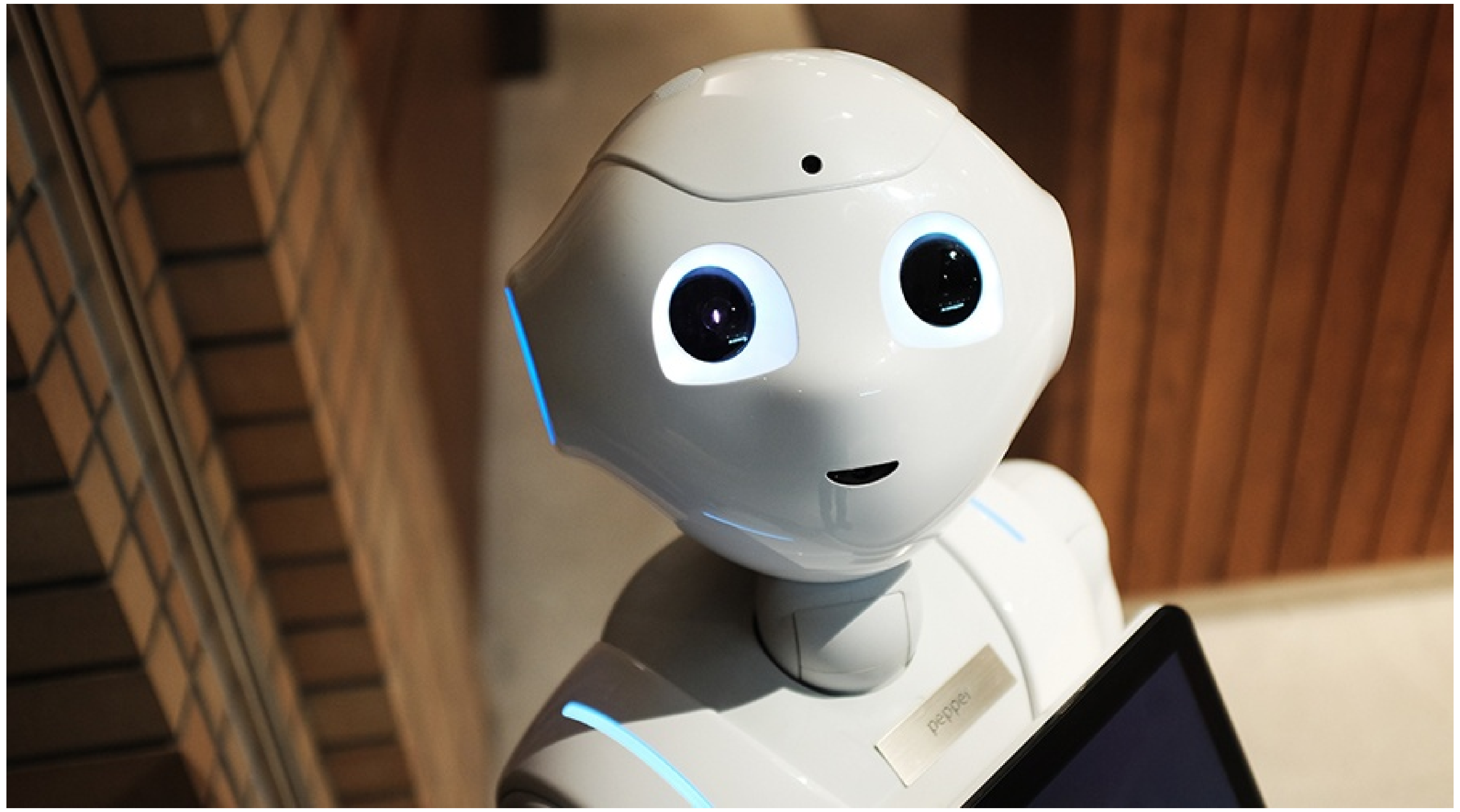


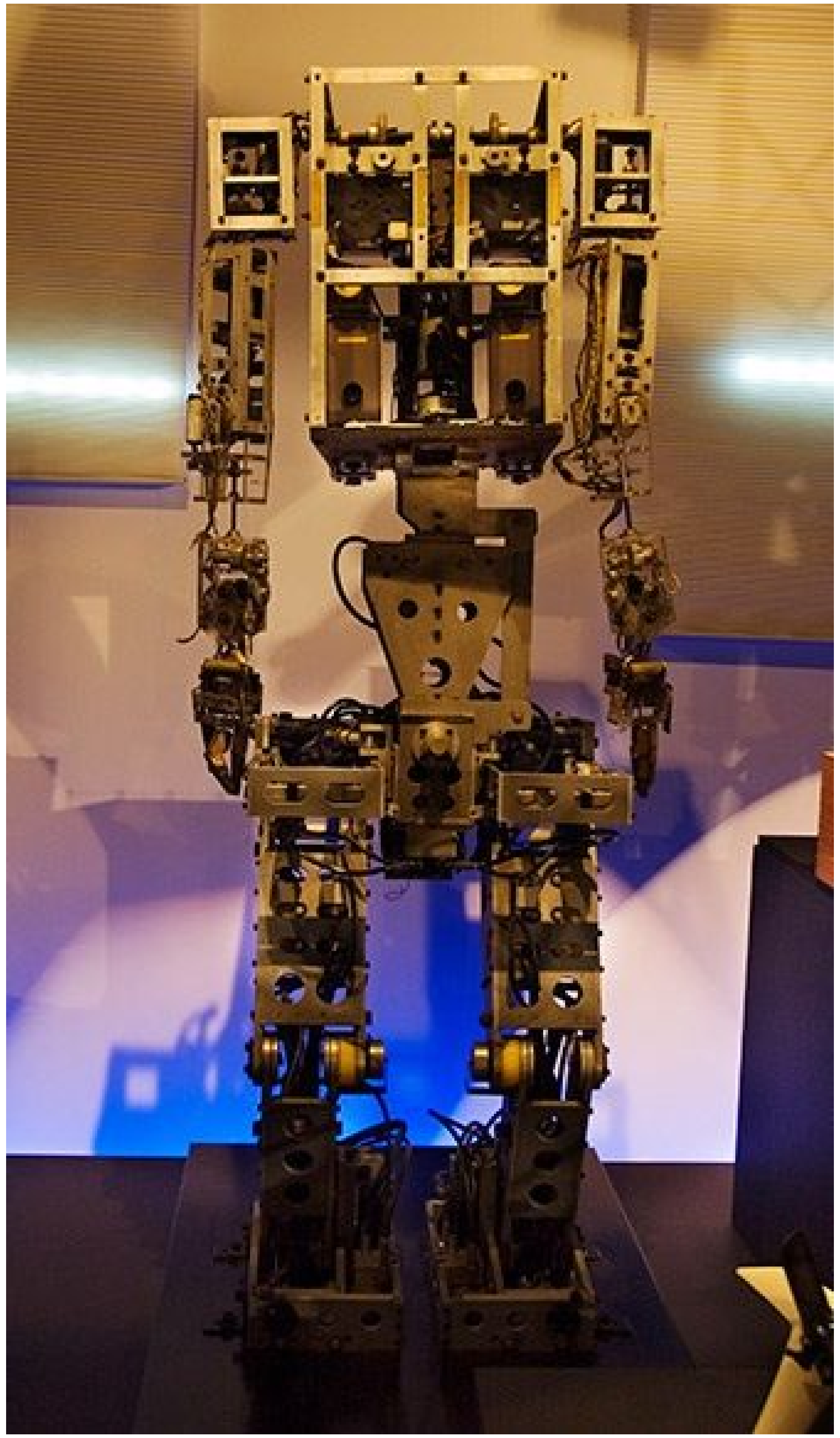
HUMANOID ROBOT

Muhammad Daniel Bin Nazmi (1911801)

CONTENTS

INTRODUCTION

A humanoid robot is a type of **robot that is meant to look like and do duties like humans**. It often features a human-like bodily structure, including a head, torso, arms, and legs. The goal of developing humanoid robots is to create machines that can interact with humans and perform more successfully in human situations.



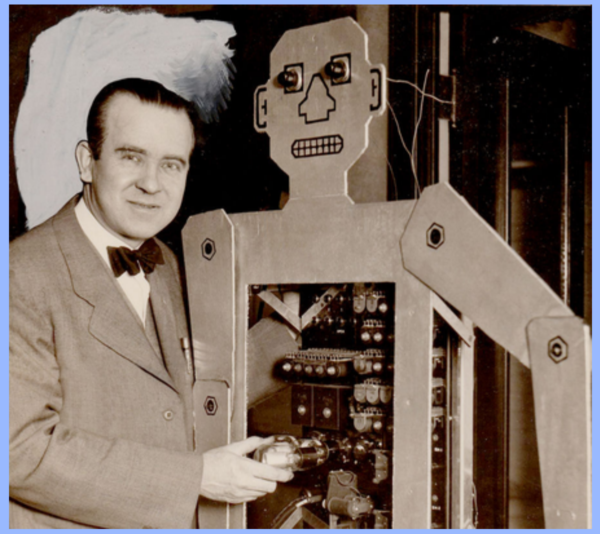
HISTORY OF THE ROBOT

Humanoid Automatons

