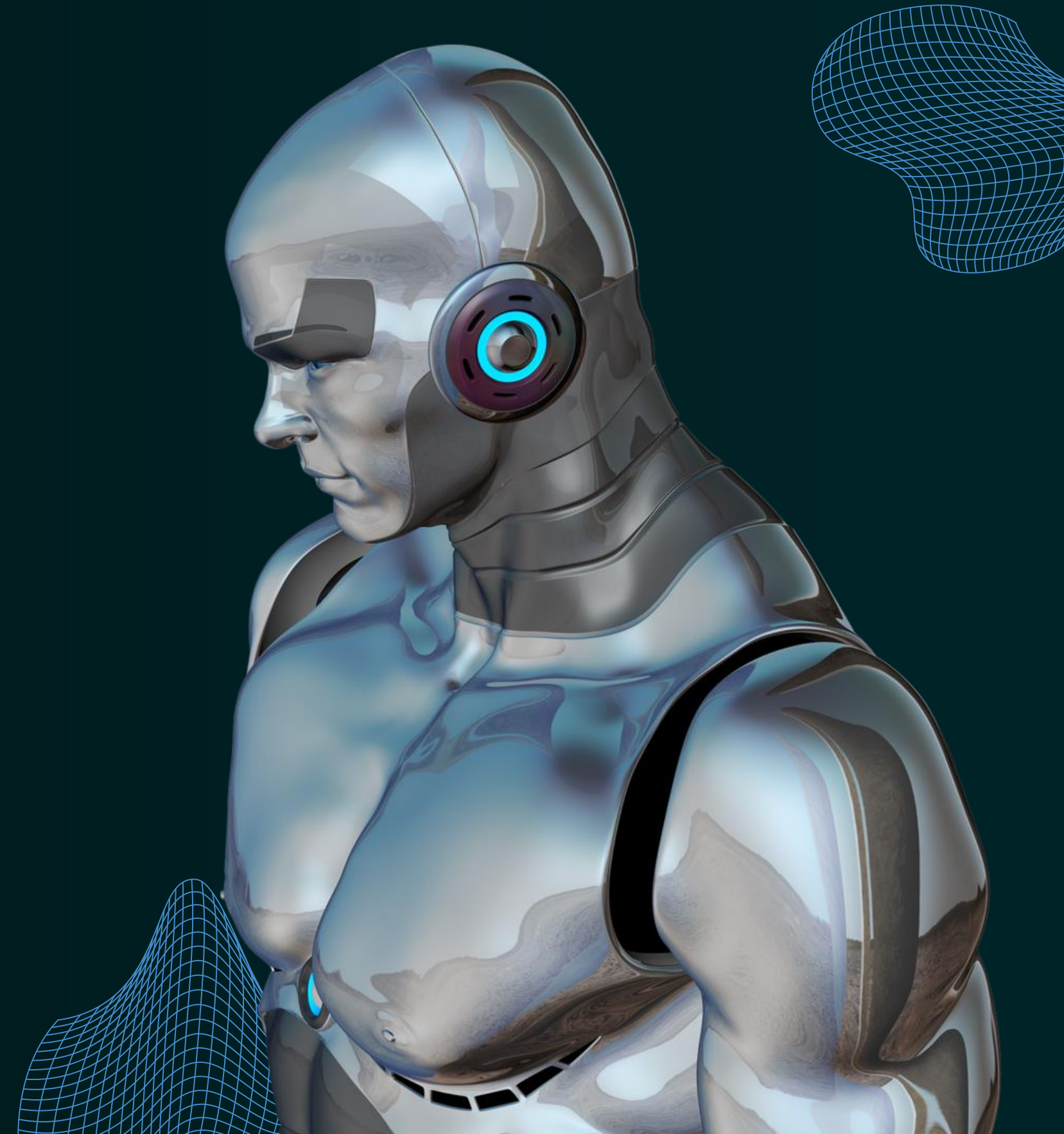# The Future of Humanoid Standards

Humanoid Robots In Human Spaces:

Building Standards for Safe, Ethical, and Effective Integration

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IEEE
Humanoid Study Group

The IEEE Humanoid Study Group report examines the safe and effective deployment of humanoid robots in human environments. Over 18 months, it brought together global experts to identify gaps in existing standards. The report highlights risks unique to humanoids—such as mobility, balance, manipulation, and interaction with people—and calls for new test methods for stability and fall behavior, as well as guidance on human-robot interaction.

