

2024世界机器人大会

2024 World Robot Conference

人形机器人十大趋势展望

10 Trends of Humanoid Robots

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人形机器人专属部组件与材料

Exclusive Components and Materials for Humanoid Robots

- 高爆发电机、高算力芯片、精密减速器、高精度传感器、长续航电池等核心零部件，将构筑起更加稳定、高性能的人形机器人硬件系统

High-explosion motors, high-computing power chips, high-precision reducers and sensors, and long-endurance batteries, will construct a more stable and high-performance hardware system for humanoid robots.



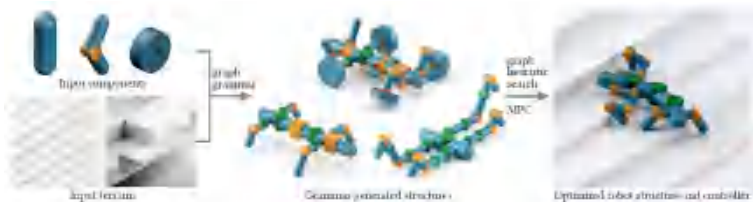
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人工智能赋能人形机器人设计

AI for Design of Humanoid Robots

- 基于神经网络、图语法、进化算法等人工智能技术，将能够根据场景和任务需求，自动构建人形机器人的腿足、手臂、躯干等模块，实现形态和控制的协同优化

Based on technologies of artificial intelligence such as neural networks, graph grammars and evolutionary algorithms, it would be possible to automatically construct modules of humanoid robots such as legs, arms and torso according to the requirements of the scene and tasks, which will achieve a synergistic optimization of form and control.



3

人形机器人运动智能

Motion Intelligence of Humanoid Robots

- ❑ **复杂地形行走:** 有望适应为人类搭建的斜坡、阶梯、门槛等复杂地形和狭窄环境, 实现稳定、自适应、抗干扰的行走

Walking on Complex Terrains: Humanoid robots are expected to adapt to complex terrains and narrow environments built for humans, such as slopes, steps and thresholds, achieving stable, adaptive, and anti-interference walking.

- ❑ **双臂协同操作:** 在下半身抖动的情况下, 将通过双臂协作, 使用人类的工具和装备, 完成高性能操作任务

Cooperative Operation of Dual-arm: In the case of unstable lower body, humanoid robots are expected to complete high-performance operation tasks with collaborative dual-arm using human tools and equipment.

- ❑ **“软补硬”技术:** 在硬件性能欠佳和传感信息匮乏时, 将通过软补硬技术系统寻找和充分利用环境和信息约束, 弥补硬件的不足, 实现高水准的任务执行

Compensation for Hardware with Software: When the hardware performance of humanoid robots is subpar and the sensory information is lacking, this technology systematically seeks and fully utilizes environmental and information constraints to compensate for the performance of hardware, achieving high-level task execution.



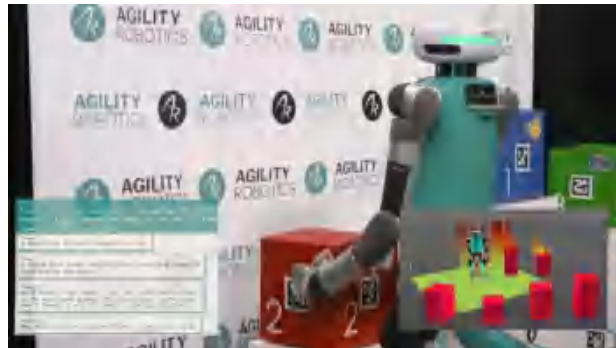
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人形机器人多模态大模型

Multimodal Large Model for Humanoid Robots

- 将能够通过融合语音、图像、文本、传感信号、3D点云等多模态信息，为人形机器人的感知和决策规划提供了更强的**多模态理解**、**生成**和**关联能力**，提升在复杂场景任务中的**泛化能力**

Multimodal Large Model will enable the integration of multimodal information such as voice, images, text, sensor signals, and 3D point clouds, providing **humanoid robots with enhanced multimodal understanding, generation, and association** capabilities for perception, cognition, and decision-making. It will also improve their **generalization** ability in complex scenarios and tasks.



