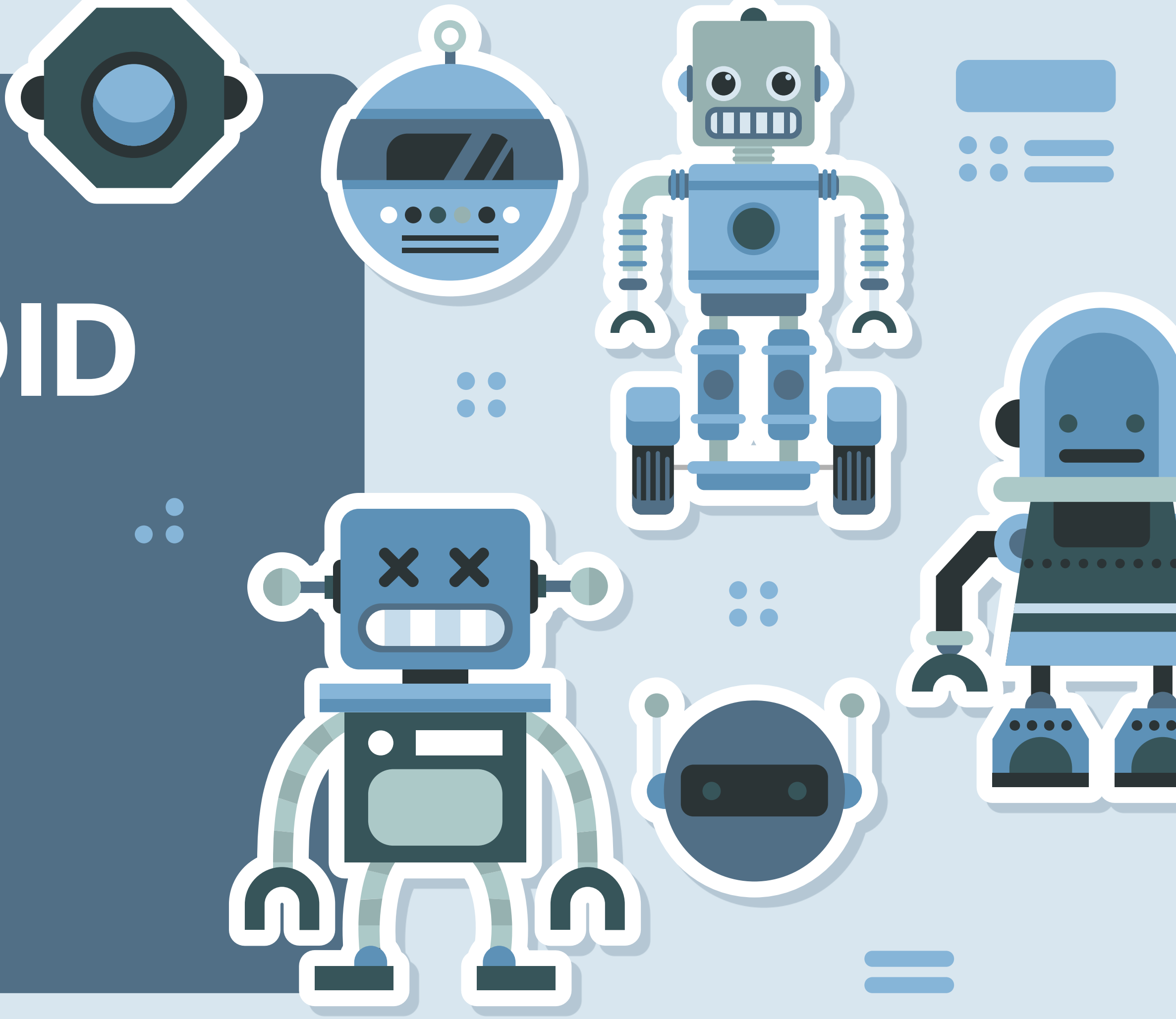
HUMANOID ROBOT



By: Azizi Bin Mohamad Tambi (1919661)

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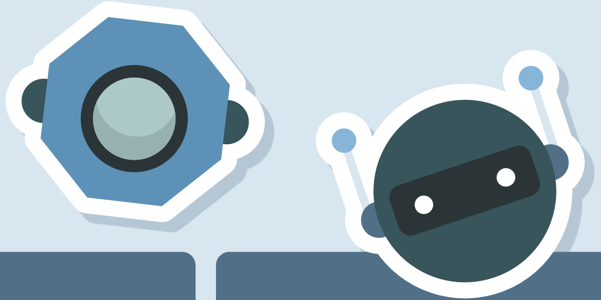


01

INTRODUCTION

INTRODUCTION

- A humanoid robot is a type of robot that is designed to resemble and interact with humans in term of physical appearance, behavior, and capabilities.
- The word “humanoid” implies that the robot has characteristics or features similar to those of a human being.
- Usually, humanoid robots have a bipedal structure, with an upright stance similar to humans.
- They can be equipped with various sensors, actuators and artificial intelligence technologies to perceive and interact with their environment.
- They can be used for research and development purposes, exploring human-like movement, behavior, and cognition.

RESEARCH BACKGROUND

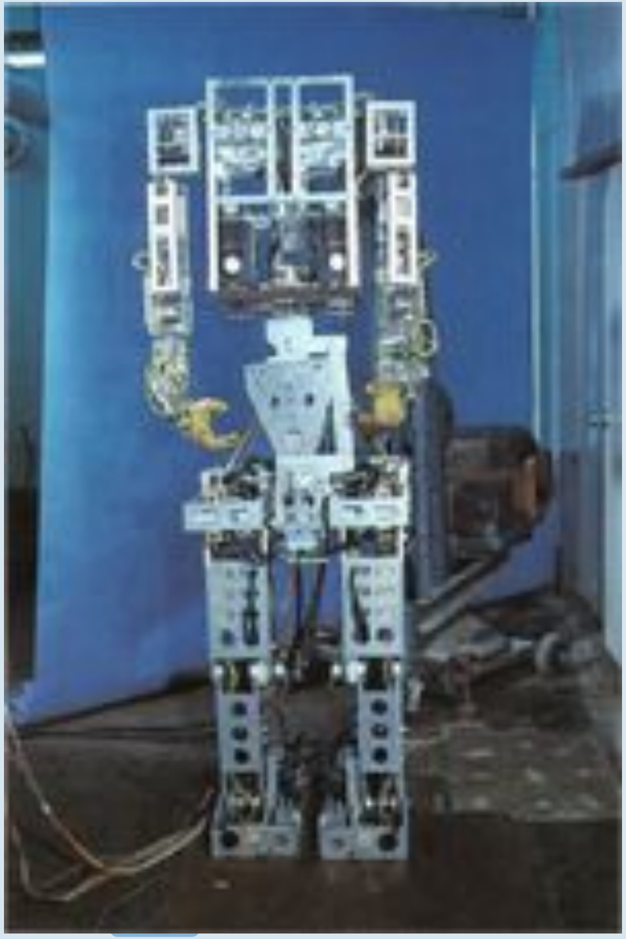
- The research background for humanoid robot are grouped into several fields such as robotics, artificial intelligence, biomechanics, and cognitive science.
- The field of robotics has been focus on creating machines that can perform tasks autonomously or with human assistance.
- In biomechanics, researchers studying the mechanics and structure of human bodies have contributed to understanding the principles of locomotion, balance and dexterity.
- Advances in AI played a crucial role enabling robots to perceive and understand their environment.
- Humanoid robot research draws insights from cognitive science to understand human cognition, behavior, and social interaction.

02

HISTORY & APPLICATIONS

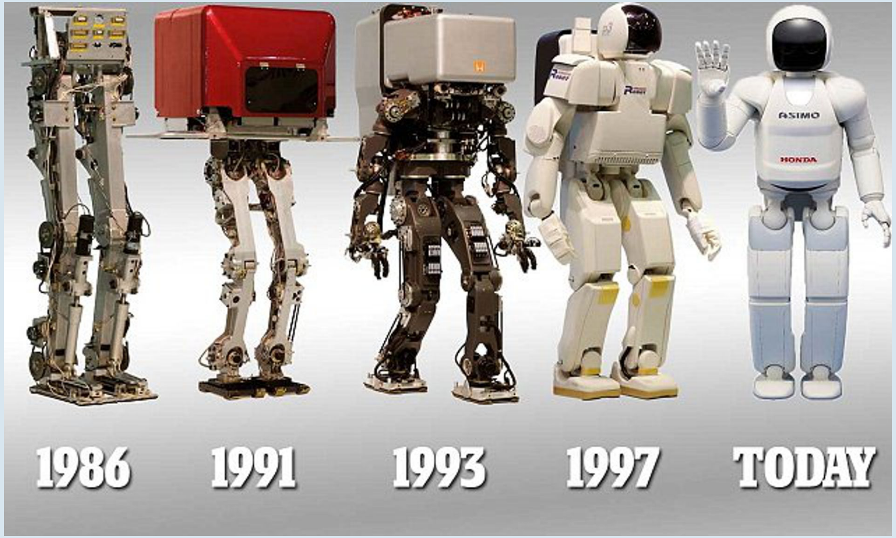
EARLY CONCEPTS

- The idea of humanoid robots began to emerge in science fiction literature and films, such as Isaac Asimov's "I, Robot" series.
- Researchers like W. Grey Walter and Valentino Braitenberg explored basic robot behaviors and simple robot designs that vaguely resembled humans.
- In 1967, the WABOT-1 was developed by researchers at the Waseda University in Japan.
- It was one of the first full-scale humanoid robots.
- WABOT-1 could walk, grip objects, and communicate using basic voice synthesis, however its capabilities were limited.



ASIMO

- In 2000, Honda's Advanced Step in Innovative Mobility (ASIMO) made significant advancements in humanoid robotics.
- ASIMO was designed to walk, run, climb stairs, and interact with humans.
- It could recognize faces, objects and gestures.
- ASIMO served as a research platform and a symbol of technological advancement, inspiring further development in the field.



APPLICATIONS

1. Personal Assistance
   -Humanoid robots can assist individuals with daily tasks such as household chores, meal preparation, medication reminders, and mobility support for elderly.
2. Healthcare
   -Can be utilized in healthcare settings to provide companionship to patients, monitor vital signs, assist with physical therapy exercises, and perform basic caregiving tasks.
3. Education
   -Can serve as educational tools, assisting in teaching various subjects, languages, or skills.
4. Customer Service
   -Can act as customer service representatives, providing information, guiding customers, and assisting with transactions.
5. Entertainment
   -Can be used for entertainment purposes, such as performing shows, exhibitions, or theme parks.
6. Research and Development
   -Employed in research laboratories to study human-like movement, cognition, and social interaction.
7. Social Companionship
   Robots like Pepper and Sophia are designed to provide social companionship, engaging in conversations, recognizing emotions, and providing companionship for people.