Rather than setting a new standard, the report provides a roadmap for future standards work, highlighting where industrial robot rules, such as ISO 10218, fall short. It encourages collaboration among IEEE, ISO, ASTM, and regulatory bodies. It highlights the importance of the new ISO group focused on dynamic stability testing, which is crucial for ensuring safe locomotion and effective fall recovery. The report frames humanoids as a socio-technical challenge, requiring coordinated progress across technology, policy, and workforce readiness.
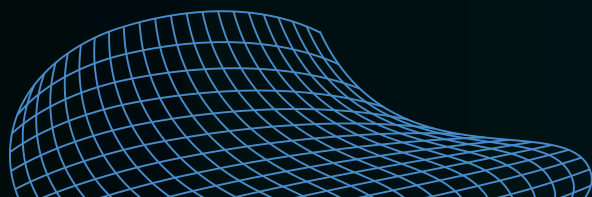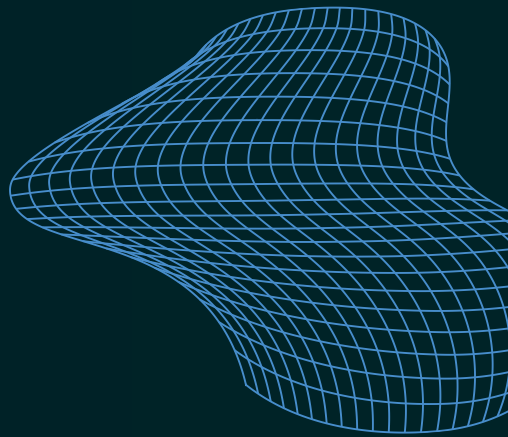
Why Humanoids Are
Something Completely New

- **Human-Centric Design = Higher Expectations and Risk**

When robots act human-like, we expect safety, intuition, and empathy. Failure isn't just technical—it's personal, ethical, and consequential.

- **Current Standards Don't Fully Address These Challenges**

They overlook key risks like dynamic stability, emotional influence, and untrained user interaction, leaving critical gaps.

