Humanoid Robot

ROBOTIC HARDWARE SYSTEMS (MCTE 4362)

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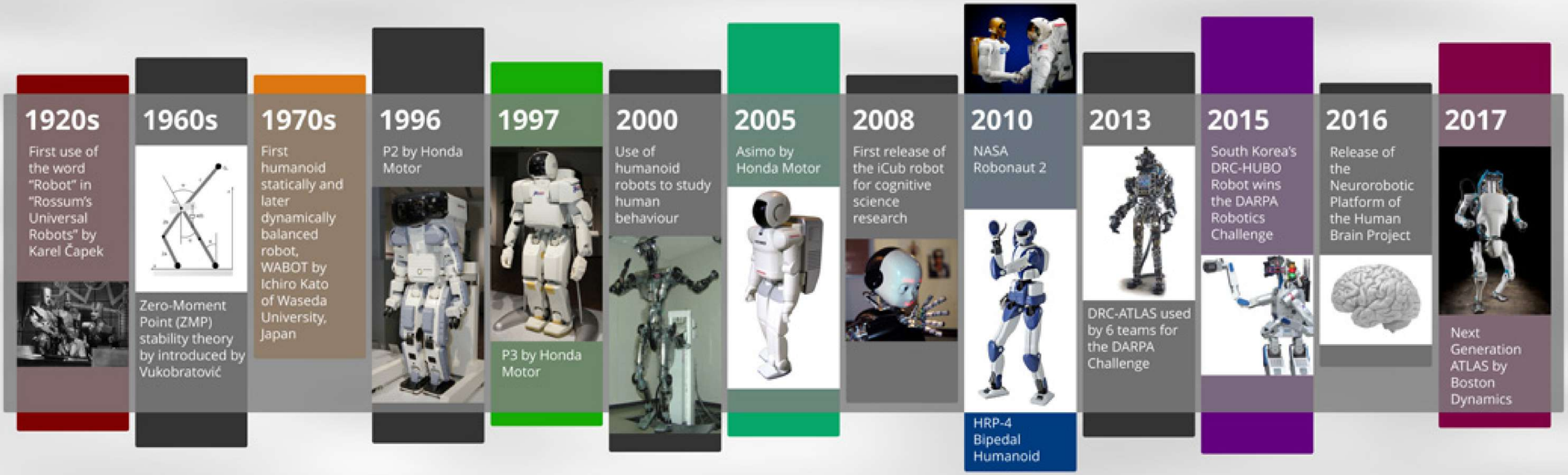
Introduction

- Humanoid robots are advanced robots designed to resemble and mimic human-like features and behaviors.
- They operate in human environments, performing tasks that require human-like capabilities.
- These robots have mechanical, electrical, and computational systems that enable precise and versatile task performance.
- Humanoid robots serve as a bridge between humans and machines, facilitating seamless communication and collaboration.
- Advancements in robotics, AI, and sensors have allowed humanoid robots to imitate human abilities.

History


1920s
First use of the word "Robot" in "Rossum's Universal Robots" by Karel Čapek
1960s
Zero-Moment Point (ZMP) stability theory by introduced by Vukobratović
1970s
First humanoid statically and later dynamically balanced robot, WABOT by Ichiro Kato of Waseda University, Japan
1996
P2 by Honda Motor
1997
P3 by Honda Motor
2000
Use of humanoid robots to study human behaviour
2005
Asimo by Honda Motor
2008
First release of the iCub robot for cognitive science research
2010
NASA Robonaut 2
HRP-4 Bipedal Humanoid
2013
DRC-ATLAS used by 6 teams for the DARPA Challenge
2015
South Korea's DRC-HUBO Robot wins the DARPA Robotics Challenge
2016
Release of the Neurorobotic Platform of the Human Brain Project
2017
Next Generation ATLAS by Boston Dynamics

Application

- **Healthcare:**

Assisting in patient care, rehabilitation, and performing delicate medical procedures.