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人形机器人大规模数据集

Large-Scale Dataset for Humanoid Robots

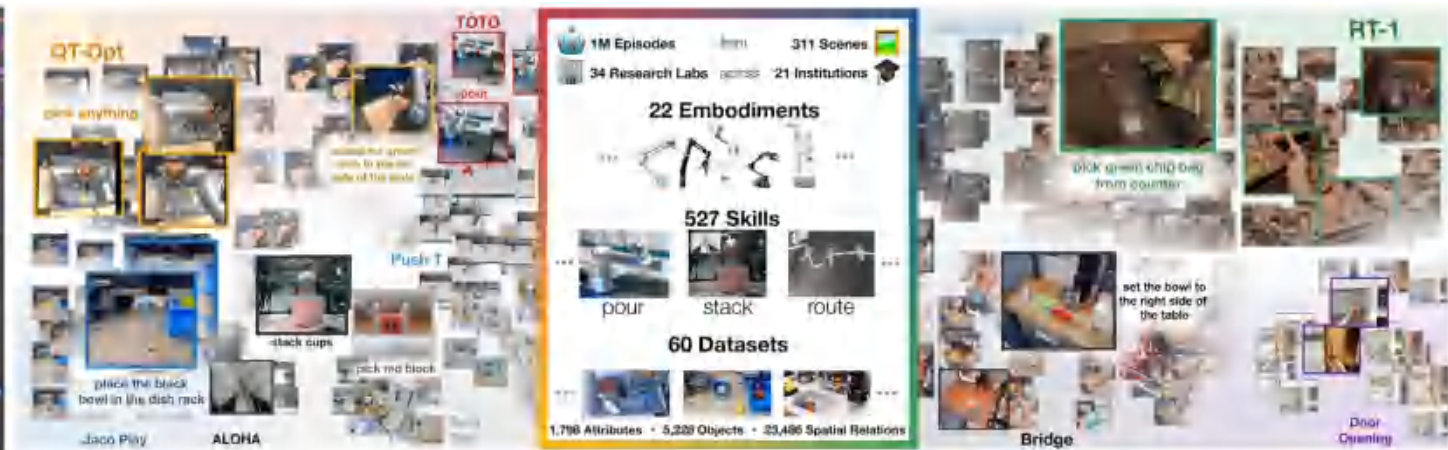
- 基于仿真合成或实体机器人采集，构建**大规模、标准化的人形机器人数据集**，有利于提高人形机器人本体设计、仿真训练和算法迁移的能力

Constructing **large-scale, standardized datasets for humanoid robots** based on data collected from simulation synthesis or physical robots is beneficial for enhancing the capabilities of body design, training in simulation, and algorithm transfer for humanoid robots.



仿真合成数据集

Dataset from Simulations



实体机器人数据集

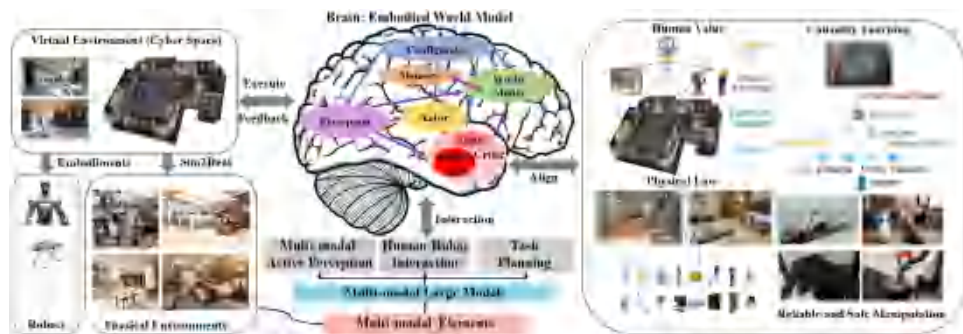
Dataset from Physical Robots

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人形机器人具身智能

Embodied Intelligence for Humanoid Robots

- 具身智能是可以在高变化下做出迅猛、精准反应的高质量、高性能智能系统；既不是单纯的虚拟环境下的计算机仿真，也不是完全偏于物理空间的机电系统，与人形机器人系统紧密相关
- Embodied intelligence refers to a high-quality, high-performance intelligent system capable of making rapid and precise responses in highly variable conditions. It is neither a mere computer simulation in a virtual environment nor an entirely mechanical-electrical system focused solely in physical space; rather, it is closely related to humanoid robot systems.