Humanoids Require A
Different Safety Lens
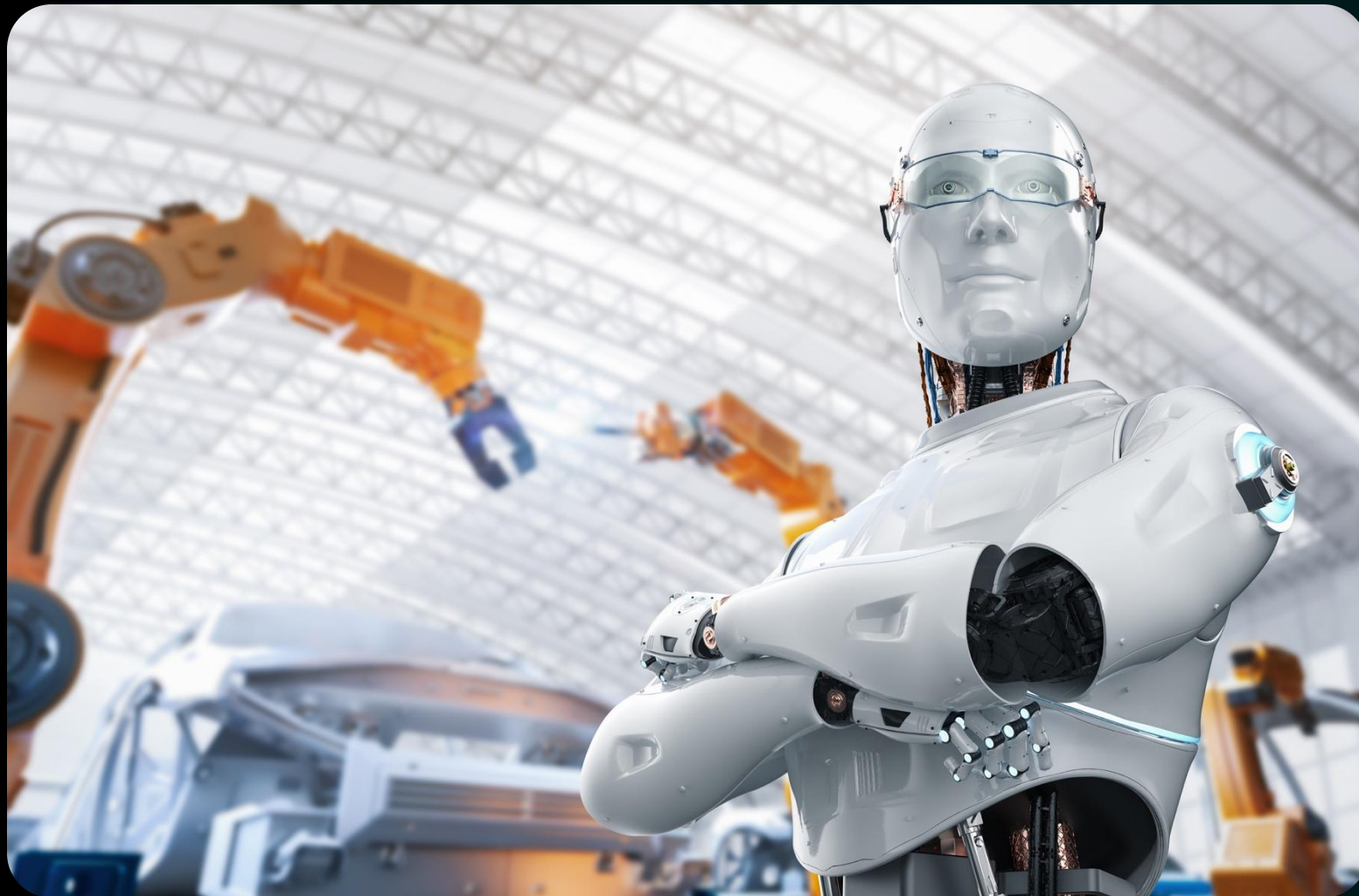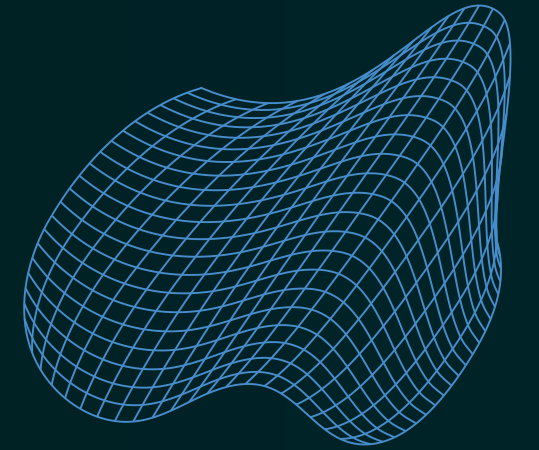
- ✓ **Anthropomorphic Design**