- **Education:**

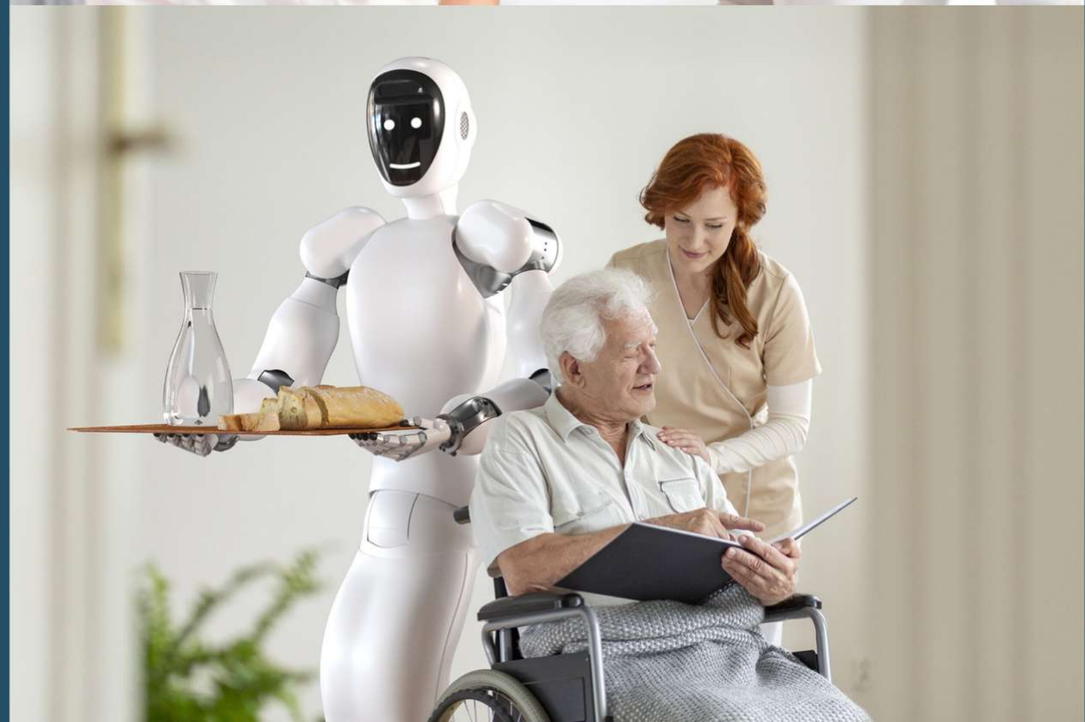
Serving as interactive companions or teachers for children and individuals with special needs.

- **Entertainment:**

Performing in shows, exhibitions, and theme parks, captivating and entertaining audiences.

- **Research:**

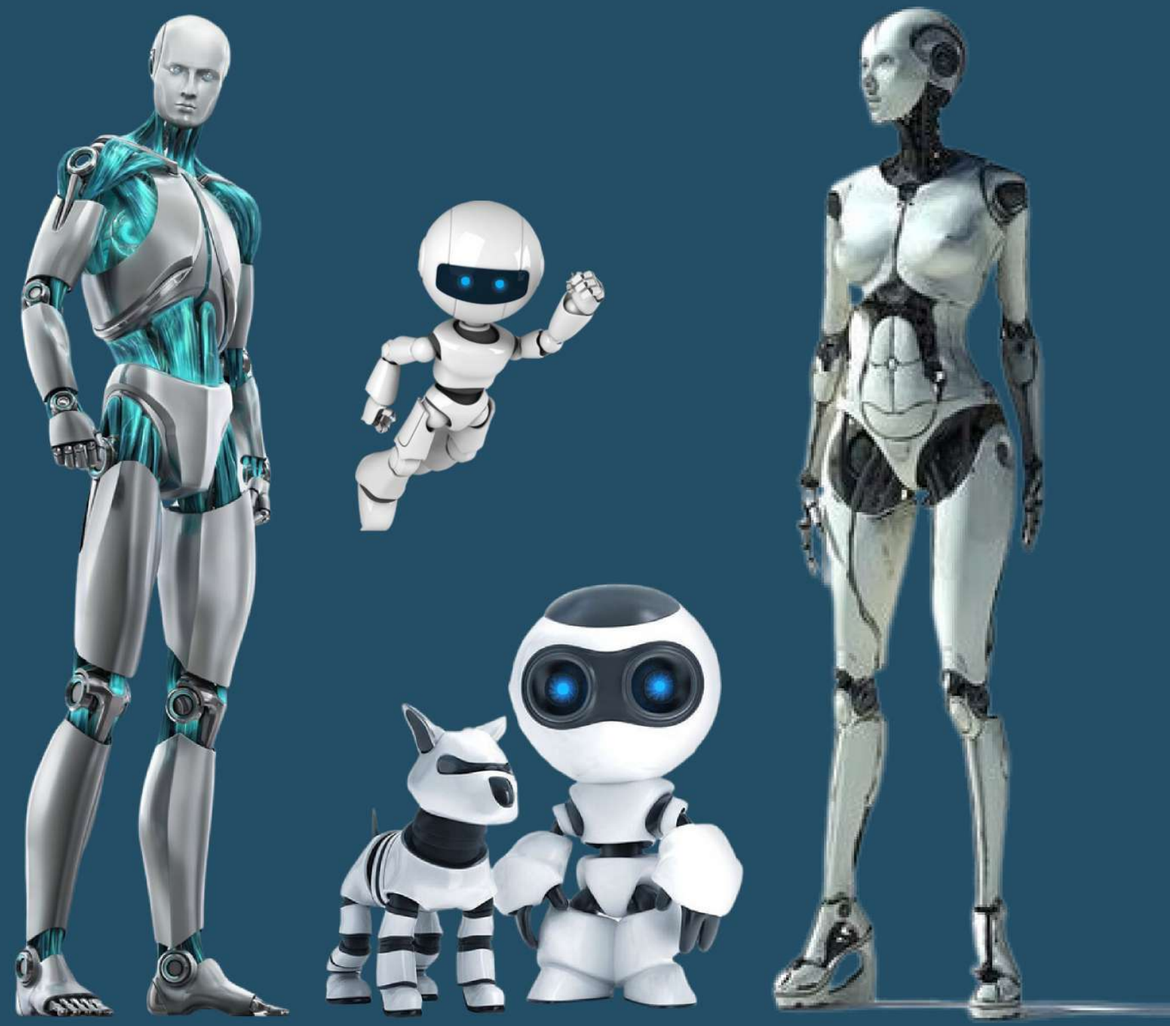
Studying human-like movement, cognition, and social interaction for scientific exploration.