The notion of humanoid automatons dates back to ancient cultures. There are references to mechanical slaves made by Hephaestus, the god of workmanship, in Greek mythology. Similarly, fables and traditions about humanoid-like robots may be found in ancient Chinese, Indian, and Egyptian societies.

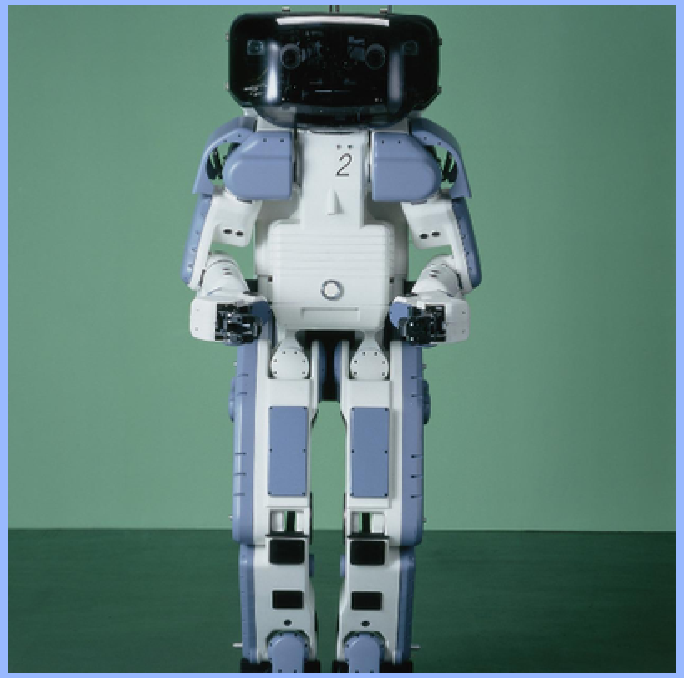
Early Robots

In the 20th century, several inventors and engineers made significant contributions to humanoid robotics. One notable example is the "Televox" robot developed by Nikola Tesla in 1898, which could respond to voice commands and perform simple tasks. In the 1920s, Czech writer Karel Čapek introduced the term "robot" in his play "R.U.R. (Rossum's Universal Robots)," where humanoid robots called "Robots" were depicted.