03 MAIN COMPONENTS

I. Frame & Hull Design

II. Propulsion System

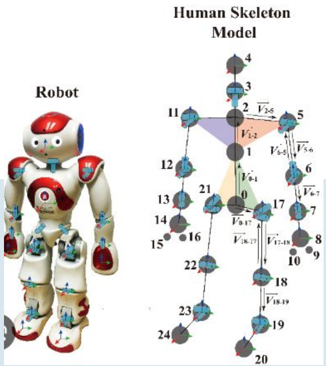
III. Navigation & Control System

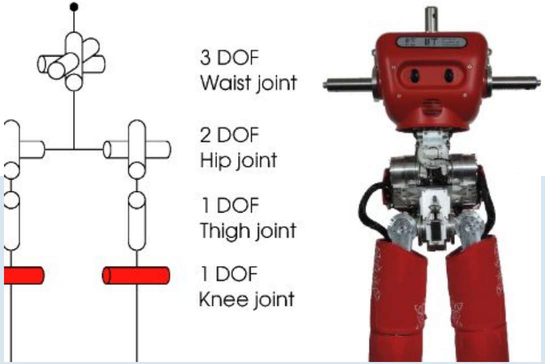
IV. Data Collection

V. Data Transmission

VI. Power Management

I. Frame & Hull Design





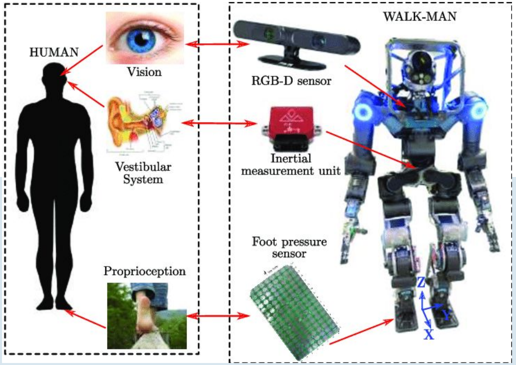
1. Structural Frame:

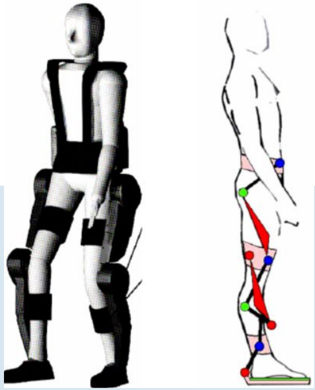
- The structural frame of a humanoid robot typically provides support and stability to the overall robot's body.
- It is usually made of lightweight and rigid materials such as aluminum, carbon fiber composites, or high-strength plastics.
- The frame is designed to withstand the loads and forces generated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

2. 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.

I. Frame & Hull Design





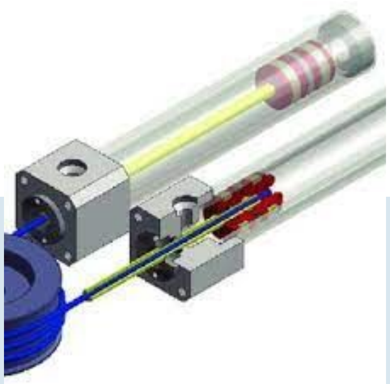
3. Sensory Integration:

- Humanoid robots incorporate various sensors throughout their body to perceive and interact with their environment.
- These sensors can 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.

4. 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.

II. Propulsion System



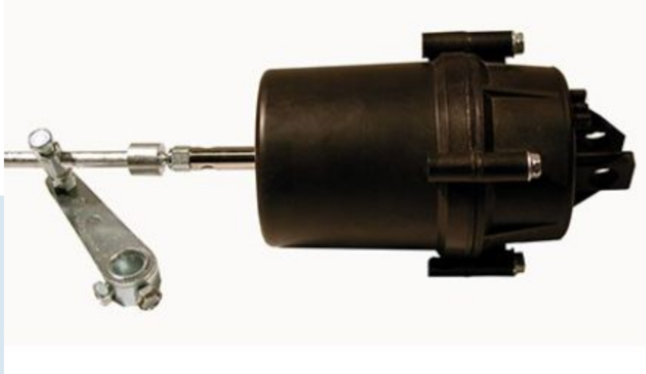
1. Electric Motors:

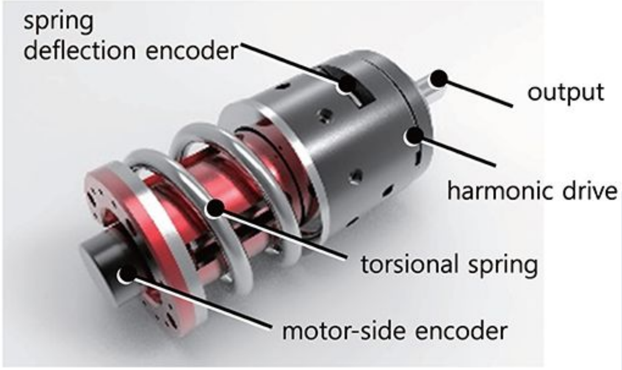
- Electric motors, such as brushed DC motors or brushless motors, are commonly used.
- They provide rotational motion and actuation for the robo's joints, enabling it to walk, grasp objects, and perform various movements.

2. Hydraulic Systems:

- Hydraulic actuators offer high power and force capabilities, allowing for precise and dynamic movements.
- Often used in robots designed for heavy lifting or demanding tasks.

II. Propulsion System





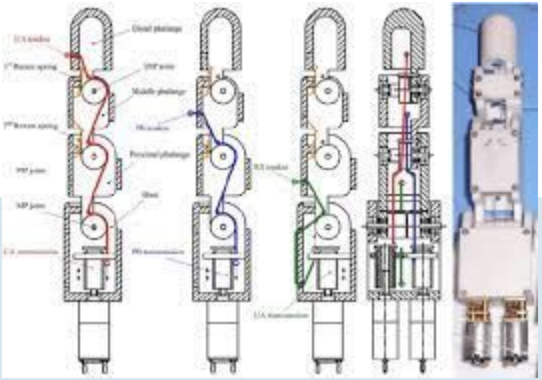
3. Pneumatic Systems:

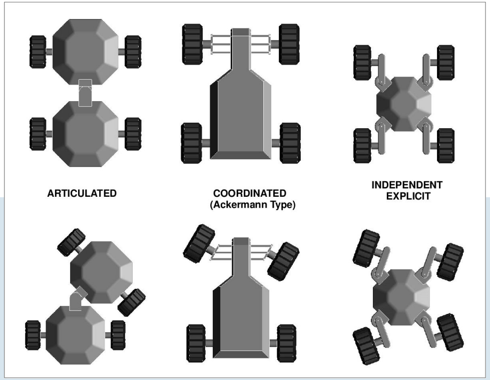
- Pneumatic systems, which use compressed air or gas, can provide fast and responsive actuation for humanoid robots.
- Pneumatic muscles, also known as artificial muscles can mimic human muscle movements and offer compliance and flexibility.

4. Series Elastic Actuators:

- Series elastic actuators incorporate elastic elements between the motor and the joint to provide compliant and force-controlled movement.
- This offer advantages such as impact absorption, force sensing, and energy efficiency, making them suitable for human-like locomotion and interaction.

II. Propulsion System





5. Tendon Drive Systems:

- This systems utilize cables or tendons connected to the robot’s joints and driven by motors or actuators located elsewhere in the robot’s body.
- This arrangement allows for lighter limbs and centralized actuation, providing flexibility and dexterity in movements.

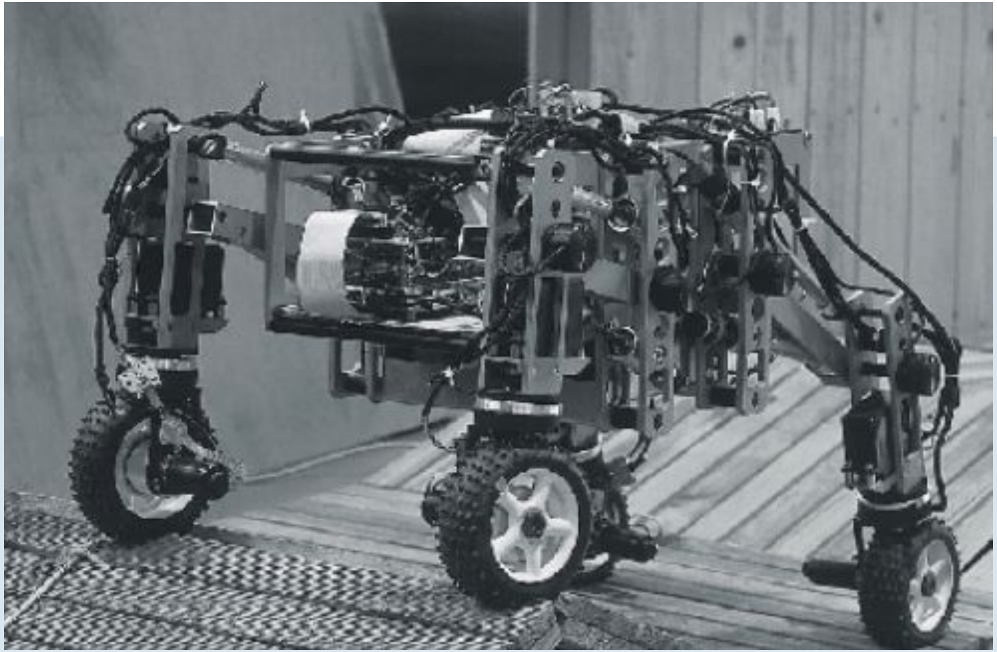
6. Wheeled/Legged Locomotion:

- Wheeled systems, often combined with stabilizing mechanisms, allow for efficient movement on flat surfaces.
- Legged systems, resembling human or animal legs, enable the robot to traverse diverse terrains and navigate obstacles.