Main Components of the Robot

1. Body Design

- Humanoid robots have a body structure resembling the human anatomy, including a head, torso, arms, and legs.
- Body materials are lightweight and durable, such as metal alloys or carbon fibre composites.
- Additional features like facial expressions and realistic skin texture enhance human-like appearance.



Main Components of the Robot

2. Locomotion:

- Humanoid robots employ various methods of locomotion, including walking, running, or even complex movements like climbing stairs.
- Locomotion mechanisms can involve wheels, legs with joints, or a combination of both, enabling versatile movements.

Locomotion Method	Description	Example
Walking	Human-like bipedal walking using legs	ASIMO humanoid robot by Honda
Rolling	Wheeled locomotion for smooth surfaces	NAO humanoid robot by SoftBank Robotics
Crawling	Crawl-like movement using multiple limbs	RoboCup humanoid robots
Flying	Aerial movement using propellers or wings	Valkyrie humanoid robot by NASA

Main Components of the Robot

3. Navigation:

- Humanoid robots use advanced navigation systems to perceive their environment and navigate through it.
- Sensors like cameras, depth sensors, and LiDAR enable perception of surroundings.
- Mapping and localization algorithms help in creating internal maps and determining robot position.

Navigation System	Description	Example
Vision-based	Using cameras and image processing for object recognition and mapping	Pepper humanoid robot by SoftBank Robotics
Laser-based	Utilizing laser sensors for environment perception and obstacle avoidance	Atlas humanoid robot by Boston Dynamics
Simultaneous Localization and Mapping (SLAM)	Creating a map of the environment while estimating robot's location	NAO humanoid robot by SoftBank Robotics
Global Positioning System (GPS)	Outdoor navigation based on satellite signals	Humanoid robots for search and rescue missions

Main Components of the Robot

4. Data Collection:

- Humanoid robots incorporate various sensors for data collection and interaction with the environment.
- Sensors may include cameras for visual input, microphones for audio input, and touch sensors for physical interaction.
- These sensors enable the robot to gather information, recognize objects, and respond to stimuli.

Data Collection Method	Description	Example
Cameras	Capturing visual information for object detection and recognition	iCub humanoid robot by IIT
Microphones	Collecting audio data for voice recognition and sound localization	NAO humanoid robot by SoftBank Robotics
Force/Torque Sensors	Measuring forces and torques for object manipulation and interaction	PR2 humanoid robot by Willow Garage
Environmental Sensors	Gathering data on temperature, humidity, and other environmental factors	REEM-C humanoid robot by PAL Robotics

Main Components of the Robot

5. Communication:

- Humanoid robots employ communication systems to interact with humans and other robots.
- Speech recognition and synthesis allow the robot to understand and generate spoken language.
- Gestures, facial expressions, and body language contribute to effective communication and social interaction.

Communication Method	Description	Example
Wi-Fi	Wireless communication using standard Wi-Fi protocols	Pepper humanoid robot by SoftBank Robotics
Bluetooth	Short-range wireless communication for connecting with other devices	NAO humanoid robot by SoftBank Robotics
Ethernet	Wired communication through Ethernet cables	HRP humanoid robot by AIST
Zigbee	Low-power wireless communication for coordination in a swarm of robots	Swarm robotics research projects

Main Components of the Robot

6. Power Management:

- Humanoid robots require efficient power management systems for prolonged operation.
- Power sources can include batteries, fuel cells, or a combination of renewable energy sources.
- Power management systems optimize energy consumption and recharge or refuel as necessary.

Power Management Method	Description	Example
Battery	Using rechargeable batteries as the primary power source	ASIMO humanoid robot by Honda
Power Cord	Tethered operation with a continuous power supply through a cord	NAO humanoid robot by SoftBank Robotics
Solar Power	Harnessing energy from sunlight using solar panels	RoboThespian humanoid robot by Engineered Arts
Fuel Cell	Generating electricity through a chemical reaction, typically using hydrogen	HRP humanoid robot by AIST

Conclusion

- Humanoid robots represent a significant advancement in robotics, imitating human-like behaviors and capabilities.
- With their potential applications in healthcare, education, entertainment, and research, humanoid robots are shaping the future of human-robot interaction.
- Ongoing research and development will further enhance their capabilities, making them more integrated and beneficial in various aspects of our lives.


Thank you!