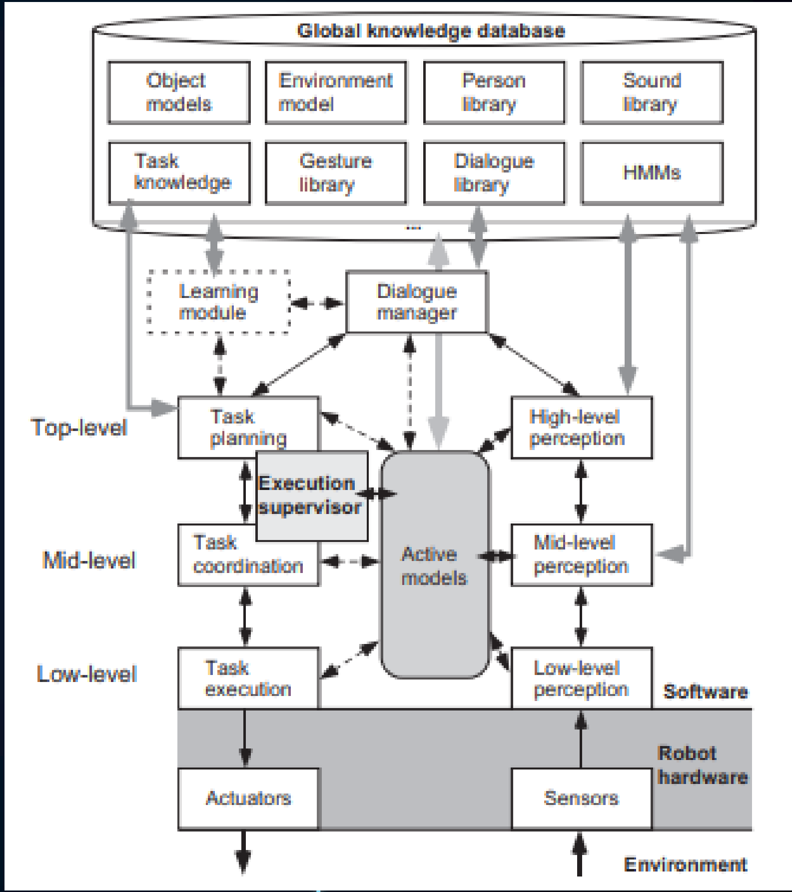


SOFTWARE ARCHITECTURE

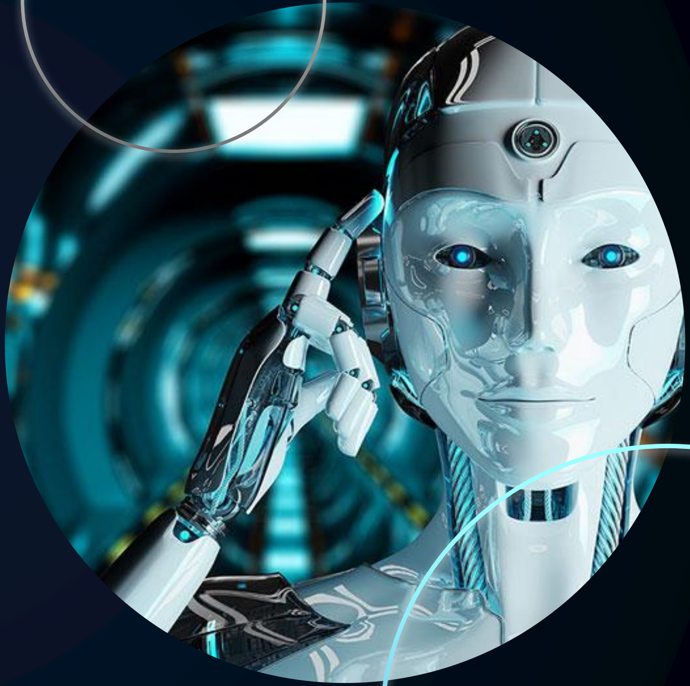


HUMANOID ROBOT HARDWARE ARCHITECTURE





BODY DESIGN



BODY DESIGN

HUMAN-LIKE BODY

- Resemble the human body, featuring a head, torso, arms, and legs
- Eg: ASIMO by Honda, Pepper by SoftBank Robotics

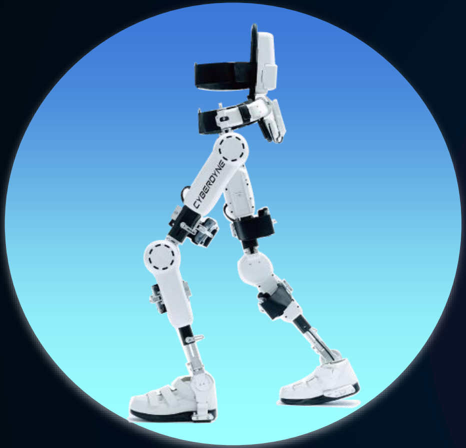
MINIMALIST DESIGN

- Simplified body design with basic shapes and fewer articulated joints
- Eg: Nao by SoftBank Robotics.