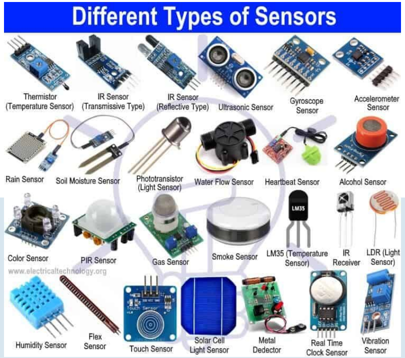
II. Propulsion System

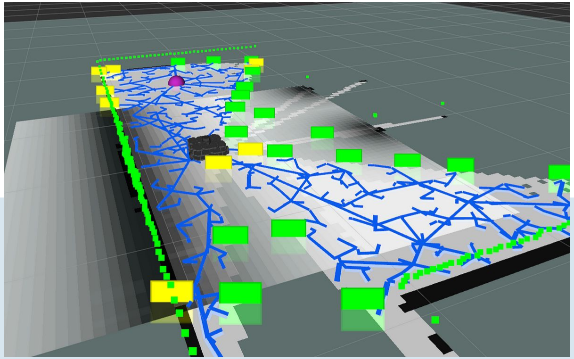
7. Hybrid:

- Many humanoid robots combine multiple propulsion systems to achieve versatile and adaptive locomotion.
- A humanoid robot may use electric motors for join actuation and incorporate wheels or legs for mobility in different situations.



III. Navigation System





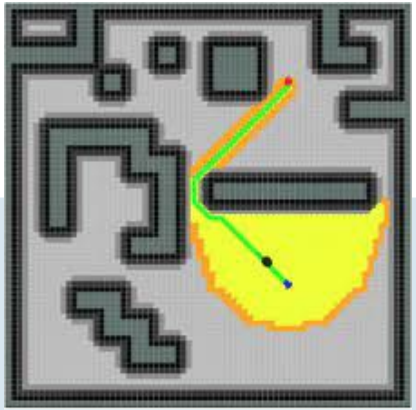
1. Sensors:

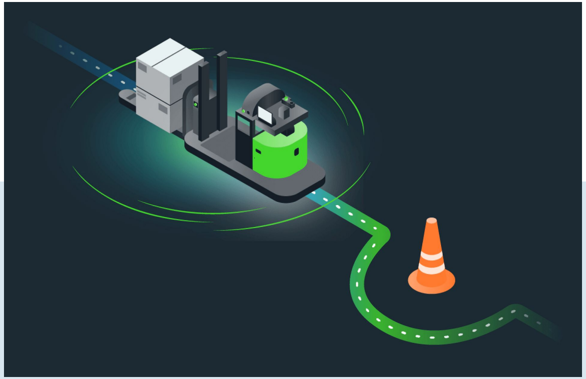
- Utilized various sensors for environmental perception, including cameras, depth sensors (such a LiDAR or depth cameras), IMUs and proximity sensors.
- These sensors provide information about the robot’s position, orientation, distance to object, and obstacle detection.

2. SLAM:

- Simultaneous Localization and Mapping (SLAM) algorithms are commonly employed to create a map of the environment while localizing the robot within it.
- SLAM algorithms integrate sensor data to estimate the robot’s position and create a representation of the surroundings.

III. Navigation System





3. Path Planning:

- Path planning algorithms determine the optimal path for the humanoid robot to navigate from its current position to a desired location while avoiding obstacles.
- These algorithms take into account the robot’s kinematics, the map of the environment, and any constraints on movement.

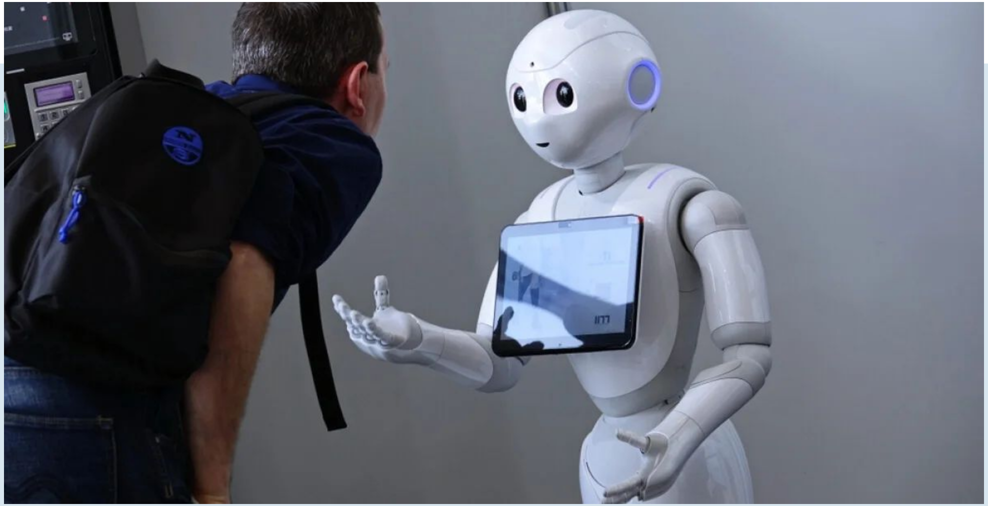
4. Obstacle Avoidance:

- Humanoid robots incorporate obstacle avoidance algorithms that use sensor data to detect and avoid obstacles in real-time.
- These algorithms adjust the robot’s trajectory or generate alternative paths to avoid collisions.

III. Navigation System

5. Human-Robot Interaction:

- May have features that enable interaction with humans during navigation.
- This include recognizing and following human gestures or commands, as well as predicting human movement for safe and coordinated navigation.



III. Control System

1. Centralized or Distributed Control:

- May have centralized or distributed control architectures.
- In centralized control, a central processing unit coordinates the robot's actions.
- In distributed control, individual joints or subsystems have their own control units, which communicate and coordinate with each other.

2. Motion Control:

- Generate control signals to actuate the robot's joints and achieve desired movements.
- These algorithms can include position control, torque control, or impedance control, depending on the specific requirements and objectives.

III. Control System

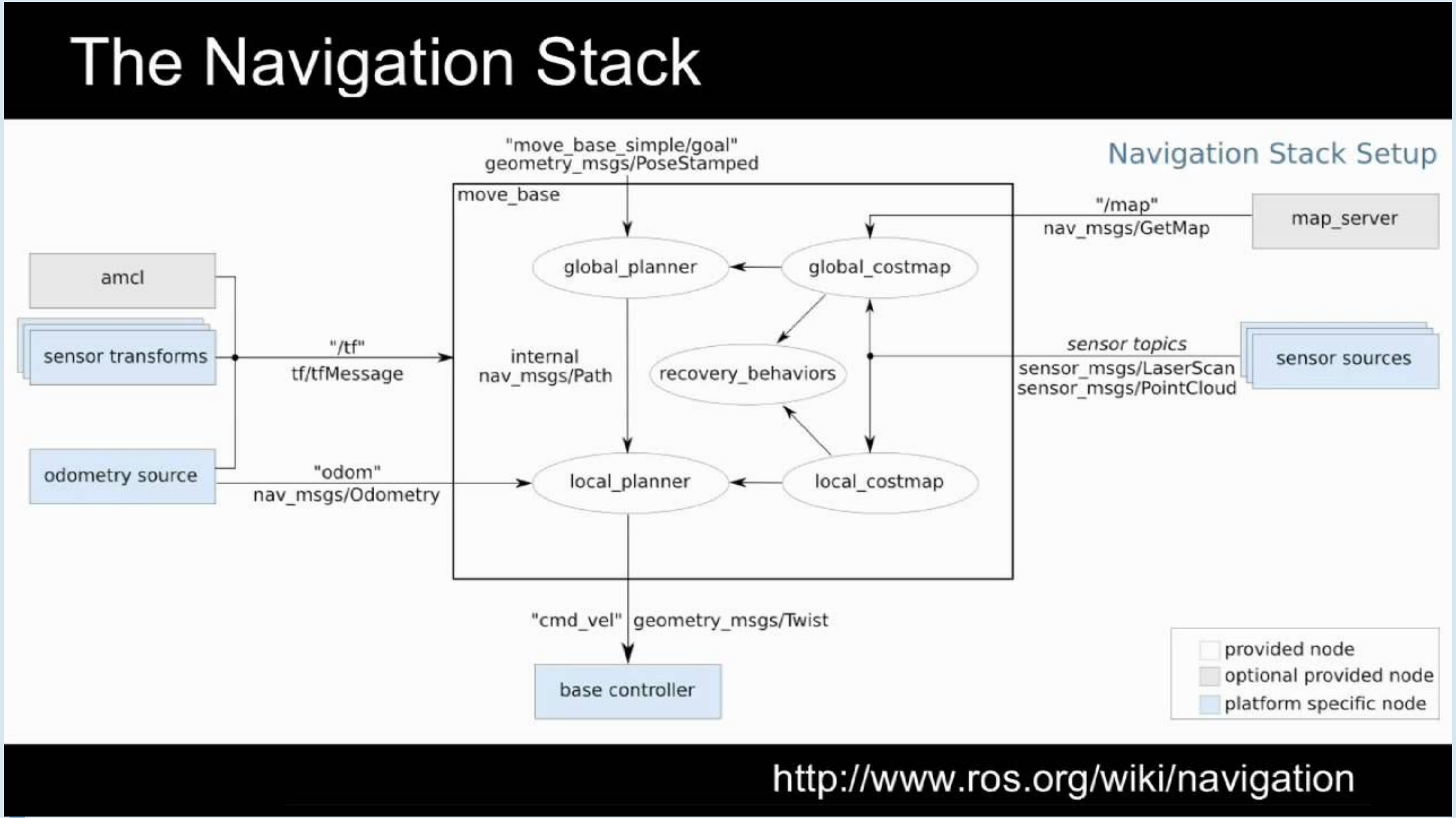
3. Stability and Balance Control:

- Control algorithms, often utilizing feedback from sensors, adjust joint movements and torques to maintain stability during standing, walking, or performing dynamic movements.

