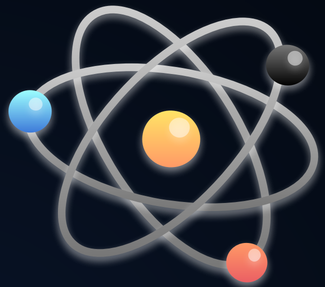
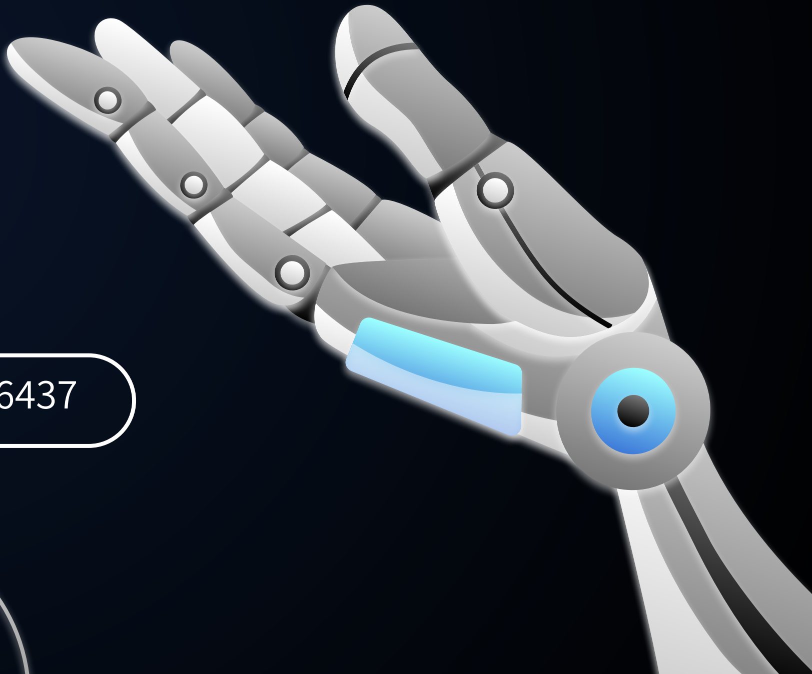
HUMANOID ROBOT





Prepared by: Muhammad Syahmi Bin A Rahim 1916437

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INTRODUCTION

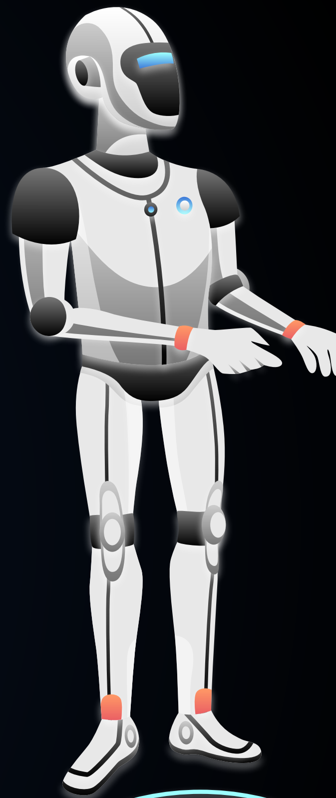
INTRODUCTION

- A humanoid robot refers to a type of robot that is designed to resemble or mimic the physical appearance and capabilities of a human being.

- These robots are created with the intention of performing tasks or interacting with the environment in a way that is similar to how a human would.

- A humanoid robot typically possesses a body structure resembling that of a human, with a head, torso, arms, and legs.

- Humanoid robots may be equipped with sensors, actuators, and artificial intelligence (AI) systems to perceive and interact with their surroundings.