MODULAR BODY

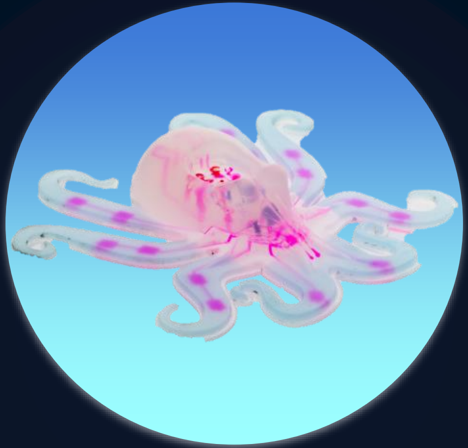
- Have a modular body design, consisting of interchangeable components or modules that can be reconfigured or replaced
- Eg: Poppy robot by Inria

BODY DESIGN



EXOSKELETONS

- Wearable devices that enhance human capabilities
- Eg: HAL (Hybrid Assistive Limb) exoskeleton by Cyberdyne



SOFT ROBOTICS

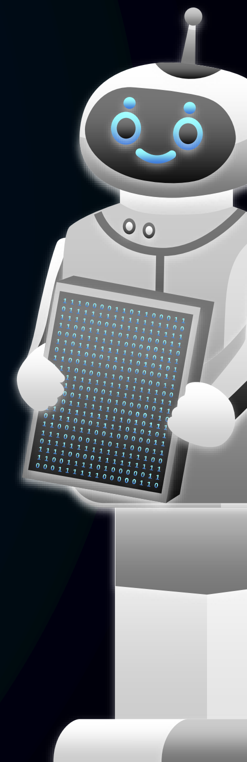
- Flexible and deformable materials to achieve compliance and adaptability
- Eg: Octobot developed by Harvard University

ANIMAL-INSPIRED DESIGNS

- Have features resembling animals' limbs, locomotion, or body structures
- Eg: MIT Cheetah robot, Festo BionicANTs

HUMANOID ROBOT COMPARISON

BODY DESIGN	PROS	CONS	PRICE
HUMAN-LIKE BODY	• Resembles human form and behavior • Natural movements and interactions	• Complex and costly to manufacture • Limited mobility and agility	• High
MINIMALIST DESIGN	• Simple and functional design • Ease of use and maintenance	• Limited range of movements • Less human-like appearance	• Moderate
MODULAR BODY	• Customizable and adaptable • Flexibility in component	• Assembly and compatibility issues	• Varies (depending on customization)
EXOSKELETONS	• Augments human capabilities • Provides support and assistance	• Requires human wearer for operation • Limited autonomy and mobility	• High
SOFT ROBOTICS	• Safe interactions with humans • Potential for flexible locomotion	• Limited strength and load-bearing capabilities • Complex control and fabrication	• Moderate to high
ANIMAL-INSPIRED DESIGNS	• Mimics animal locomotion and behavior • Unique and engaging design	• Limited human-like appearance	• Varies (depending on customization)

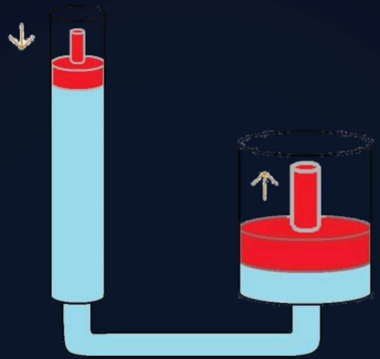


PROPULSION SYSTEMS FOR LOCOMOTION

PROPULSION SYSTEM

ELECTRIC MOTORS

Motors can be coupled with gears or transmission systems to drive the robot's joints, limbs, or wheels, enabling locomotion



HYDRAULIC ACTUATORS

Provide high force output and are often employed in larger or more heavy-duty humanoid robots

PNEUMATIC ACTUATORS

Lightweight and can provide fast and responsive movements, making them suitable for agile locomotion in certain humanoid robots