WABOT-1

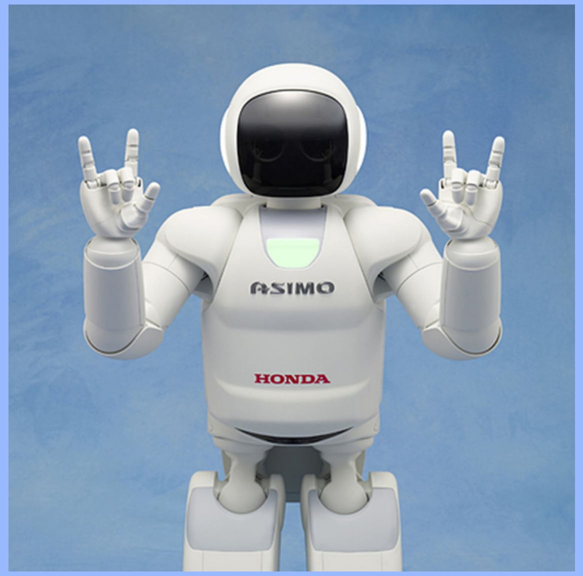
In 1973, Waseda University in Japan developed WABOT-1, considered the world's first full-scale humanoid robot. It stood at 1.85 meters tall and had a total of 50 degrees of freedom. WABOT-1 could walk, grip objects, and even communicate through a voice synthesizer.



HISTORY OF THE ROBOT

ASIMO

Honda's ASIMO, introduced in 2000, became one of the most well-known humanoid robots. ASIMO stood at 1.3 meters tall and incorporated advanced technologies for balance, mobility, and human interaction. It could walk, climb stairs, recognize faces and gestures, and perform various tasks. ASIMO represented a significant leap in humanoid robot capabilities and served as a platform for further research.

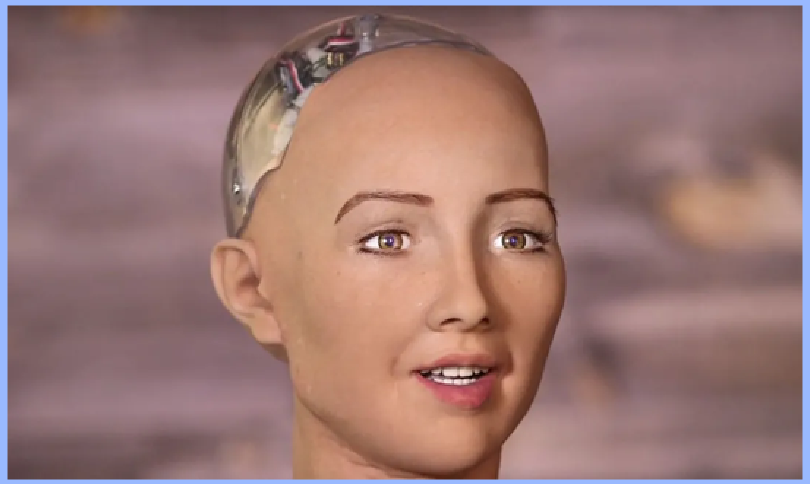


Boston Dynamics Robots

Boston Dynamics, a robotics company founded in 1992, has made remarkable advancements in humanoid and bipedal robots. Their creations, such as Atlas and Spot, showcase impressive mobility, agility, and dynamic balance. These robots have demonstrated abilities like walking on uneven terrain, opening doors, and carrying objects.

Sophia

Developed by Hong Kong-based Hanson Robotics, Sophia gained significant attention for its human-like appearance and expressions. Although primarily a social robot, Sophia has showcased advancements in facial recognition, natural language processing, and speech synthesis.