INTRODUCTION

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HISTORY

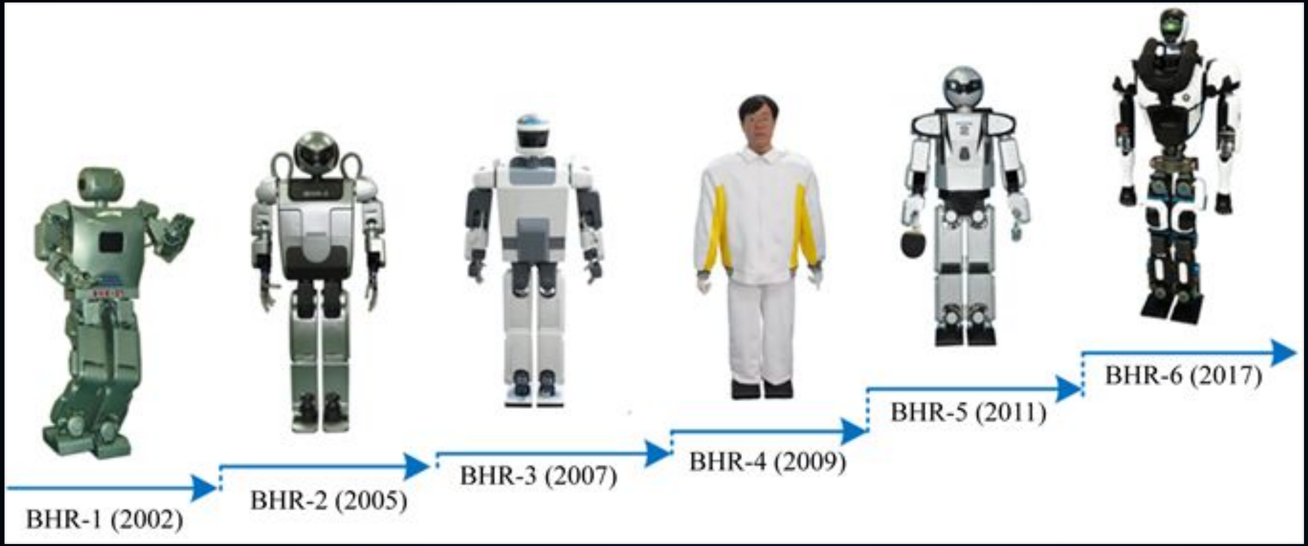
HISTORY

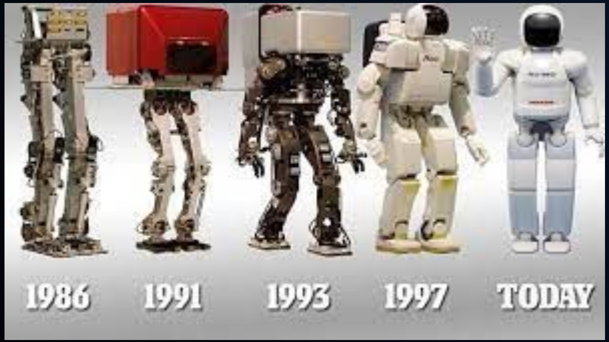
Year	Milestone
1921	The first humanoid robot, known as "Robotski" or "Eric," was built by Czech writer Karel Čapek and his brother Josef. It was featured in the play "R.U.R." (Rossum's Universal Robots), introducing the term "robot" to the world.
1948	WABOT-1, developed by the Japanese scientist Dr. Waseda, became the first humanoid robot with electromechanical hands. It had a basic ability to move and interact with objects.
1970s	The "Shakey" robot, developed at Stanford Research Institute (SRI), was a pioneering autonomous mobile robot that used a TV camera and sensors to navigate its environment. Though not humanoid, it contributed to the development of robotic perception and control.
1986	Honda introduced the P2 humanoid robot, a significant step in humanoid robotics. It had the ability to walk and climb stairs, showcasing advancements in bipedal locomotion.
1990s	MIT's Cog project, led by Rodney Brooks, focused on developing a humanoid robot with the ability to perceive and interact with its environment. Cog demonstrated cognitive capabilities and embodied intelligence, paving the way for research in human-like artificial intelligence.
2000	Honda released ASIMO (Advanced Step in Innovative Mobility), an advanced humanoid robot capable of walking on uneven surfaces, recognizing faces and voices, and interacting with humans. ASIMO showcased improvements in mobility, dexterity, and human-robot interaction.