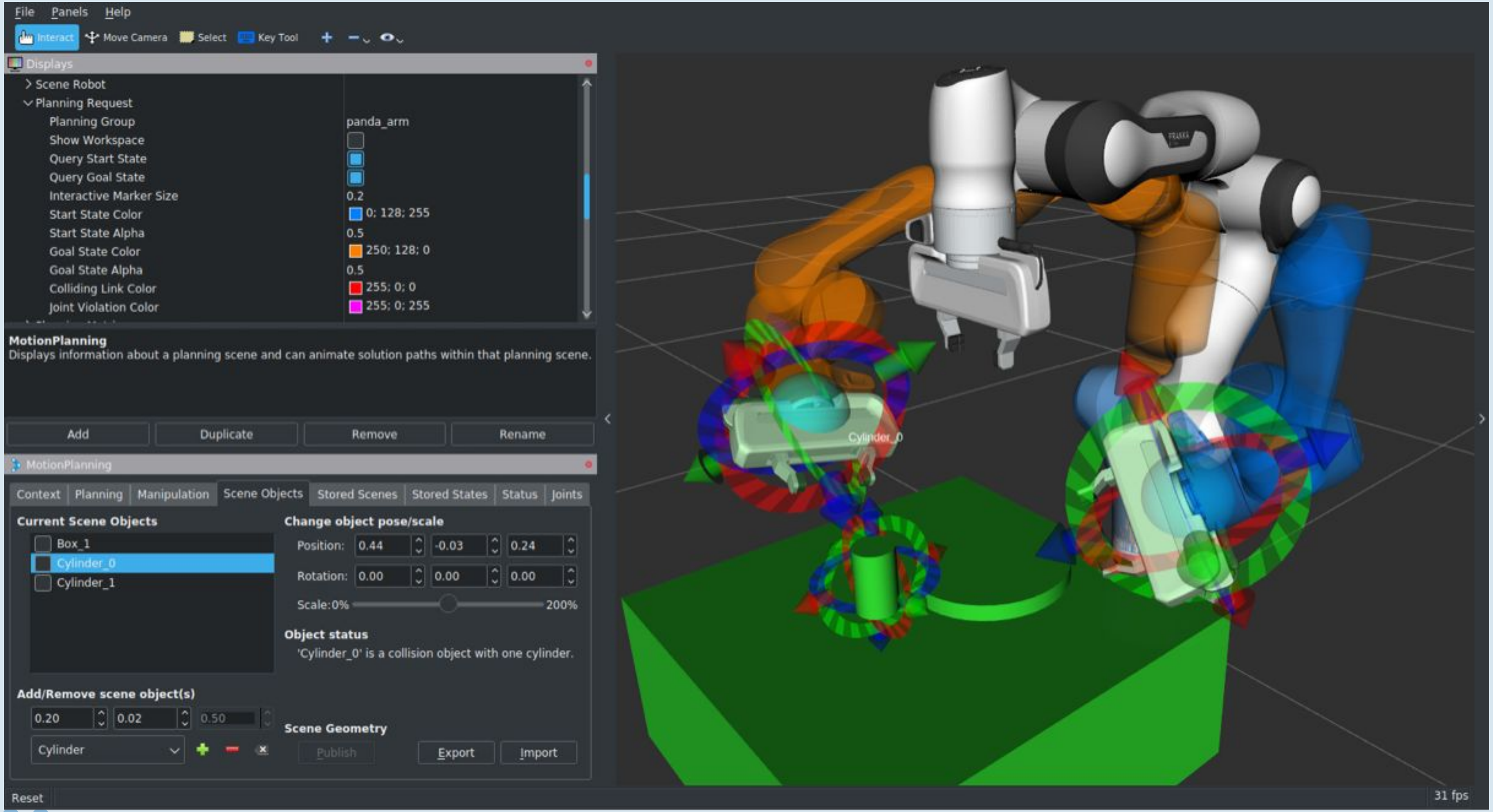
4. Gait Control:

- Gait control algorithms determine the timing and coordination of joint movements for walking or running.
- These algorithms focus on achieving stable and efficient locomotion, adapting to different surfaces or terrains.

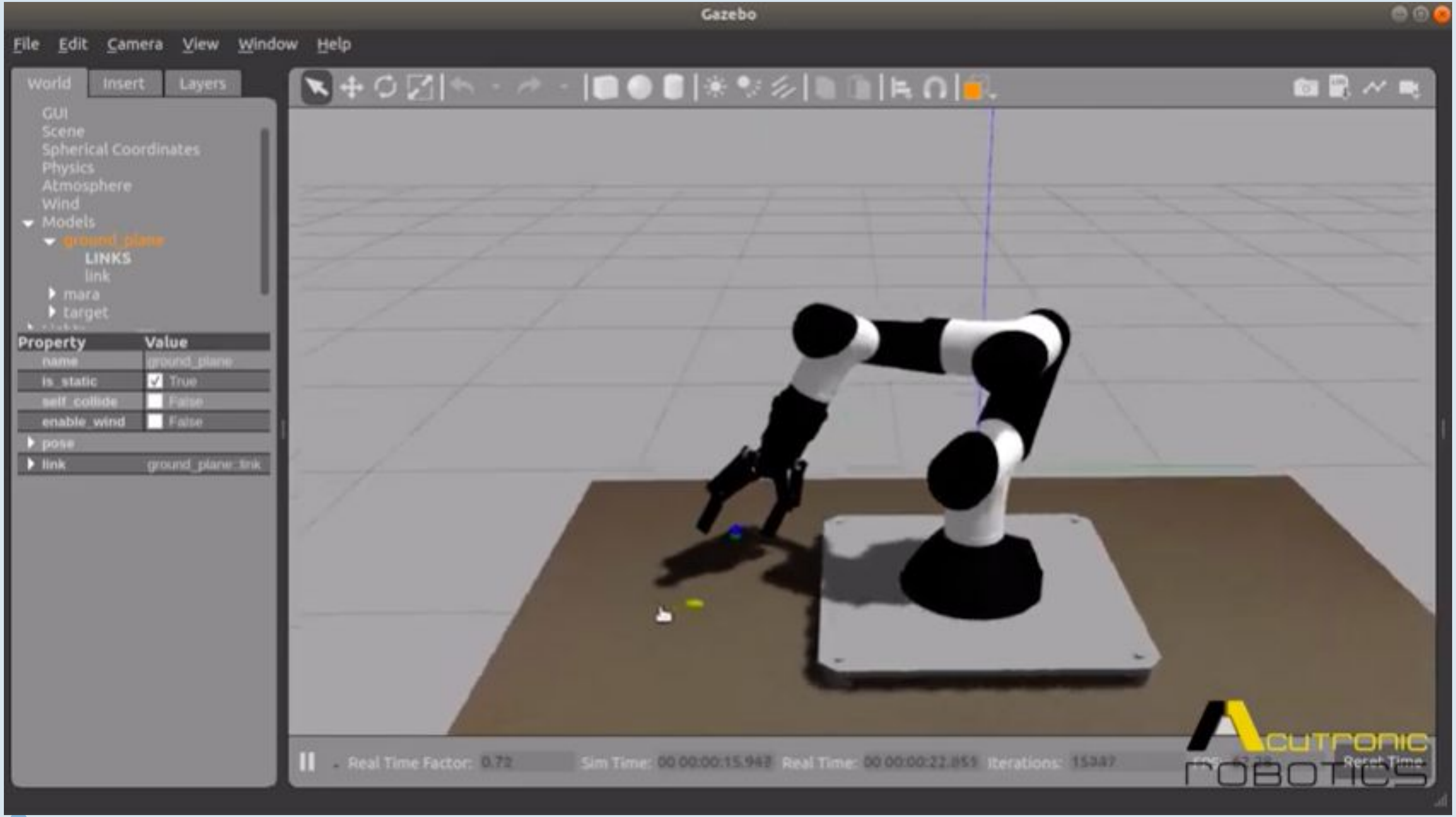
ROS Navigation Stack



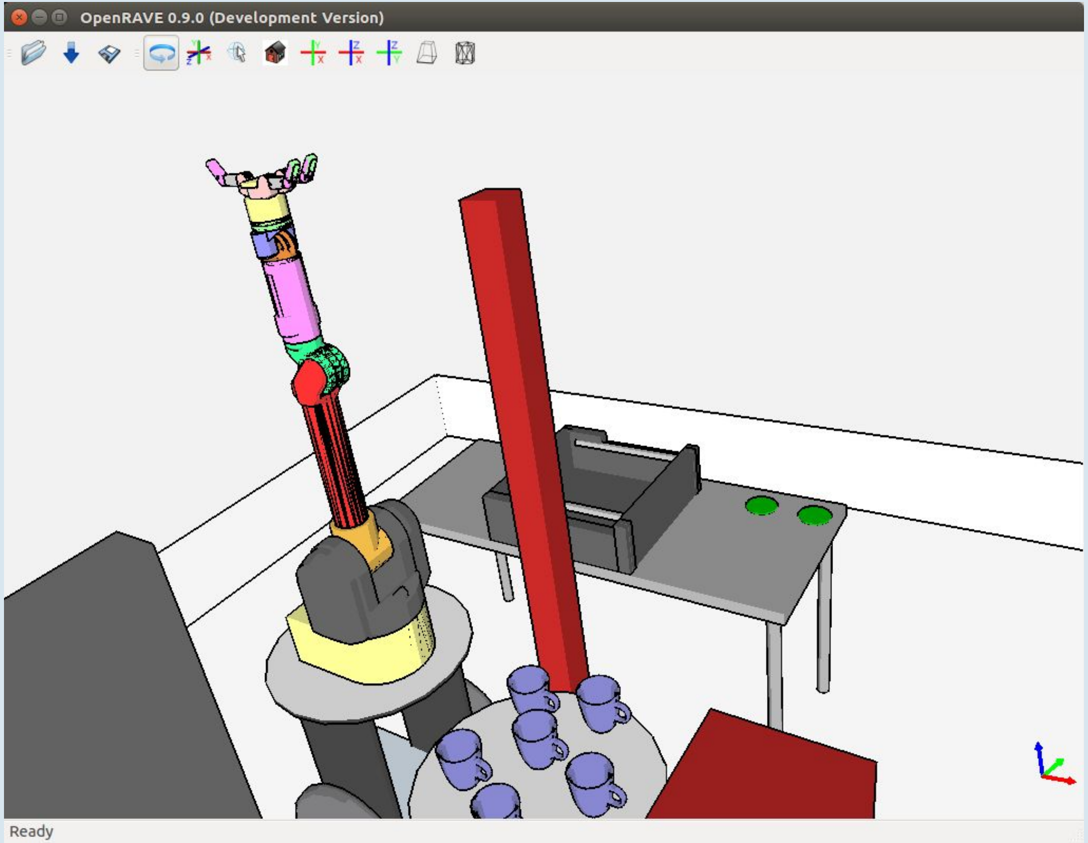
MoveIt!