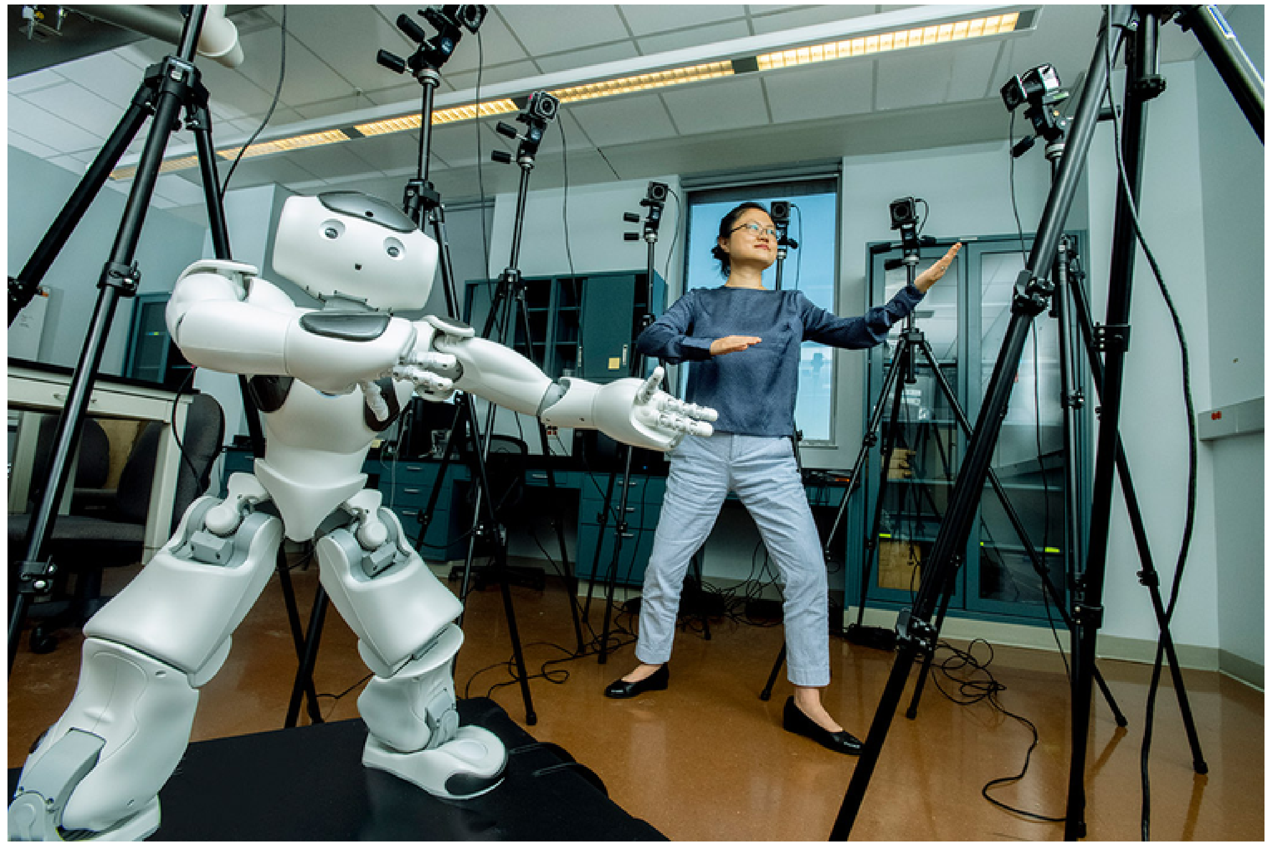
APPLICATIONS

PERSONAL ASSISTANCE

HEALTHCARE

EDUCATION

CUSTOMER SERVICES



ENTERTAINMENT

RESEARCH & DEVELOPMENT

SOCIAL COMPANIONSHIP

MAIN COMPONENTS

Frame & Design

Propulsion System

Navigation & Control System

Data Collection

Data Transmission

Power Management

FRAME & DESIGN

Structural Frame

- provides support and stability to the overall robot's body.
- It is usually made of lightweight and rigid materials such as aluminum, carbon fiber composites, or high-strength plastics.
- The frame is designed to withstand the loads and forces generated during movements and interactions

Joints & Actuators

- Humanoid robots have multiple joints, allowing them to achieve a range of movements and postures similar to Humans.
- Joints are usually actuated by motors, hydraulic systems, or pneumatic systems to provide the necessary force and flexibility.

Sensory Integration

- Incorporate various sensors throughout their body which include cameras, depth sensors, touch sensors, force sensors, accelerometers, and gyroscopes.
- The design of the frame and hull takes into account the optimal placement of sensors to enable effective perception and feedback.

Ergonomics & Anthromorphism

- Humanoid robots strive to mimic human form and movement, which involves considering anthromorphic proportions and ergonomics in their design.
- The frame and hull are designed to resemble human body segments, with considerations for limb length, joint placement, and range of motion.

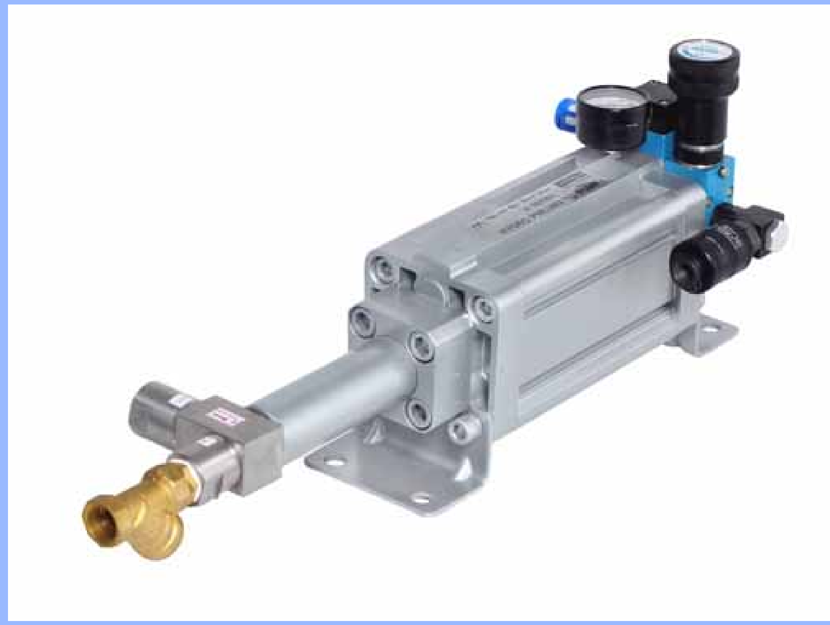
PROPULSION SYSTEM

Electric Motors

provide rotational motion and actuation for the robot's joints, allowing it to walk, grip items, and conduct other tasks.