HISTORY

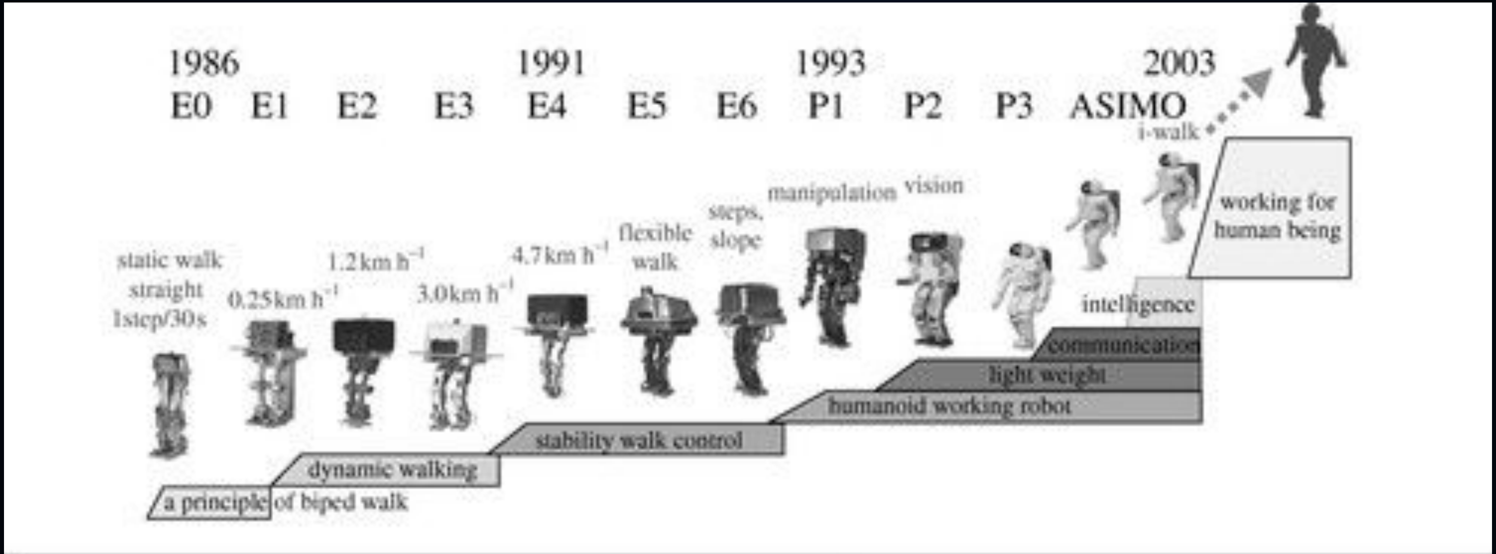
Year	Milestone
2011	Boston Dynamics unveiled PETMAN, a humanoid robot designed for testing protective clothing. It showcased impressive balance, agility, and the ability to mimic human movements, setting a new standard for dynamic humanoid robotics.
2016	SoftBank Robotics introduced Pepper, a humanoid robot designed for human interaction and companionship. Pepper could recognize and respond to emotions, engage in conversations, and assist with tasks. It found applications in retail, customer service, and education, highlighting the potential for humanoid robots as social companions.
Present	Ongoing research and development continue to advance humanoid robotics. Companies like Boston Dynamics, Toyota, and Honda are working on next-generation robots with improved capabilities, agility, and human-like behaviors. Progress is being made in areas such as AI, machine learning, computer vision, and materials science, shaping the future of humanoid robots and their integration into various aspects of society.

HISTORY


BHR-1 (2002)
BHR-2 (2005)
BHR-3 (2007)
BHR-4 (2009)
BHR-5 (2011)
BHR-6 (2017)


1986
1991
1993
1997
TODAY

HISTORY



a step-by-step approach has been taken, starting with a basic, static walk, through an automatically adjustable, intelligent walk, ending towards the capability of working for a human-being

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APPLICATIONS

APPLICATIONS

Application	Description	
Healthcare Assistance	Humanoid robots can assist in healthcare settings by providing support to patients, such as monitoring vital signs, reminding them to take medication, and offering companionship. They can also assist healthcare professionals by carrying out basic tasks like delivering supplies or helping with patient rehabilitation exercises.	
Elderly Care	Humanoid robots can provide assistance and companionship to the elderly. They can help with daily tasks like fetching items, reminding them of appointments, or engaging in conversation to reduce loneliness. These robots can also monitor the well-being of seniors, alerting caregivers or medical professionals in case of emergencies.	

APPLICATIONS

Application	Description	
Research and Development	Humanoid robots serve as valuable tools in robotics research and development. They enable scientists and engineers to study human-robot interaction, develop and test algorithms, and explore advancements in AI, computer vision, and robotics.	
Customer Service	Humanoid robots can serve as interactive and engaging customer service representatives in various settings, such as retail stores, hotels, and airports. They can answer frequently asked questions, provide directions, and offer information about products or services. These robots can enhance the customer experience by providing a unique and memorable interaction.	