File
Panels
Help
Interact
Move Camera
Select
Key Tool
Displays
Scene Robot
Planning Request
Planning Group
panda_arm
Show Workspace
Query Start State
Query Goal State
Interactive Marker Size
0.2
Start State Color
0; 128; 255
Start State Alpha
0.5
Goal State Color
250; 128; 0
Goal State Alpha
0.5
Colliding Link Color
255; 0; 0
Joint Violation Color
255; 0; 255
MotionPlanning
Displays information about a planning scene and can animate solution paths within that planning scene.
Add
Duplicate
Remove
Rename
MotionPlanning
Context
Planning
Manipulation
Scene Objects
Stored Scenes
Stored States
Status
Joints
Current Scene Objects
Box_1
Cylinder_0
Cylinder_1
Change object pose/scale
Position: 0.44 -0.03 0.24
Rotation: 0.00 0.00 0.00
Scale:0%
200%
Object status
'Cylinder_0' is a collision object with one cylinder.
Add/Remove scene object(s)
0.20
0.02
0.50
Cylinder
Scene Geometry
Publish
Export
Import
Reset
31 fps

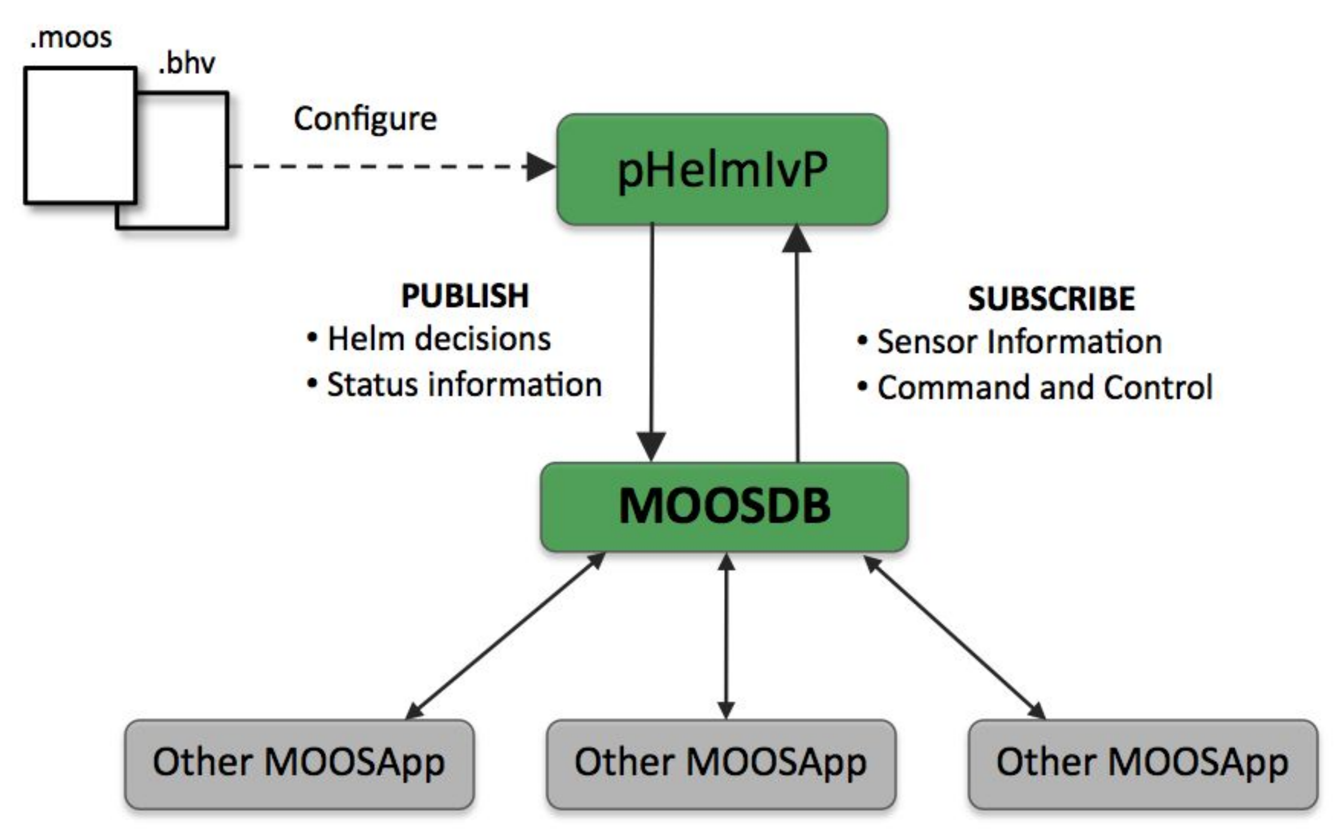
Gazebo


Gazebo
File Edit Camera View Window Help
World Insert Layers
GUI
Scene
Spherical Coordinates
Physics
Atmosphere
Wind
Models
ground_plane
LINKS
link
mara
target
Property Value
name ground_plane
is_static True
self_collide False
enable_wind False
pose
link ground_plane::link
Real Time Factor: 0.72
Sim Time: 00 00:00:15.947
Real Time: 00 00:00:22.851
Iterations: 15347
Reset Time
ACUTRONIC
ROBOTICS

OpenRAVE



MOOS-IvP


.moos
.bhv
Configure
pHelmIvP
PUBLISH
• Helm decisions
• Status information
SUBSCRIBE
• Sensor Information
• Command and Control
MOOSDB
Other MOOSApp
Other MOOSApp
Other MOOSApp

IV. Data Collection

SENSORS

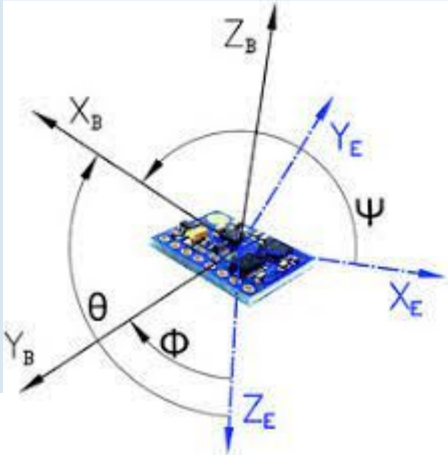
1. Cameras
2. IMUs
3. LiDAR
4. Ultrasonics sensor
5. Force/Torque sensor
6. Tactile sensor
7. Proximity Sensor
8. Joint Encoders
9. Microphones.