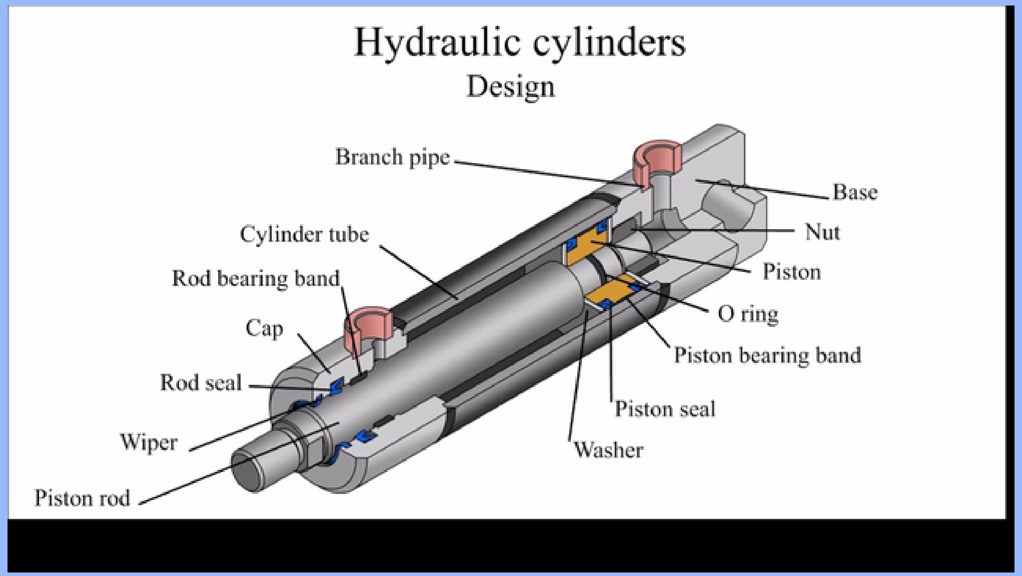
Pneumatic Systems

The use of compressed air or gas can offer humanoid robots with rapid and responsive actuation.



Hydraulic Systems

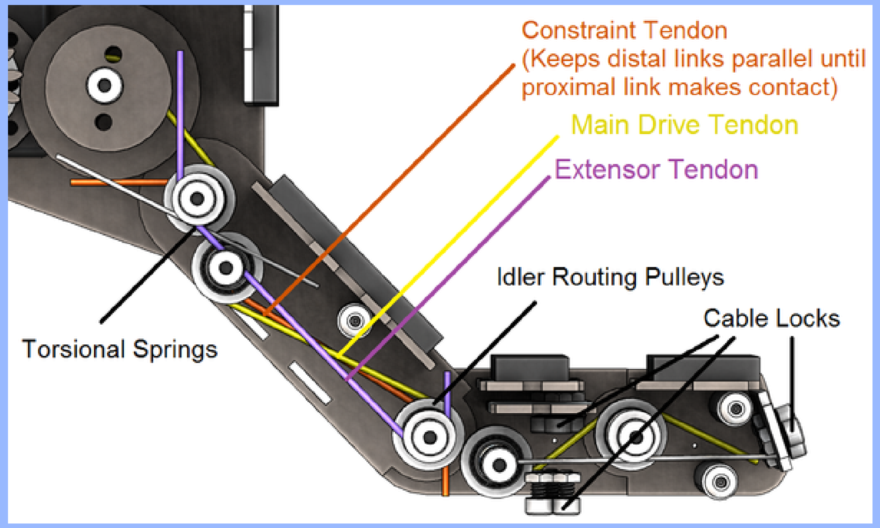
Used in robots built for heavy lifting or difficult jobs.



PROPULSION SYSTEM

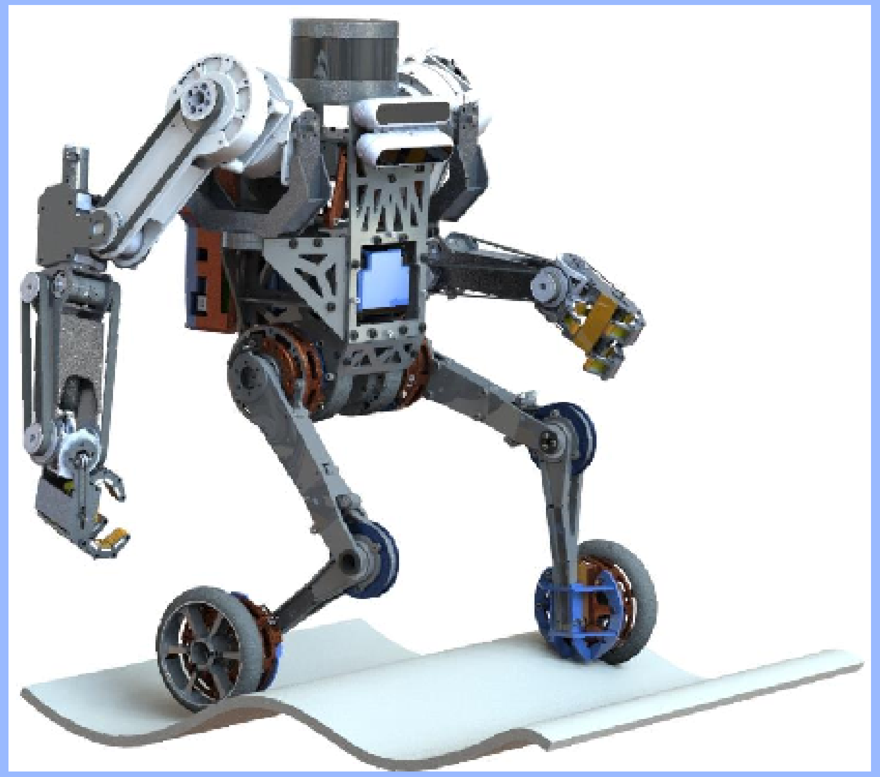
Tendon Drive Systems

use cables or tendons attached to the joints of the robot and powered by motors or actuators