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MAIN COMPONENTS

MAIN COMPONENTS

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BODY DESIGN

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LOCOMOTION

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DATA COLLECTION

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DATA TRANSMISSION

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POWER DISTRIBUTION

BODY DESIGN

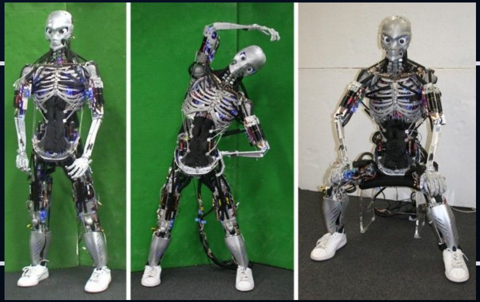
- In general, humanoid robots encompass a body design that includes a torso, a head, two arms, and two legs, closely resembling the basic structure of a human body.
- The considerations for humanoid robot design:

Consideration	Description	Example
Proportions of the body	Achieving human-like kinematics and mass distributions	Similar link lengths and mass distributions
Skeletal structure	Fidelity in mimicking human joints and flexible upper body	Combination of single-axis rotation and rolling-sliding joints; spine joints with multiple vertebrae
Joint performance	Impact on whole-body motion, range of motion, and power output	Degrees of freedom (DOF) used for joints
Arrangement of muscles	Identifying muscle-joint-operational mappings	Incorporating muscle actuators for human-like arrangement

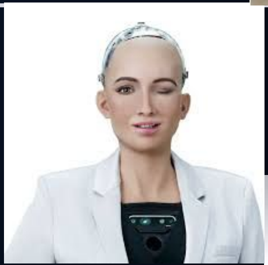
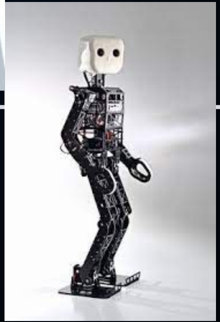
BODY DESIGN

BODY DESIGN

Body Design	Description	Example
Bipedal	Two-legged design resembling the human form	Honda's ASIMO
Wheeled Base	Incorporates a wheeled base for faster mobility	SEROPI (Service Robot Platform Initiative)
Exoskeleton	Robotic structure worn by humans for strength augmentation	



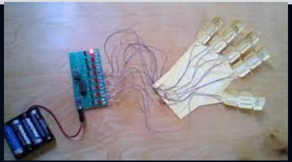
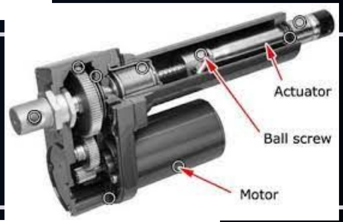
BODY DESIGN

Body Design	Description	Example
Humanoid Torso	Limited design focusing on upper torso and arms	Toyota's HSR (Human Support Robot) 
Android	Resembles human appearance and facial expressions	Hanson Robotics' Sophia 
Miniature Humanoid	Smaller-sized humanoid design	RoboCup TeenSize humanoid robots 

LOCOMOTION

Actuator	Description	Example
Electric Motors	Electrical devices that convert electrical energy into rotational motion	
Servo Motors	Rotary actuators that provide precise control of angular position	dynamixel servo 
Pneumatic Actuators	Driven by compressed air or gas, providing fast and powerful movements	Festo's Fluidic Muscle actuators 
Hydraulic Actuators	Powered by hydraulic fluid to generate large forces and movements	Moog's Radial Piston Pump 

LOCOMOTION

Actuator	Description	Example
Shape Memory Alloys	Materials that can change shape in response to thermal or electrical stimuli	Nitinol-based muscle wires 
Electromagnetic	Actuators that use the force produced by the interaction of magnetic fields	Solenoids 
Linear Actuators	Provide linear motion and are used for pushing, pulling, or lifting tasks	Ball screw actuators 
Fiber Muscles	Synthetic fiber-based actuators that contract and expand to generate movement	Festo's Fluidic Muscle actuators 

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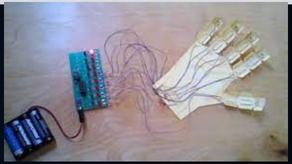
Shape Memory Alloys	Materials that can change shape in response to thermal or electrical stimuli	Nitinol-based muscle wires 
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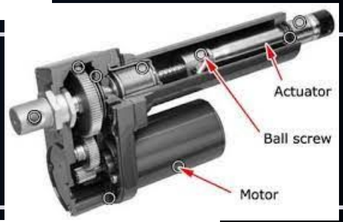
Linear Actuators	Provide linear motion and are used for pushing, pulling, or lifting tasks	Ball screw actuators 
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NAVIGATION