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

SENSORS

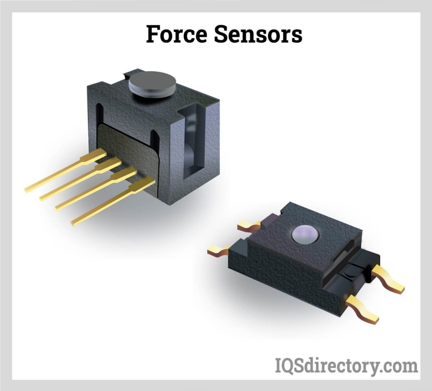
Cameras

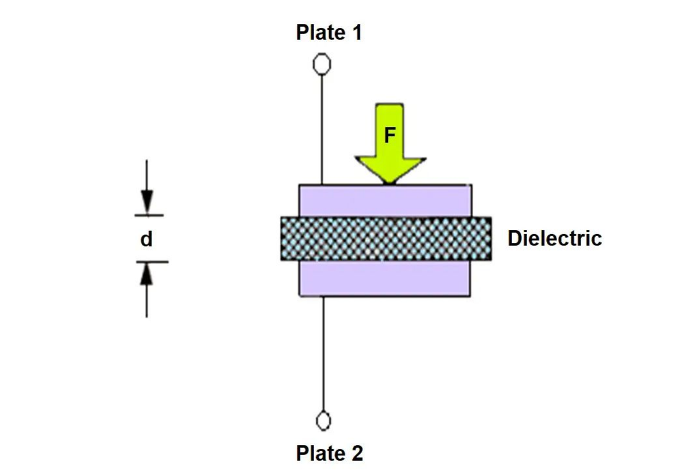


IMUs

LiDAR

SENSORS





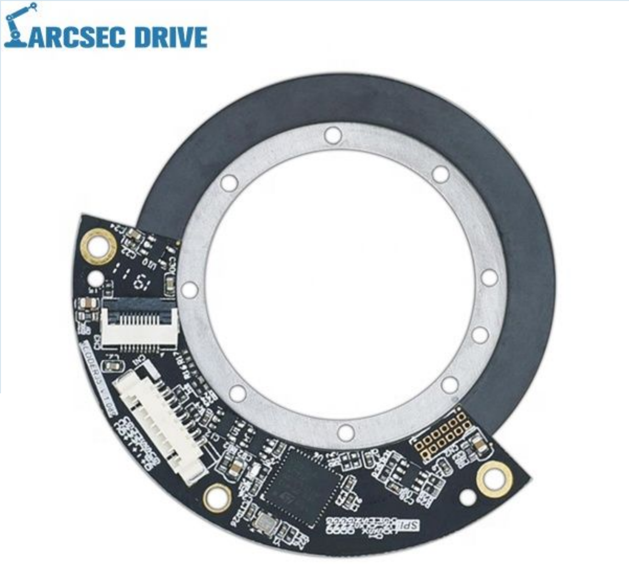
Ultrasonic Sensor

Force/Torque Sensor

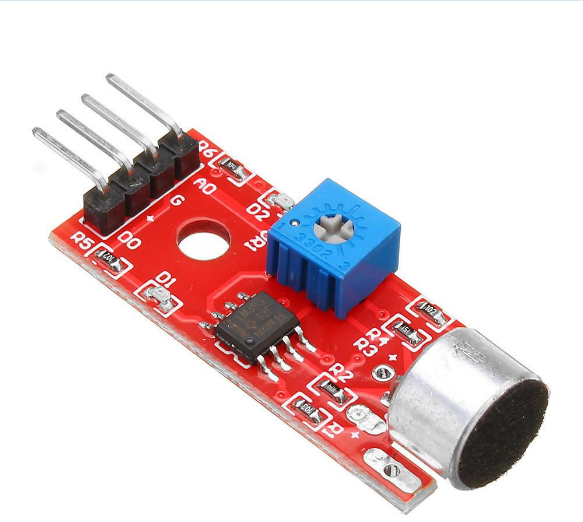
Tactile Sensor

SENSORS

Proximity
Sensor



Joint
Encoders



Microphones

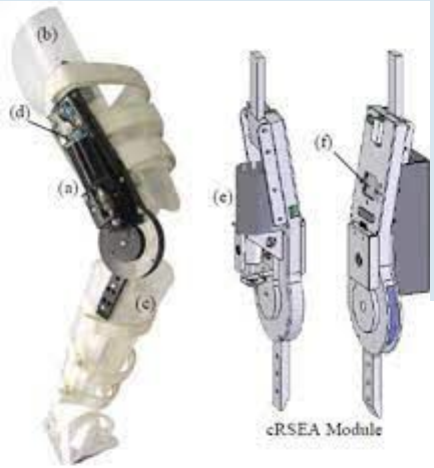
ACTUATORS

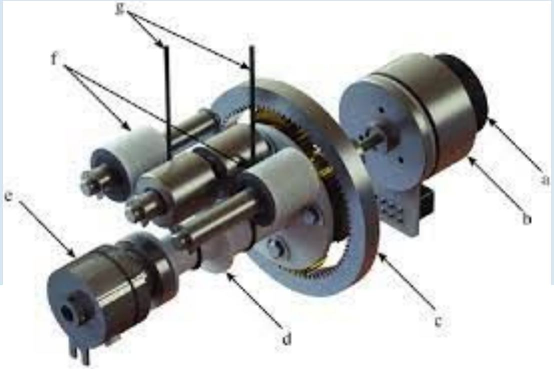
Electric Motors

Hydraulic Actuators

Pneumatic Actuators

ACTUATORS





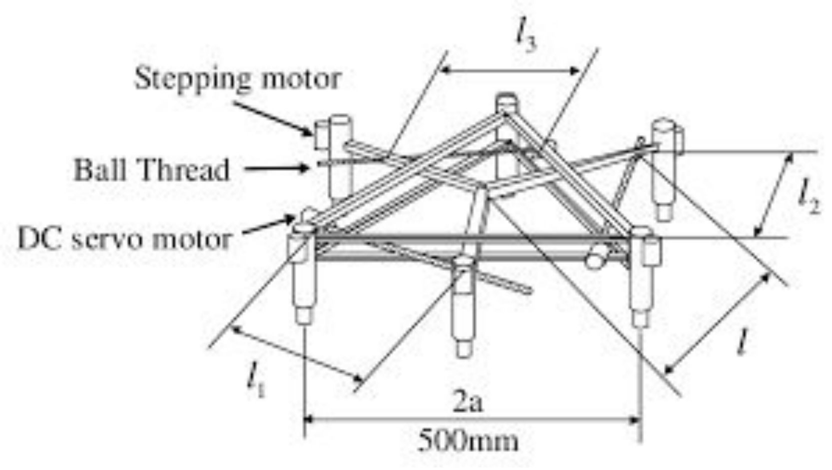
SEA

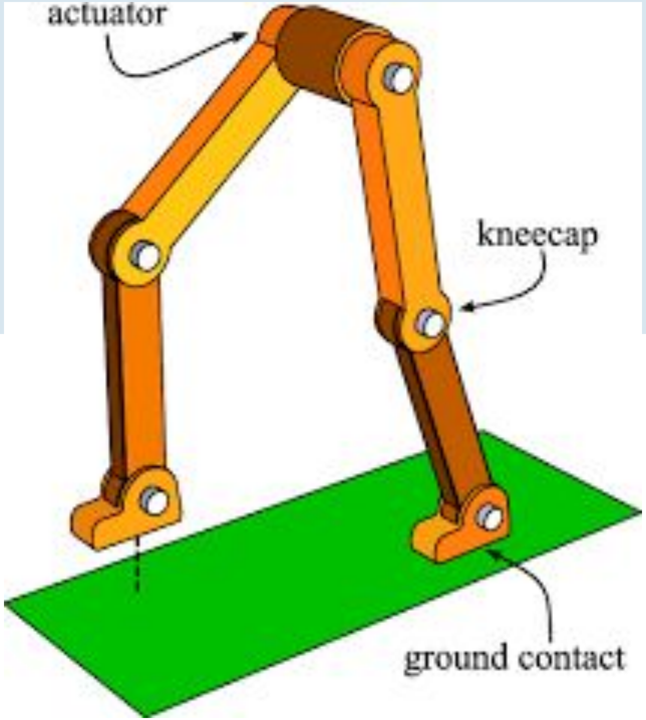
Tendon Drives

End Effectors

ACTUATORS

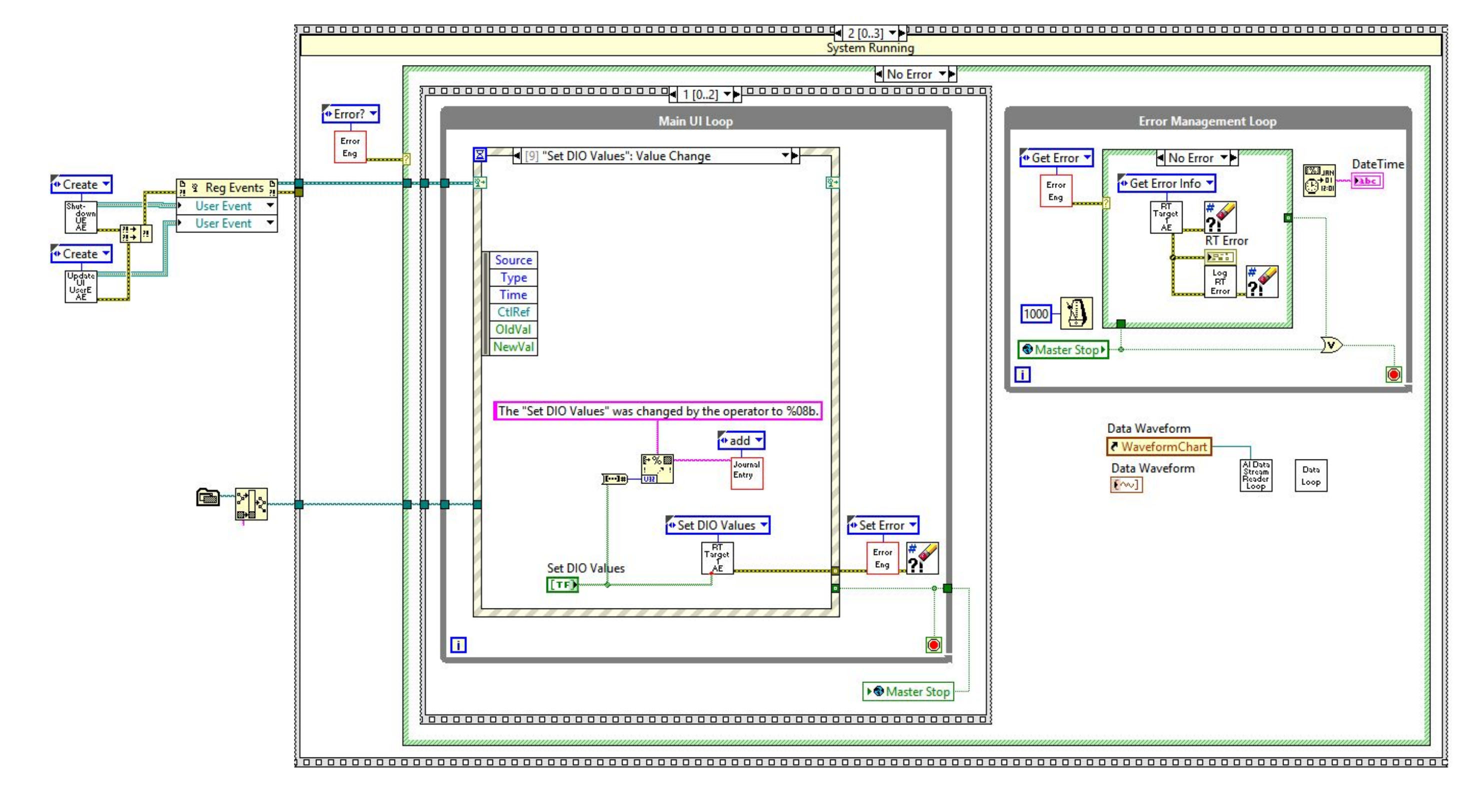
Walking Mechanism:





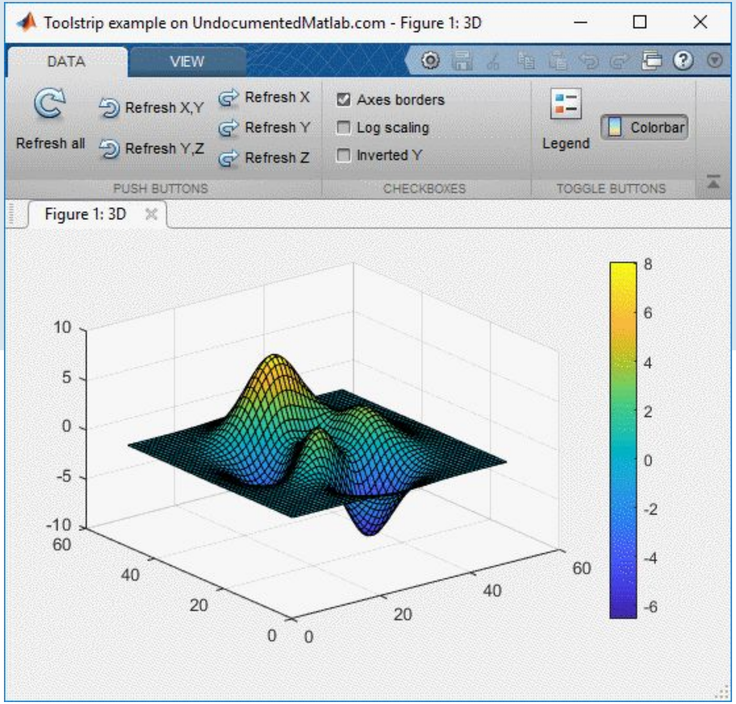
Data Acquisition Software

LabView:



Data Acquisition Software

MATLAB/Simulink:



V. Data Transmission

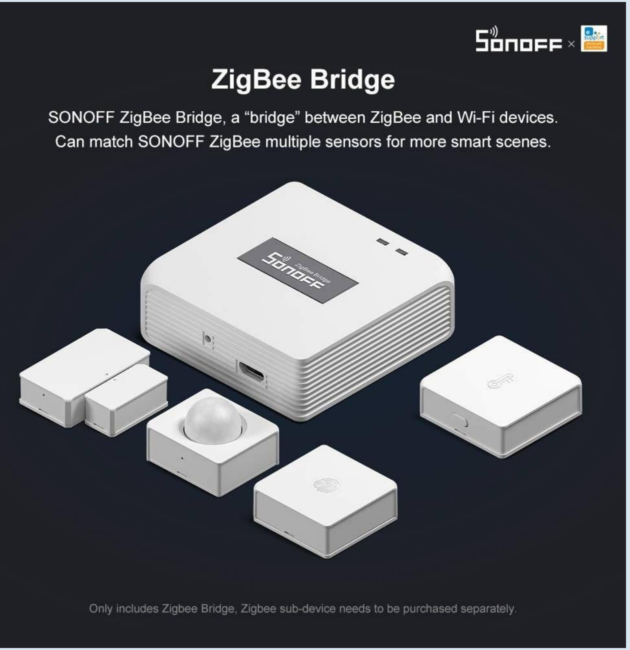
Ethernet:

USB:

Wi-Fi:

V. Data Transmission

Zigbee:

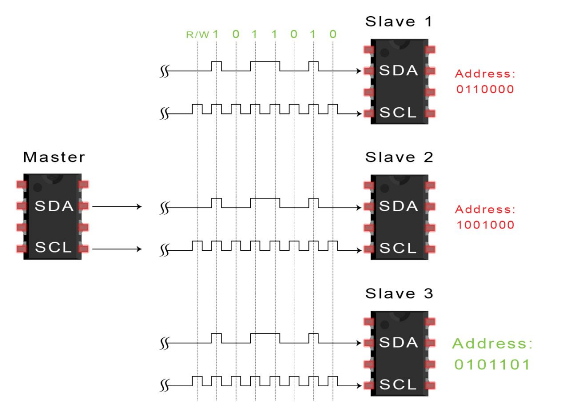


Radio Frequency:

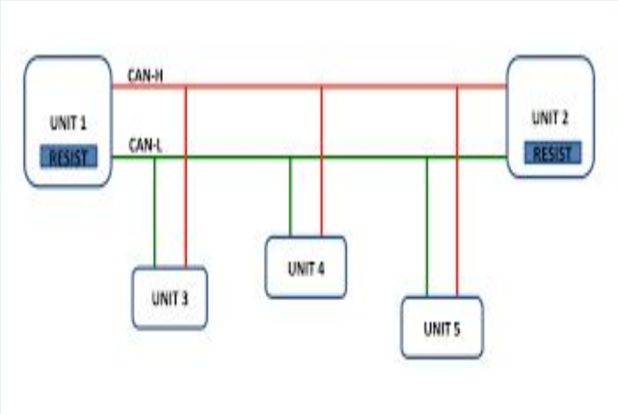
RS-232:

V. Data Transmission

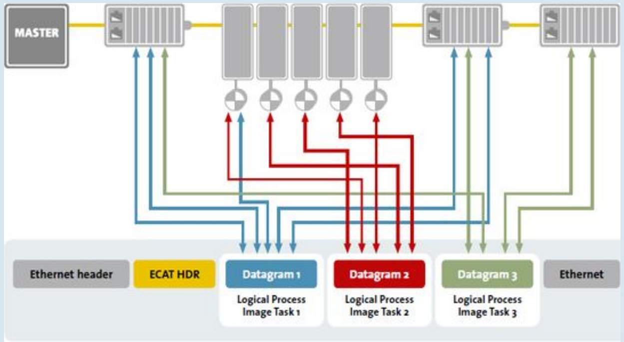
I2C:



CAN:



EtherCAT:



VI. Power Management

Battery Power Management:

- Employ monitoring systems to track the state of the batteries including voltage levels, current draw, temperature, and remaining capacity.
- Power management systems regulated the charging and discharging of batteries to ensure optimal performance and prolong battery life.

Power Saving Techniques:

- Can utilize sleep or idle modes for subsystems that are not actively performing tasks.
- Employ techniques such as dynamic frequency scaling and voltage scaling to adjust the power consumption of processors and other active components based on workload.

Power Distribution & Regulation:

- PDUs distribute power from main source to various subsystems and components of the humanoid robot.
- Voltage regulators or power converters are employed to maintain stable and appropriate voltage levels for different components

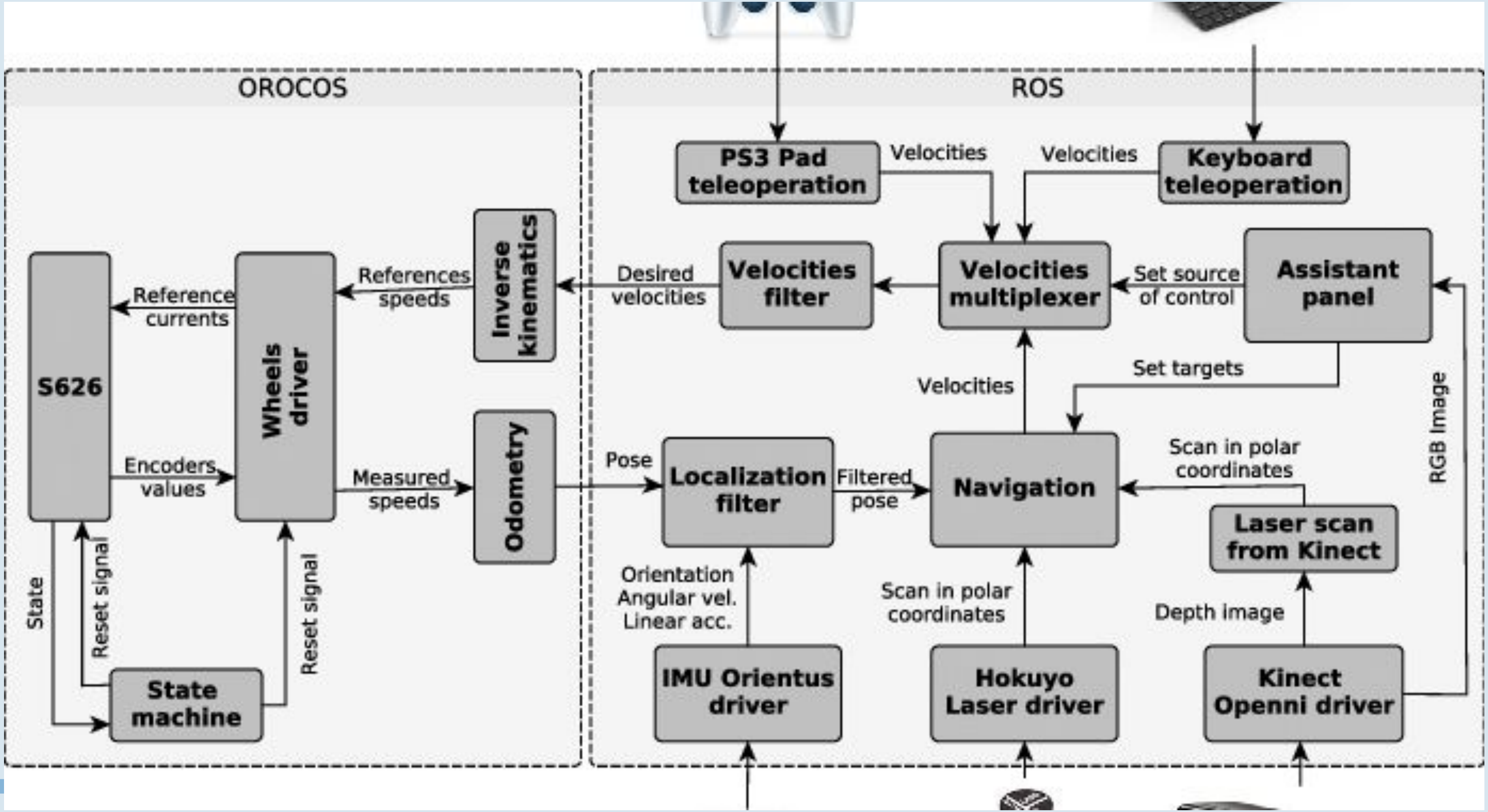
Energy Harvesting:

- May incorporate solar panels to harness energy from sunlight, providing a renewable and continuous power source.
- Robots equipped with moving parts can employ kinetic energy harvesting techniques to convert mechanical motion or vibrations into electrical energy.