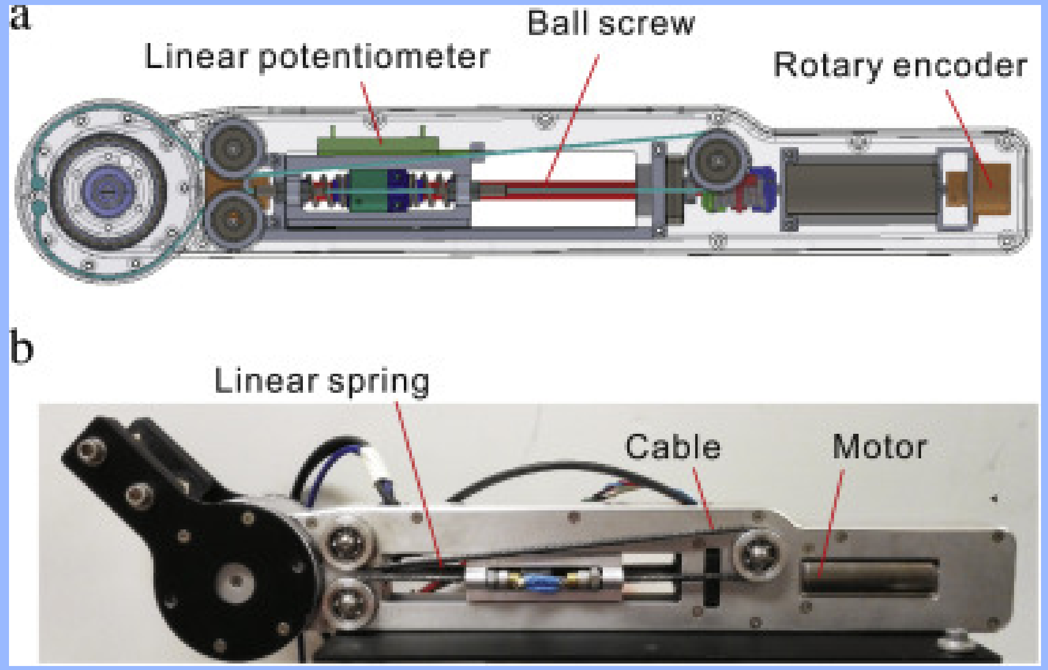
Hybrid

to create variable and adaptable movement, integrate several propulsion systems



Series Elastic Actuators

To enable compliant and force-controlled movement, include elastic devices between the motor and the joint.



PROPULSION SYSTEM

Wheeled/Legged

Wheeled systems, which are frequently paired with stabilising devices, enable effective mobility on flat terrain.
- Legged systems, which resemble human or animal legs, allow the robot to traverse different terrains and avoid impediments.

NAVIGATION & CONTROL SYSTEM

Sensors

Sensors offer information about the robot's location, orientation, distance to an item, and detection of obstacles.

Perception & Mapping

building a map of the surroundings, identifying items, and estimating their locations and distances. Simultaneous localization and mapping (SLAM) algorithms are examples of advanced perception algorithms.

Path Planning

Path planning algorithms consider impediments, the physical capabilities of the robot, and any limits or objectives stated by the job at hand.

Localization

This is frequently accomplished by comparing sensor data to the map and calculating the robot's pose (position and orientation) relative to the map.

DATA COLLECTION

SENSORS

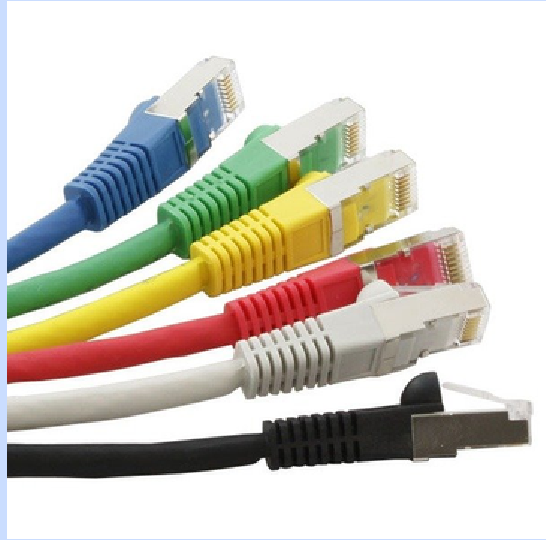
1. Cameras
2. IMUs
3. LiDAR
4. Ultrasonics sensor
5. Force/Torque sensor
6. Tactile sensor
7. Proximity Sensor
8. Joint Encoders
9. Microphones

ACTUATORS

1. Electric Motors
2. Hydraulic Actuators
3. Pneumatic Actuators
4. Series Elastic Actuators (SEA)
5. Tendon Drives
6. Grippers/End Effectors
7. Walking Mechanisms