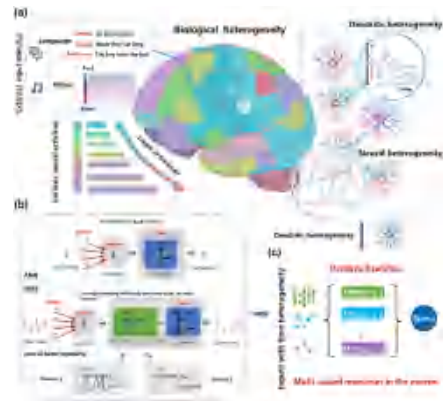
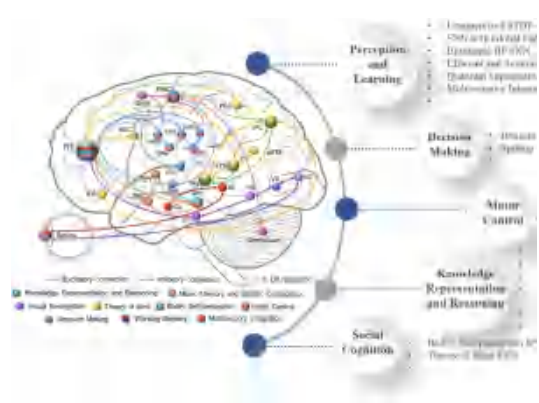
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受人体结构和神经机制启发的人形机器人

Humanoid Robots Inspired by Human Anatomy and Neural Mechanisms

□ 不同于现有人形机器人研究中的大部分方法从外向内地模拟人的功能，**从内向外模拟人的肌肉骨骼系统和神经机理**，探索人类实现高灵巧、高柔顺、高智能行为的本质机理。作为**人形机器人研究的新途径**，有望搭建更接近人的**高效稳定系统**

Unlike most existing algorithms in humanoid robot research that simulate human functions from the outside in, this approach simulates the human musculoskeletal system and neural mechanisms **from the inside out**, exploring the essential principles supporting humans to achieve highly dexterous, compliant, and intelligent behaviors. As a **new avenue in humanoid robot research**, it aims to build a more efficient and stable system that closely resembles human capabilities.



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人形机器人开源社区

Open Source Community for Humanoid Robots

- 将在全球范围内聚集人形机器人领域专家学者，促进技术研讨、信息交流和多方合作，助力产业链上下游的深度融合与协同发展

Global experts and scholars in the field of humanoid robots will be gathered to promote technical discussions, information exchange, and multi-party cooperation, fostering deep integration and coordinated development of the entire industrial chain.



Fold Clothes
(autonomous)



9

人形机器人“大工厂” ‘Manufactory’ of Humanoid Robots

- 将在软件环境打通基于分析技术和大模型的本体设计-控制-智能算法研发，根据性能需求**快速、定制化地设计和加工高质量、智能人形机器人系统**，通过软硬一致性和新型零部件研发，实现硬件系统及其验证

The process of body design, control, and intelligent algorithm development based on analytical techniques and large language models will be integrated within a unified software environment. This will enable the **rapid and customized design and manufacturing of high-quality, intelligent humanoid robot systems** based on performance requirements, and realize hardware systems and their validation through software-hardware consistency and development of new components



- **快速生成本体设计（本体）：**
通过AI4Design和控制验证实现结构设计提速10倍以上；

- Rapid Generation of Body Design (Body):
Achieve more than a tenfold increase in structural design speed through AI for Design and control validation



- **快速生成控制系统（小脑）：**
构建机器人库和控制算法库，实现Sim2Real和软补硬；

- Rapid Generation of Control Systems (Cerebellum):
Build a library of robots and control algorithms to achieve Sim2Real and compensation for hardware with software



- **快速生成智能系统（大脑）：**
生成适配机器人性能和应用场景的智能交互控制系统；

- Generation of Intelligent Systems (Brain):
Develop intelligent interactive systems tailored to the robot's performance and application scenarios.