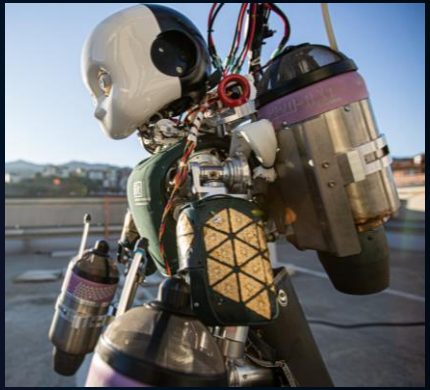
PROPULSION SYSTEM

WHEELS AND TREADS

powered by electric motors or other drive mechanisms, allowing the robot to move on flat surfaces or rough terrain

LINEAR ACTUATORS

Electric linear motors or pneumatic cylinders, provide linear motion for locomotion in humanoid robots

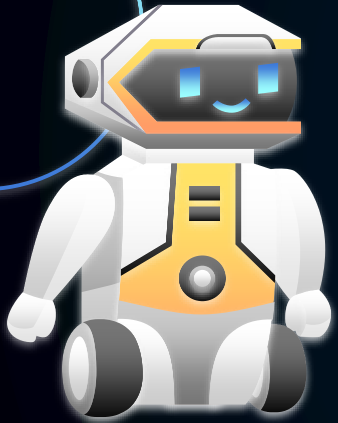


JET PROPULSION

Thrusters or jets, may be employed for locomotion. These systems generate thrust to propel the robot through air or water.

NAVIGATION SYSTEM & CONTROL

NAVIGATION SYSTEM



1. SLAM (Simultaneous Localization and Mapping)

Combines sensor data, such as camera, LIDAR, or depth sensors, with algorithms to estimate the robot's position and build a representation of the surroundings

2. Sensors

Include vision sensors (cameras, RGB-D sensors), range sensors (LIDAR, ultrasonic sensors), inertial sensors (gyroscopes, accelerometers), and proprioceptive sensors (joint encoders). The sensors provide information about the robot's surroundings, its position, and help detect obstacles and landmarks for navigation.

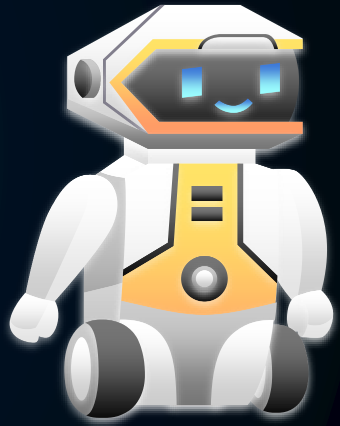
3. Human-Robot Interaction (HRI)

Involves the use of sensors and algorithms to perceive human intentions, gestures, and commands, allowing the robot to navigate safely and effectively in a shared environment.

NAVIGATION SYSTEM

4. Obstacle Avoidance

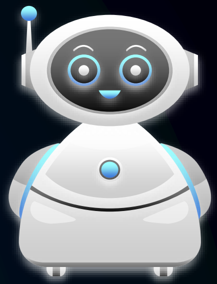
Can be achieved using sensor data, such as LIDAR or depth sensors, to perceive the environment and plan appropriate trajectories or adjust movements to avoid collisions. Algorithms for obstacle detection and avoidance help the robot navigate safely in complex and dynamic environments.



5. Path Planning

Takes into account the robot's current position, the map of the environment, and constraints such as robot dynamics and obstacle avoidance. Path planning algorithms ensure efficient and collision-free navigation towards a goal location.

CONTROL SYSTEM



TYPES OF SOFTWARE

ROS (Robot Operating System)

- Allow developers to implement various functionalities, such as perception, motion planning, and control, to create complex behaviors for humanoid robots.

NAOqi

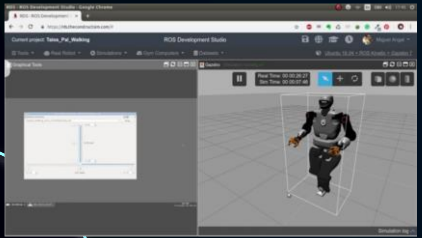
- Offers functionalities such as speech recognition, motion control, vision processing, and human-robot interaction

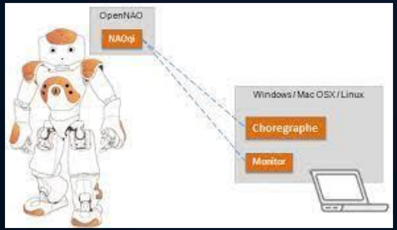
Gazebo

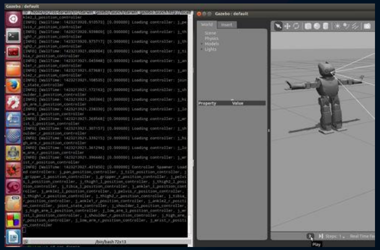
- Provides physics simulation, sensor models, and a robust API for controlling robot behaviors.