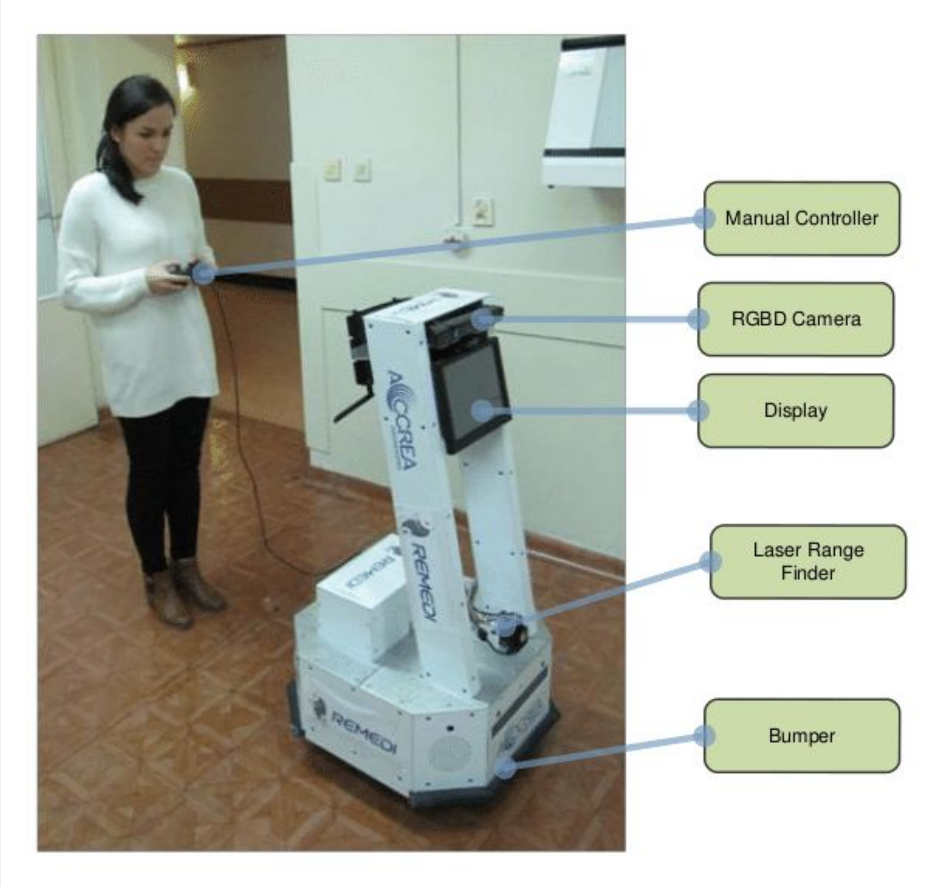
04

BUILDING YOUR OWN

Complete Humanoid Robot’s System Architecture

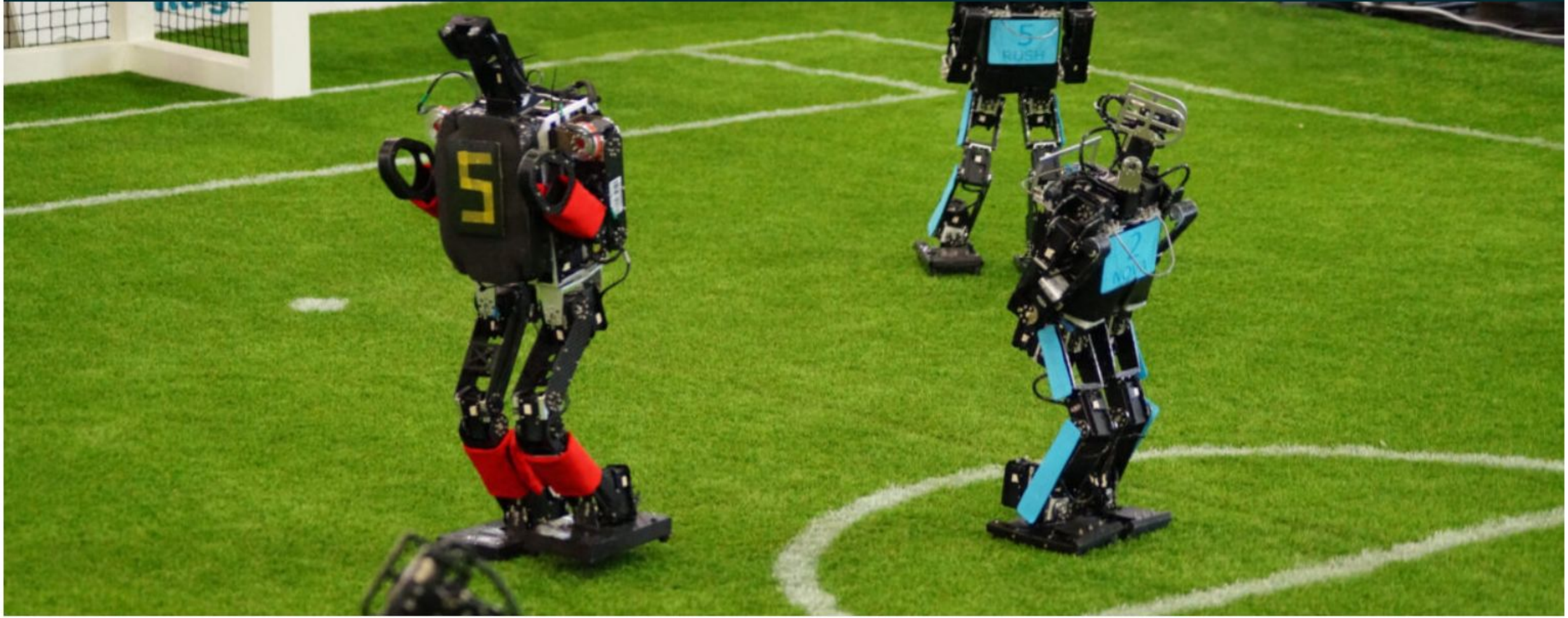


Hands On Session




MINGGU SAINS NEGARA
#KELUARGA MALAYSIA
KEMENTERIAN SAINS, TEKNOLOGI DAN INOVASI
PUSAT SAINS NEGARA
HUMANOID
ROBOT COMPETITION
SPORTS WITH ROBOTICS
4 Cabaran Terpilih
01 Obstacle Run
02 Basketball
03 Sprint
04 Freestyle
JUARA WANG TUNAI RM 6000
+ Piala dan Sijil Penghargaan
NAIB JUARA WANG TUNAI RM 3000
+ Sijil Penghargaan
TEMPAT KE-3 WANG TUNAI RM 2000
+ Sijil Penghargaan
SAGUHATI WANG TUNAI RM 1000
+ Sijil Penghargaan
Imbas kod QR untuk maklumat lanjut dan pendaftaran.
psn.gov.my/hrc/
Penyertaan PERCUMA & terbuka kepada pelajar Institut Pengajian Tinggi (Awam / Swasta), Persatuan Robotik dan kumpulan awam (18 tahun dan ke atas)
Tarikh Tutup Pendaftaran pada 24 Ogos 2022
MERAKYATKAN SAINS MENGINSANKAN TEKNOLOGI
psn.gov.my
Pusat Sains Negara

RoboCup Humanoid League



05 Market Player

Market Player:

1. Malaysian Robotics and Automation Group (MyRAG)
2. UTM
3. Cyberjaya University College of Medical Sciences (CUCMS)

Who can use this?

1. Healthcare
   -Hospitals, clinics, and healthcare facilities.
2. Education
   -Universities, colleges, and schools.
3. Hospitality and Tourism
4. Retail
5. Manufacturing and Industrial Automation
6. Researchers
7. Entertainment and Events

Obstacles

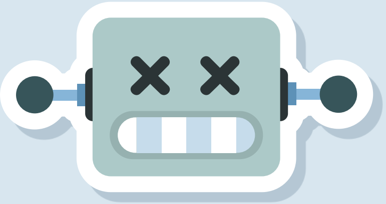
Cost
Complex and sophisticated machines, making it expensive.

Lack Expertise
Requires specialized knowledge and expertise in robotics.

Infrastructure
Limited in infrastructure to develop humanoid robots.

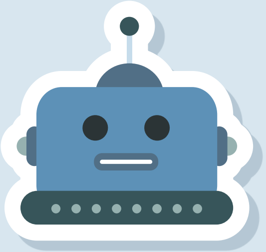
Regulations
The deployment of humanoid robots raises various regulatory and ethical considerations.

Top Things To Remember When Using Humanoid Robot



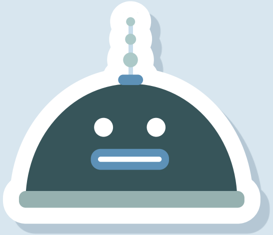
Safety

- Follow proper safety protocols, including wearing appropriate equipment and ensuring that the robot is operated in a safe environment.



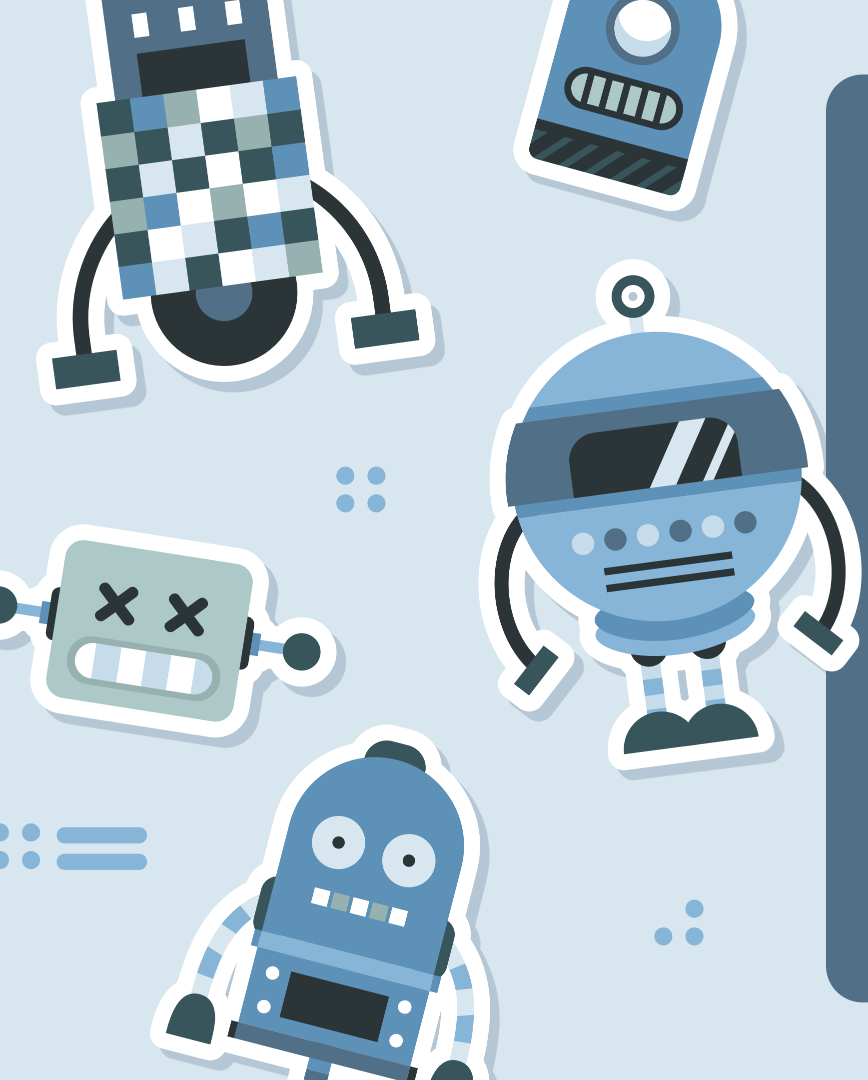
Power Management

- Pay attention to the robot’s power source and monitor battery levels or power supply to prevent unexpected shutdowns or interruptions.



Maintenance

- Perform routine maintenance tasks as recommended.
- This includes cleaning, lubrication, inspection of mechanical parts and calibration of sensors.



06 Conclusion

In conclusion, humanoid robots represent a remarkable advancement in the field of robotics, mimicking human-like characteristics and capabilities. They hold immense potential in various industries and sectors. As technology move forward, humanoid robots are expected to become more sophisticated, capable, and affordable. It is hoped that the full potential of humanoid robot can be unlocked, enabling us to harness their capabilities for the betterment of humanity.