- ✓ **Cooperative vs. Collaborative**

- ✓ **Real-World Roles, Real-World Risks**

Humanoid robots bring mobility and tool use to human spaces, but also raise expectations and risks. Their collaborative roles in dynamic environments exceed the scope of existing standards, which were designed for static, isolated machines, not emotionally, ethically, or physically complex systems working alongside people. New frameworks are urgently needed.
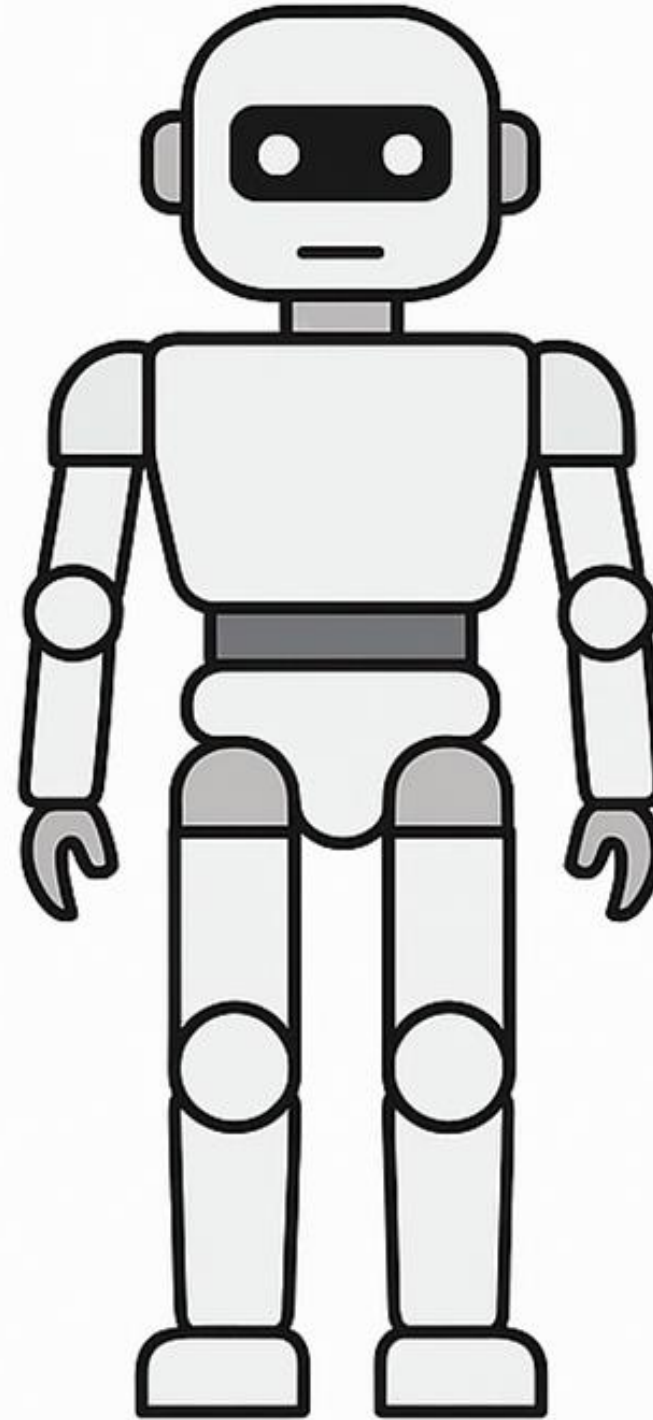
Physical Safety
Tip-overs, forceful motions, contact injuries

Psychosocial Impacts
Overtrust, frustration, social isolation

Ergonomic Limits
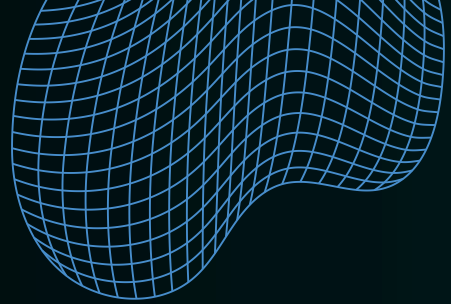Fine motor control, handling, cluttered spaces

Privacy & Ethics
Intrusive sensors in sensitive environments

Cybersecurity
Data theft, remote control, sabotage

Reliability & Predictabllity
Subsystem glitches, handoff errors

## Different Environments, Different Risks

Humanoid robots face varying risk profiles depending on the environment. In warehouses, the primary focus is on mechanical stability and lifting safety. In elder care, it shifts to emotional trust, physical contact, and ethical concerns. Public spaces introduce unpredictable crowds and necessitate intuitive navigation. A uniform safety approach can't cover these divergent needs.

Starting Point:
How & Where The Robot Is Used

|	Warehouse	Hospital	Public Space
Physical Safety			
Psychosocial Impacts			
Privacy			
Cybersecurity			
Reliability			
Ergonomic Limits			
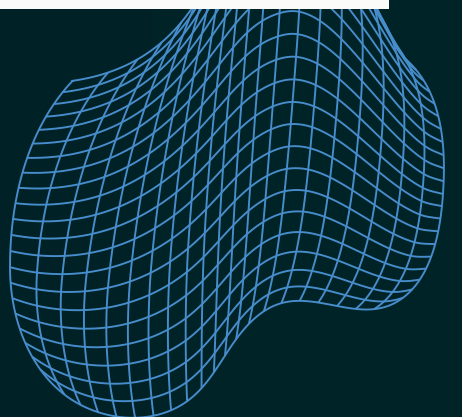
A Need For A Humanoid Classification Framework

A flexible, multi-dimensional classification system for humanoid robots is essential to support safety, performance, and interoperability across diverse applications. Current standards lack clear definitions, ignore key behaviors, and fail to address humanoids' complexity, creating gaps in design, testing, and public trust.