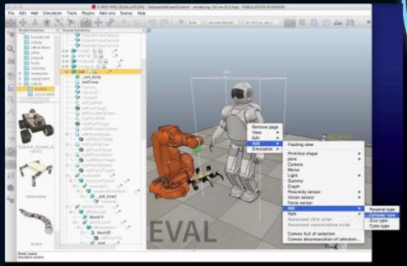
V-REP (Virtual Robot Experimentation Platform)

- Provides a wide range of sensors, actuators, and physics simulation capabilities, allowing developers to create realistic simulations for their robots









DATA
COLLECTION

CAMERAS

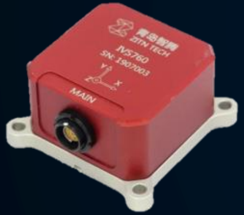
Provide visual feedback like image recognition, depth estimation, and human-robot interaction

LIDAR

Used for mapping, localization, obstacle detection, and navigation

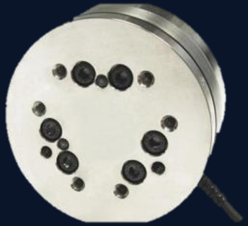
ULTRASONIC SENSORS

Used for proximity sensing, obstacle avoidance, and navigation



IMU

Consist of accelerometers, gyroscopes, and sometimes magnetometers. They measure the robot's acceleration, angular velocity, and orientation in space.



FORCE/TORQUE SENSORS

Measure the forces and torques exerted on the robot's limbs or end-effectors

PRESSURE SENSORS

Detect variations in pressure and are often used in the soles of humanoid robot feet to provide feedback on ground contact and balance control

MICROPHONES

Capture sound signals, enabling speech recognition, sound localization, and voice-based commands

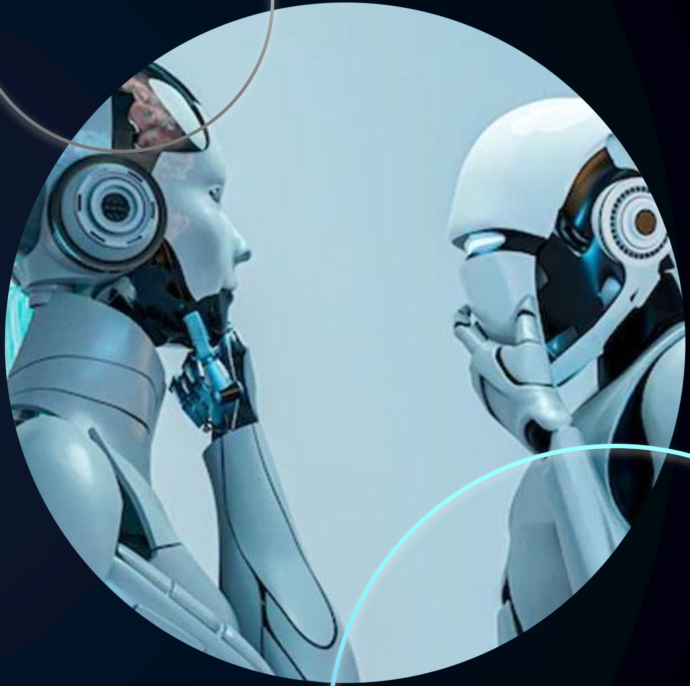
TACTILE SENSORS

Measure pressure, vibration, or contact forces applied to the robot's skin or fingertips

RANGE FINDERS

Used for localization, mapping, and obstacle detection in indoor environments

DATA TRANSMISSION

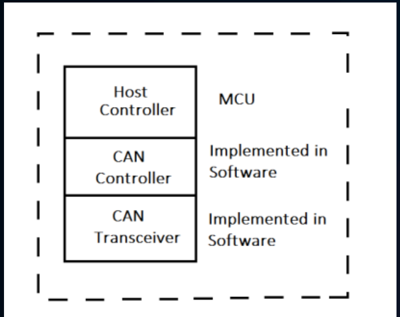


WIRED CONNECTIONS

- Ethernet cables, USB cables, serial communication (RS-232 or RS-485), or other custom communication protocols
- Provide reliable and high-speed data transmission but may limit the robot's mobility and require physical connections