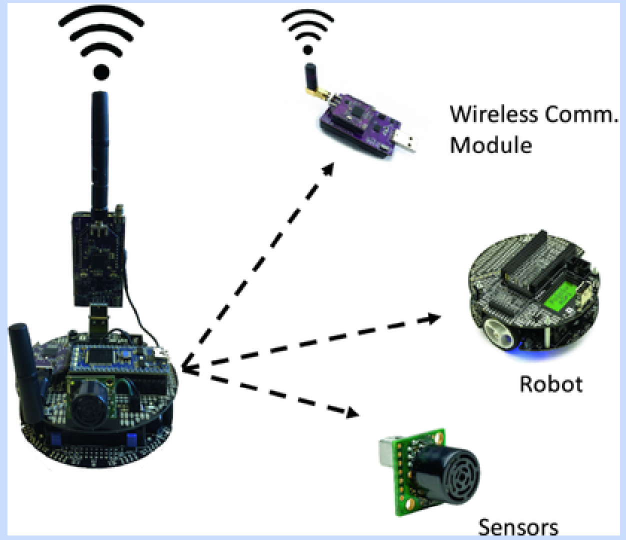
DATA TRANSMISSION

Ethernet

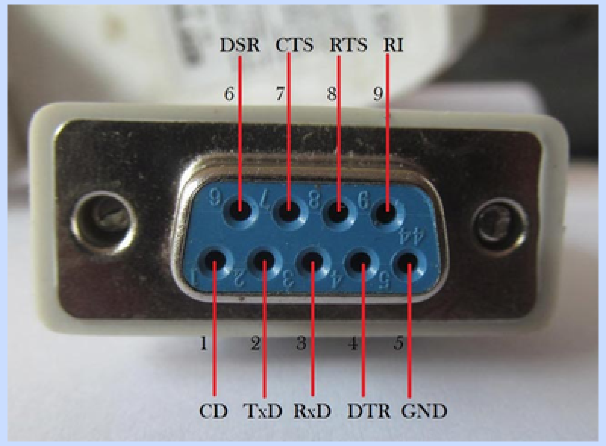


USB

WIFI

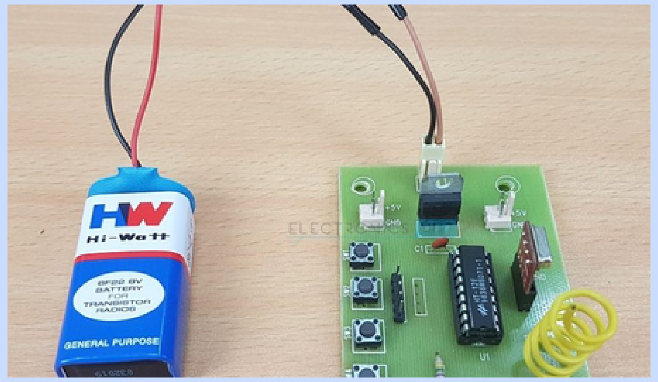


RS-232

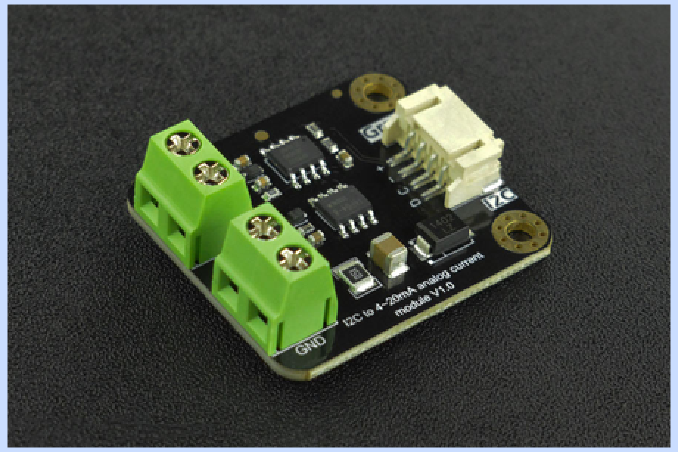


DATA TRANSMISSION

Radio Frequency



I2C



CAN

EtherCAT

POWER MANAGEMENT

Battery Power Management

regulated the charging and discharging of batteries to ensure optimal performance

Power Saving Techniques

utilize sleep or idle modes for subsystems that are not actively performing tasks

Power Distribution & Regulation

PDUs distribute power from main source to various subsystems and components of the humanoid robot.