Instead of relying on visual appearance, classification should focus on physical capabilities, behavioral functions, use context, and risk exposure. This universal framework can guide future standards, ensuring consistency across robot types while supporting regulators, developers, and users alike.

Humanoid Classification: A Multi-Axis Framework

Physical Capabilities
- Mobility (fixed, wheeled, bipedal)
- Arms/DOF
- Sensors

Behavioral Intelligence
- Planning
- Interaction modes
- Task recovery

Operational Context
- Public
- Industrial
- Medical, residential

Stability & Risk Profile
- Static, dynamic, biomimetic
- Level of human contact
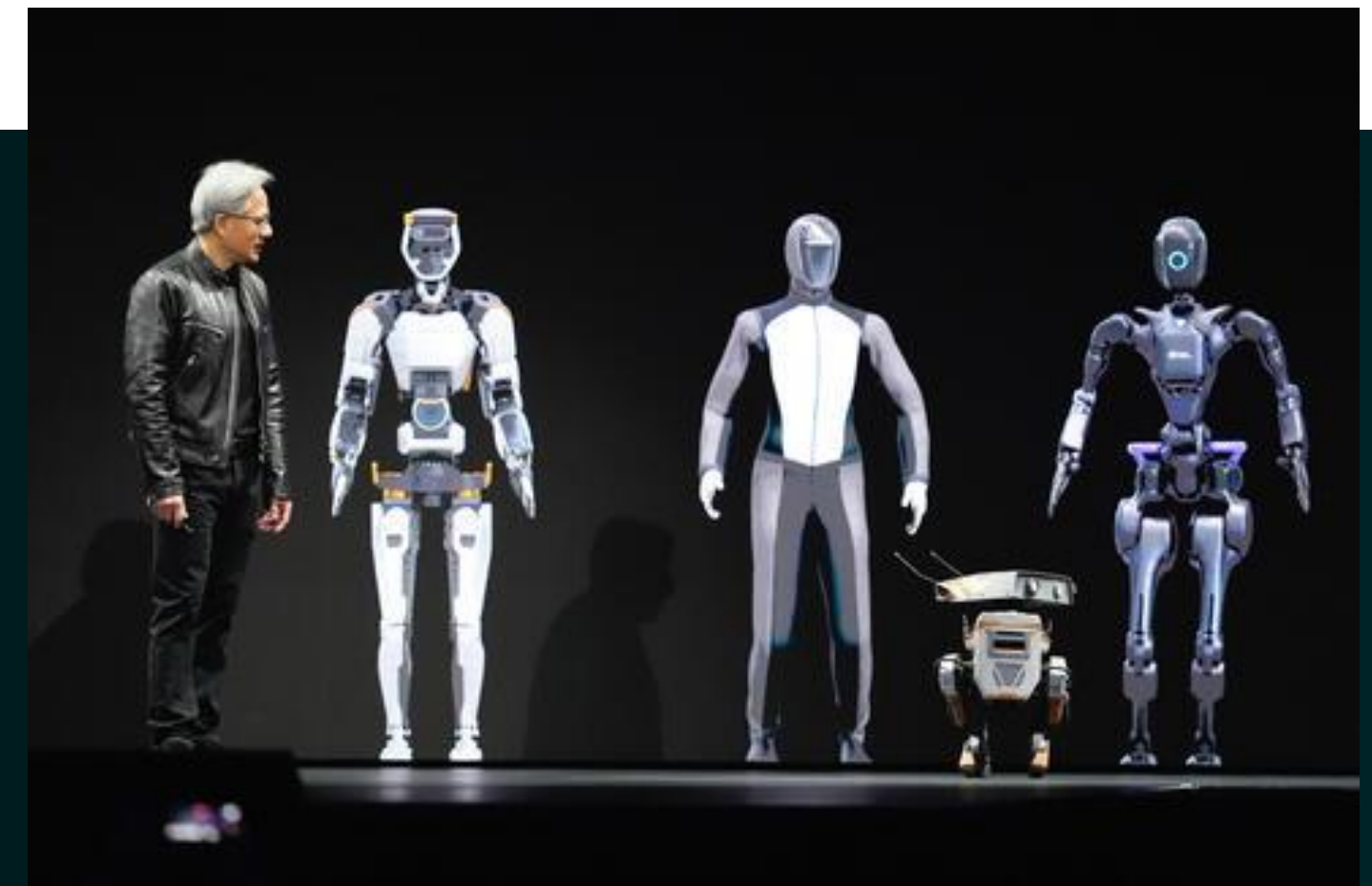
Stability Concerns
#1 Humanoid Safety Concern