Navigation Method	Hardware Used	Algorithms Used	Example
Wheeled Base	Wheels or omnidirectional wheels	Path planning, obstacle avoidance algorithms	Boston Dynamics' Handle
Bipedal Walking	Legs and foot sensors	Gait generation, balance control algorithms	Honda's ASIMO
SLAM (Simultaneous Localization and Mapping)	Sensors (e.g., cameras, LiDAR)	SLAM algorithms, mapping and localization	Boston Dynamics' Atlas
Vision-Based	Cameras or stereo vision systems	Visual odometry, image processing algorithms	SoftBank Robotics' Pepper
GPS-Based	GPS receiver	Localization using GPS coordinates	None (GPS-based navigation)

NAVIGATION

Navigation Method	Hardware Used	Algorithms Used	Example
Inertial Navigation	Inertial Measurement Unit (IMU)	Dead reckoning, sensor fusion algorithms	Boston Dynamics' Spot
Lidar-Based	Lidar sensors	Environment mapping, obstacle detection	ANYmal by ANYbotics
Motion Capture	Motion capture systems or sensors	Real-time motion tracking and control	University of Tokyo's HRP-4 robot
Neural Network-Based	Neural network models or deep learning	Learning-based navigation and decision-making	Agility Robotics' Cassie

DATA COLLECTION

Data Collected	Hardware Used	Purpose
Vision Data	Cameras, RGB-D sensors	Object recognition, scene understanding, visual perception
Inertial Data	Inertial Measurement Unit (IMU)	Orientation estimation, motion tracking
Force/Torque Data	Force/torque sensors	Grasping force control, object manipulation
Environmental Data	Temperature sensors, humidity sensors	Environmental monitoring, adaptive behavior
Audio Data	Microphones	Speech recognition, sound localization
Lidar Data	Lidar sensors	Obstacle detection, mapping and localization
Touch Data	Tactile sensors	Object exploration, haptic interaction
Joint Position/Force Data	Encoders, load cells	Motor control, joint stability
Biometric Data	Heart rate sensors, EEG sensors	Emotion recognition, user engagement

DATA TRANSMISSION

- Data transmission allows humanoid robots to exchange information with external devices, communicate with other robots or systems, and receive commands or updates.

- It enables the transfer of sensory data, control signals, programming instructions, and other relevant information.

- For example, humanoid robots may transmit vision data from cameras or sensors to analyze their surroundings, receive commands for specific actions or tasks, transmit telemetry data for monitoring and diagnostics, or communicate with a central control system for coordination in multi-robot systems.

DATA TRANSMISSION

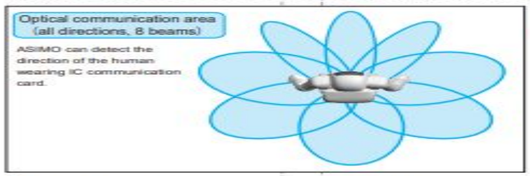
Data Transmission Method	Hardware Used	Description
Wired Communication	Ethernet cables, USB cables	Data transmission through physical wired connections
Wireless Communication	Wi-Fi, Bluetooth, Zigbee, Radio Frequency (RF)	Data transmission over wireless networks
Infrared Communication	Infrared transceivers	Communication using infrared light signals
Radio Communication	Radio transceivers	Communication using radio waves
CAN (Controller Area Network)	CAN bus modules	Network protocol for real-time control applications
Optical Communication	Optical fibers, photodiodes	Transmission of data using optical signals
NFC (Near Field Communication)	NFC modules, RFID tags	Short-range wireless communication for small data
Cellular Communication	Cellular modules, SIM cards	Data transmission using cellular networks
Satellite Communication	Satellite transceivers	Long-range communication via satellite networks

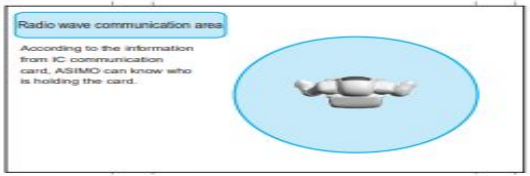
DATA TRANSMISSION

IC Communication Card

In collaboration with Honda's unique IC communication card, an IC tag with optical communication functions, ASIMO autonomously selects and executes its tasks.

Based on customer information pre-registered in the IC communication card, ASIMO identifies the characteristics and relative position of its target person. Even with multiple people around, ASIMO can determine their positions and who they are, and respond to each person individually.





Attending to a person while recognizing the person

Based on the information in the IC Communication card, ASIMO recognizes the individual and attends to the person accordingly.