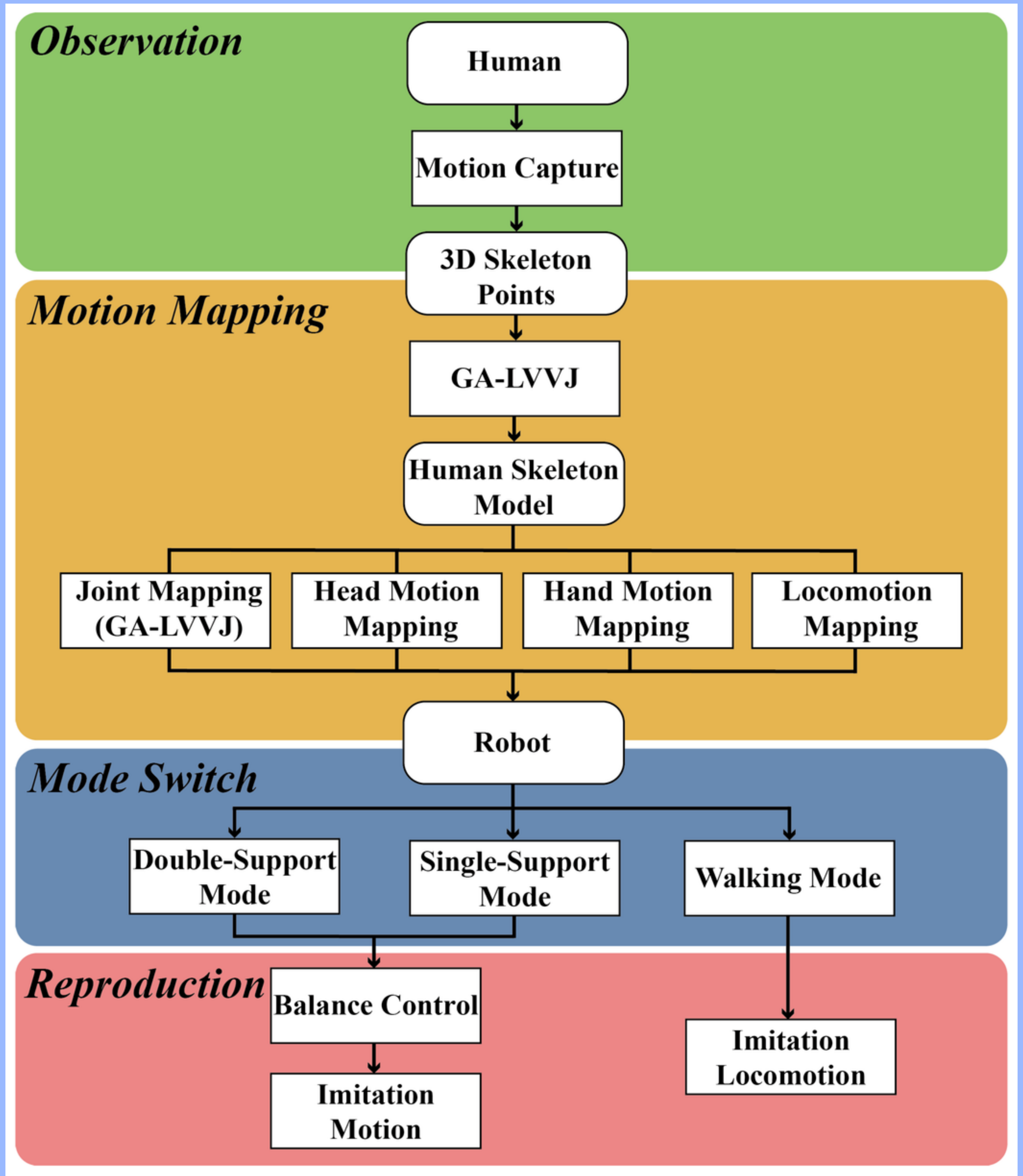
POWER MANAGEMENT

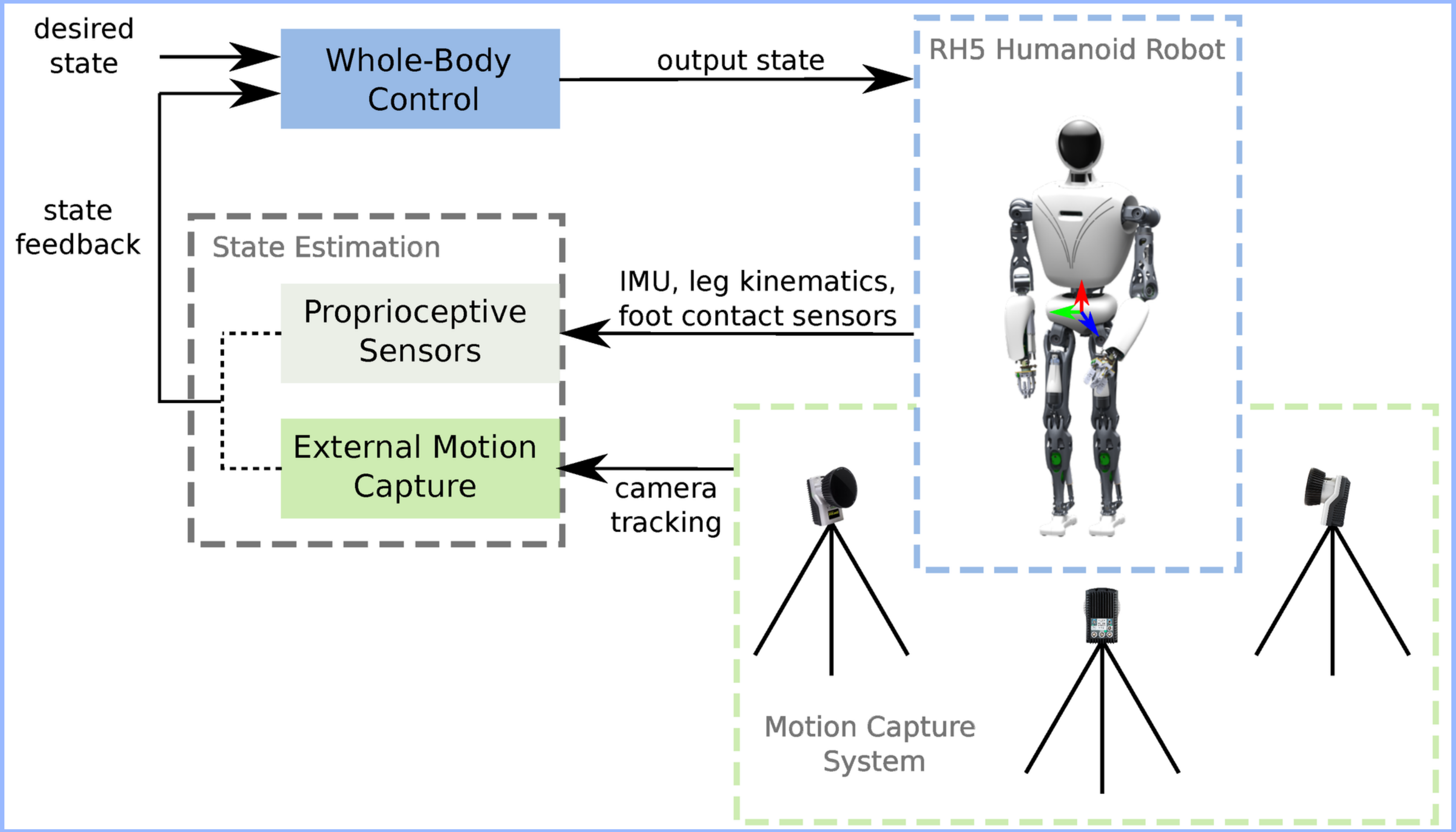
Energy Harvesting

providing a renewable and continuous power source

Charging and Docking Stations

provide a convenient and automated way for robots to recharge their batteries when they are not actively performing tasks


Observation
Human
Motion Capture
3D Skeleton Points
Motion Mapping
GA-LVVJ
Human Skeleton Model
Joint Mapping (GA-LVVJ)
Head Motion Mapping
Hand Motion Mapping
Locomotion Mapping
Robot
Mode Switch
Double-Support Mode
Single-Support Mode
Walking Mode
Reproduction
Balance Control
Imitation Motion
Imitation Locomotion


desired state
Whole-Body Control
output state
RH5 Humanoid Robot
state feedback
State Estimation
Proprioceptive Sensors
IMU, leg kinematics, foot contact sensors
External Motion Capture
camera tracking
Motion Capture System

THANK YOU FOR LISTENING!