- ✓ **Humanoids can fall due to numerous issues**

- ✓ **No current standard fully addresses dynamic balance risks (ISO underway)**

- ✓ **Stability must be measured, monitored, and managed in real time**

A dual approach is proposed:

- **Performance Metrics** – led by organizations like ASTM, IEEE, and NIST – to define how stability and control are quantitatively measured.
- **Behavior-Based Safety Standards** – developed through ISO, ANSI, etc.– to guide how humanoids behave in response to instability or unexpected human interaction.
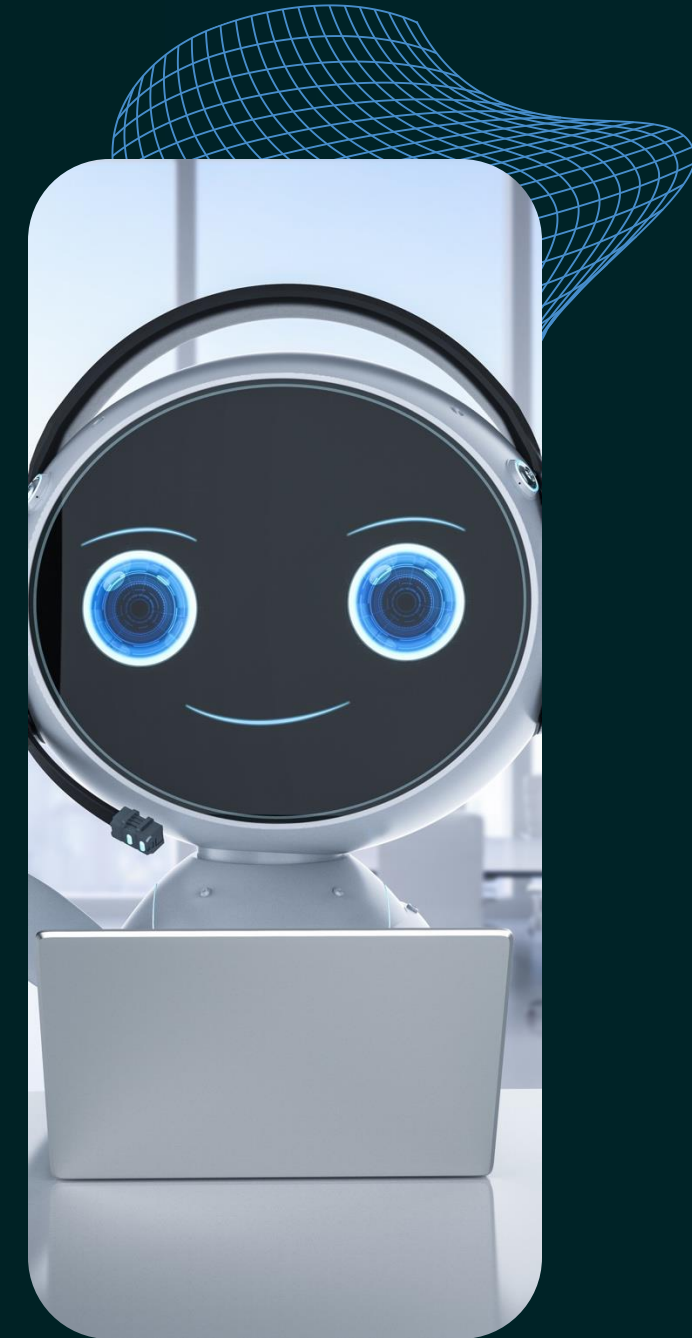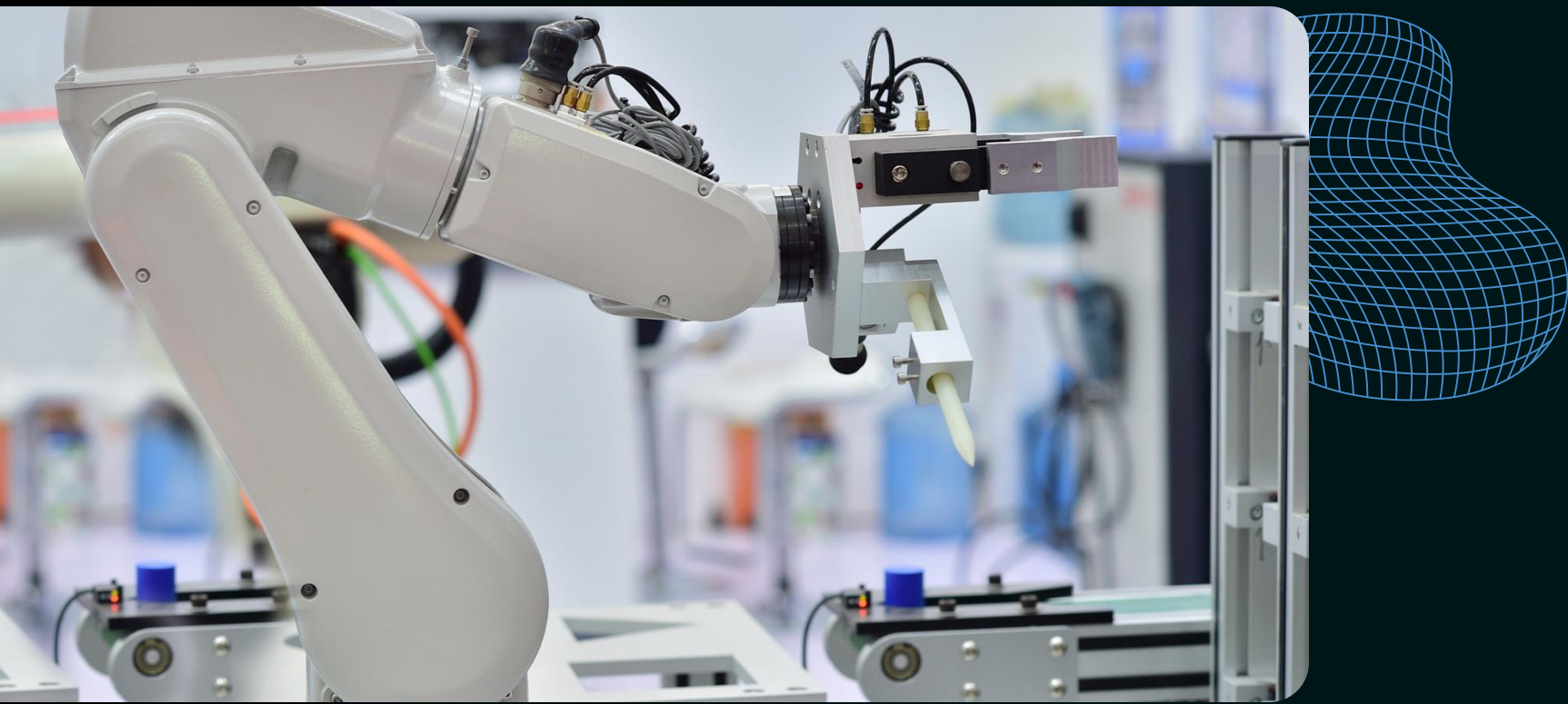
Humanoids &
Human-Robot Interactions

Emotional Expectations

Humanoids create emotional expectations—mismatched behavior risks confusion. HRI must be intuitive, multimodal, and context-aware.

Research-To-Standards

Standards must guide behavior, not just hardware. More research-to-standards work is essential for safe, trusted humanoid interaction.

Join A Standards Effort Near You

There will be numerous calls for experts in the future. Join an effort you want to contribute to.

ASTM

ASME

IEEE

ISO/IEC

National Standards Organizations

THANK YOU

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