WIRELESS COMMUNICATION

- Enable data transmission without the need for physical cables
- Eg: Wi-Fi, Bluetooth, ZigBee, Radio Frequency (RF)

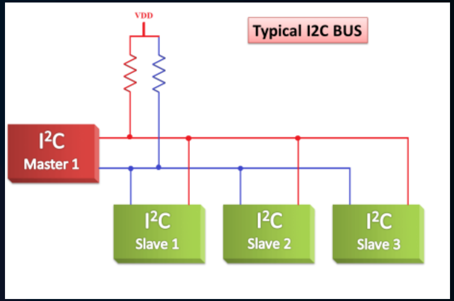


CAN (Controller Area Network)

- Used for interconnecting sensors, actuators, and control modules in complex robotic systems

Ethernet/IP

- Enables communication and data exchange between different devices or systems in an industrial environment



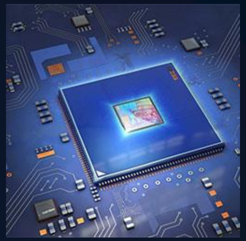
I2C (Inter-Integrated Circuit)

- Commonly used for connecting and controlling peripheral devices, such as sensors or motor controllers, within a humanoid robot.

POWER MANAGEMENT

BATTERY SYSTEMS

- provide DC power to the robot's components and can be easily replaced or recharged
- Battery systems often incorporate battery management systems (BMS) to monitor and optimize the battery's performance, ensuring safe and efficient operation



POWER EFFICIENT COMPONENTS

- Include low-power processors, low-power sensors, and optimized actuators
- Designed to operate efficiently while providing the necessary functionality, allowing the robot to maximize its battery life and overall power efficiency

ENERGY HARVESTING

- Includes solar panels, kinetic energy harvesters, or thermal energy converters
- Can supplement or recharge the primary power source, reducing reliance on external power and extending the robot's operating time.

POWER MANAGEMENT ICS

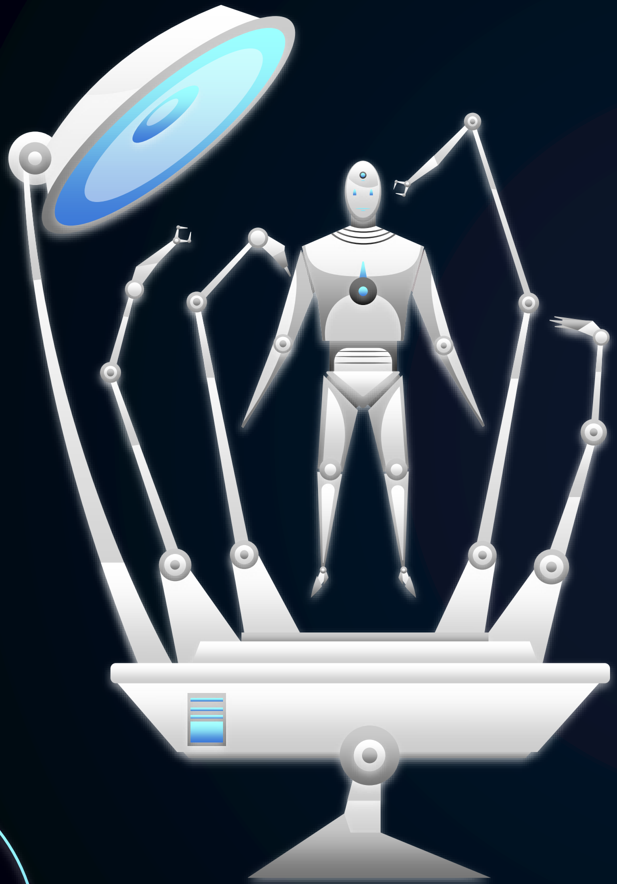
- Includes specialized chips that regulate and distribute power within the humanoid robot
- Optimize power conversion, manage voltage levels, and provide features such as power sequencing, thermal management, and dynamic power scaling

04

CONCLUSION

CONCLUSION

- The development of humanoid robots showcases the significant progress made in robotics, artificial intelligence, and sensor technologies.
- Contribute to advancements in robotics, psychology, neuroscience, and other related fields
- Humanoid robots have a wide range of potential applications, including entertainment, education, healthcare, research, and industrial settings.
- Collaboration between humans and robots can lead to increased productivity, improved efficiency, and enhanced overall performance in fields such as healthcare, manufacturing, and service industries



THANK YOU!