Attending to a person while specifying the position of the person

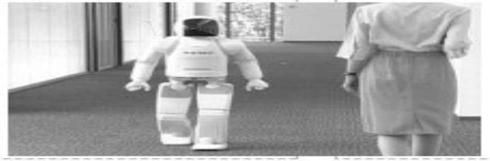
Based on the information in the IC Communication card ASIMO specifies the position of the person and adjusts its position to attend to them while facing toward that person.

Attending to a person while measuring the distance to the person

Calculating the relative distance between ASIMO and the person to attend, ASIMO adjusts its walking speed. If the distance becomes too great, ASIMO waits until the person comes closer.

Greeting people as they pass by

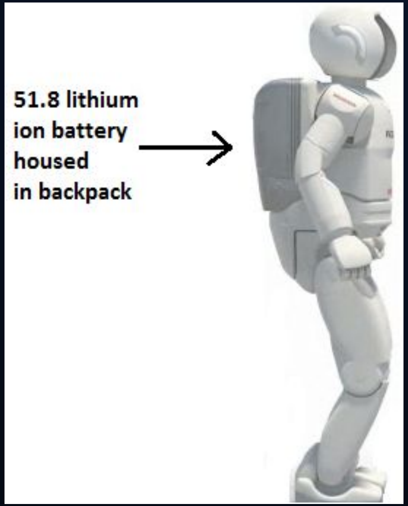
When passing a person who carries an IC communication card, ASIMO identifies the card information and greets appropriate for the person.

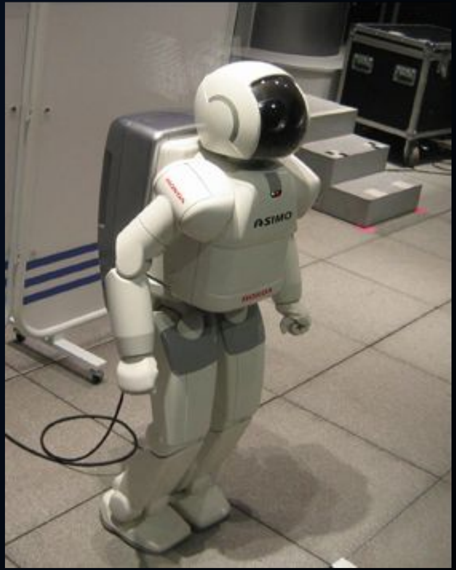


POWER MANAGEMENT SYSTEM

Power Source

- Battery: Rechargeable batteries provide portable power ie Lithium-ion batteries, such as LiPo or LiFePo
- Wired Power Cord: Directly connected to a power source





POWER MANAGEMENT SYSTEM

Charging System

- Battery Charger: Recharges the robot's batteries. Smart chargers with overcharge protection
- Inductive Charging: Wireless charging through coils

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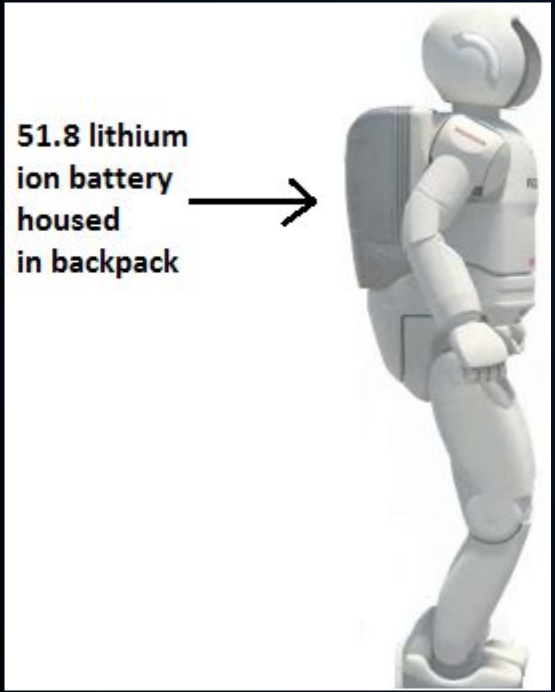
POWER MANAGEMENT SYSTEM

Power Distribution

- Power Distribution Unit (PDU): Distributes power to various components and subsystems.
- Inductive Charging: Wireless charging through coils
- Voltage Regulator: Stabilizes and regulates voltage
- Converters/Inverters: Convert power between AC and DC

POWER MANAGEMENT SYSTEM



THANK YOU