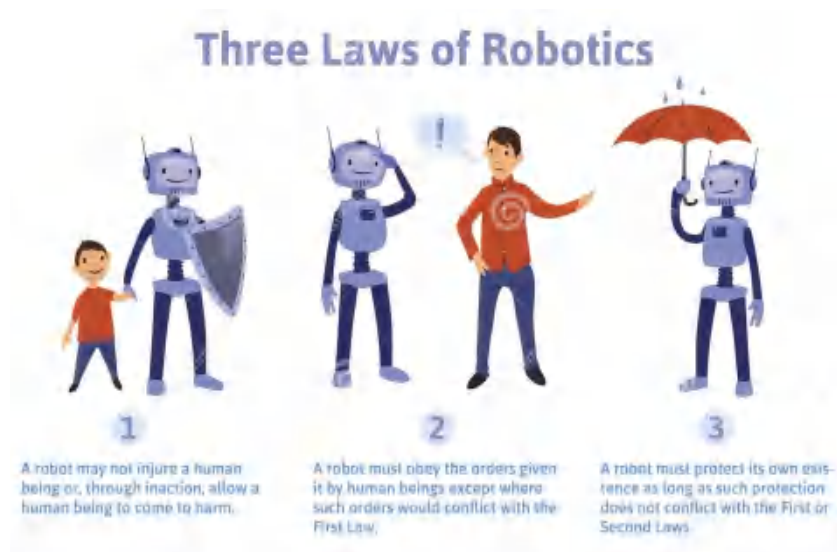
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人形机器人的道德伦理与安全性

The Ethics and Safety of Humanoid Robots

- 通过制定相关法律法规，确保人形机器人的设计、开发和应用合乎人类道德和伦理价值，持久保障人类使用人形机器人的权益和安全，将为全人类带来更多福祉和便利

With the establishment of relevant laws and regulations, it should be ensured that the design, development, and application of humanoid robots is aligning with human moral and ethical values, safeguarding the rights and safety of humans when using these robots, and ultimately bringing greater well-being and convenience to all humanity.



人形机器人的垂直应用

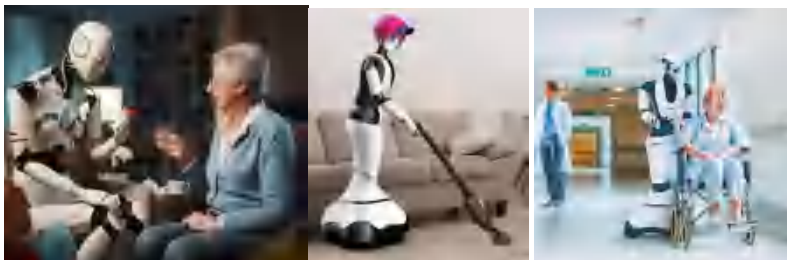
Applications of Humanoid Robots

人形机器人具有通用性，智能性，可无缝使用人类工具，将保障它的应用场景不断拓展和深化，深刻变革人类生产生活方式，引领社会走向全新的智能化发展阶段，为各行业带来颠覆性变革

- 在**工业领域**，将广泛参与危险作业生产环节，极大提高生产效率与安全性；
- 在**特种领域**，将会成为极端环境下执行科研探索、抢险救灾、安防巡检等任务的重要力量；
- 在**民生领域**，将全面融入人们生活，从提供家政服务到参与医疗辅助等，成为不可或缺的存在

The humanoid robots have versatility and intelligence, and can use human tools seamlessly. It will guarantee that the application scenarios will continuously expand and deepen, will profoundly transform human production and lifestyle, and lead society into a new stage of intelligent development, and bring disruptive changes to various industries.

- In the **industrial sector**, humanoid robots will widely participate in hazardous production processes, significantly enhancing production efficiency and safety.
- In the **specialized sector**, they will become a crucial force in executing tasks such as scientific exploration, disaster relief, and security inspections in extreme environments.
- In the **public sector**, they will fully integrate into people's lives, providing services from household chores to medical assistance as an indispensable presence.



谢谢！
Thank you!

