

Humanoid Robots (4 ft and above) for Industrial and Educational Applications

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This report presents a comparative study of full-sized humanoid robots (4 feet and above), analyzing their technical specifications, programming ecosystems, AI capabilities, and real-world applications. By evaluating each robot’s strengths and development potential, this report aims to guide users, developers, and institutions in selecting the most appropriate platform for their specific needs in industrial operations or STEM education.

1. Lingxi X2



Technical Specifications

Parameter	Specification
Height	1.3 meters (approx. 4 feet 3 inches)
Controller (Motion)	Xyber-Edge (robotic cerebellum)
Controller (Decision)	Xyber-DCU (domain control unit)
Power Management	Xyber-BMS (Battery Management System)
Vision System	Visual Language Model (VLM) with silicon photonic tech
AI Model	WorkGPT (custom LLM for task understanding)
DOF	28 degrees of freedom

Key Features:

- Agility: Bipedal movement with high stability and control.
- Natural Interaction: Reads, responds, and performs tasks via WorkGPT AI.
- Stunt Capable: Rides bikes and hoverboards.
- Compact Form Factor: Designed for confined spaces.
- Interactive voice response (IVR).
- Vision-language models (VLM) based multimodal system.
- Holographic communication.

## Programming & Development Environment

Languages	Python, C++, ROS (likely ROS 2)
Interface	Python-based WorkGPT SDK or HTTP API
Tools	Simulation suite (e.g., Gazebo, RViz)
Framework	Custom middleware + ROS stack + Xyber API
Vision Prog	OpenCV, PyTorch
OS	RTOS (low-level); Linux (high-level)

### Secondary Development Capabilities

- Modular Design: Supports joint tuning, sensor upgrades.
- AI Model Integration: Compatible with AgiBot WorkGPT and external APIs.
- Open Development Interface: SDKs, APIs, simulation tools.

## 2. Pepper



### Technical Specifications

Parameter	Specification
Height	1.2 meters (approx. 4 feet)
Controller (Motion)	NAOqi OS motion module
Controller (Decision)	NAOqi framework with onboard processors
Power Management	Rechargeable Li-ion battery (approx. 12 hours standby)
Vision System	2 HD cameras + 3D depth sensor

AI Model	NAOqi AI SDK (face recognition, speech, gesture)
DOF	20 degrees of freedom

#### Key Features

- Voice interaction and speech recognition.
- Facial and object recognition.
- Tablet integration for HMI.
- Multilingual support.
- Adaptive behavior system.
- Educational and customer service roles.

#### Programming & Development Environment

Languages	Python, Java, C++
Interface	NAOqi SDK + Android SDK
Tools	Choregraphe, web-based simulator
Framework	NAOqi OS + middleware
Vision Prog	Integrated OpenCV
OS	NAOqi OS (Linux-based)

#### Secondary Development Capabilities

- SDK and simulator for behavior training.
- Open APIs for speech, motion, and tablet control.
- Community support and plug-and-play modules.

### 3. TIAGo



## Technical Specifications

Parameter	Specification
Height	1.2 meters (approx. 3.9 feet, adjustable to 4+ ft with extensions)
Controller (Motion)	PAL Robotics motion planning stack
Controller (Decision)	ROS-based decision architecture
Power Management	Rechargeable battery system (up to 8 hrs use)
Vision System	RGB-D camera, laser scanners, stereo vision
AI Model	ROS-integrated AI, supports custom AI plugins
DOF	14+ degrees of freedom

## Key Features

- Mobile base with arm and hand manipulation.
- Speech interaction and facial recognition.
- Human-robot interaction (HRI) ready.
- Customizable for healthcare, logistics, research.
- Built-in sensors for environmental navigation.

## Programming & Development Environment

Languages	Python, C++, ROS (1 & 2)
Interface	ROS topics, services, actions, MoveIt
Tools	Gazebo, RViz, PAL simulation suite
Framework	ROS + MoveIt + custom PAL modules
Vision Prog	OpenCV, TensorFlow
OS	Ubuntu with ROS

## Secondary Development Capabilities

- Modular design for easy expansion.
- Strong ROS community support.
- Extensive simulation and control tools available.

#### 4. Sanbot Elf



##### Technical Specifications

Parameter	Specification
Height	1.1 meters (approx. 3.6 feet, close to 4 ft)
Controller (Motion)	Sanbot motion platform (proprietary)
Controller (Decision)	AI Cloud + onboard processor
Power Management	Rechargeable lithium-ion battery
Vision System	HD camera, 3D depth camera
AI Model	Speech, face recognition AI via Qihan Cloud
DOF	14 degrees of freedom

##### Key Features

- Voice interaction and cloud-based services.
- Facial recognition and thermal sensing.
- Touchscreen for interactive apps.
- Educational, hotel, and healthcare assistant use.

##### Programming & Development Environment

Languages	Java, Python (via Android SDK)
Interface	Sanbot Cloud SDK, APIs
Tools	Sanbot Dev Tools + emulator

Framework	Proprietary + Android-based modules
Vision Prog	Android-compatible CV libraries
OS	Android OS

#### Secondary Development Capabilities

- Sanbot Cloud for app deployment.
- IoT integration through proprietary APIs.
- Educational packages are available via Qihan.

### 5. Waker X



#### Technical Specifications

Parameter	Specification
Height	1.45 meters (approx. 4.75 feet)
Controller (Motion)	UBTECH Motion AI Engine
Controller (Decision)	AI decision-making + NLP processor
Power Management	Built-in battery with long runtime
Vision System	Stereo vision, lidar, RGB cameras
AI Model	AI voice assistant, navigation AI, gesture control
DOF	36+ degrees of freedom

#### Key Features

- Bipedal humanoid with strong balance
- Autonomous walking and object handling
- Voice, vision, and gesture interaction
- Designed for home and industrial research

## Programming & Development Environment

Languages	Python, C++, proprietary APIs
Interface	UBTECH SDK + ROS bridge
Tools	Simulator (custom) + ROS tools
Framework	Custom AI stack + ROS modules
Vision Prog	OpenCV, TensorRT
OS	Linux + RTOS

## Secondary Development Capabilities

- Full-body humanoid with strong manipulation abilities.
- Developed for industrial, research, and home use.
- Supports both local and cloud AI processing.

## 6. THORMANG3



## Technical Specifications

Parameter	Specification
Height	1.5 meters (approx. 4.9 feet)
Controller (Motion)	Dynamixel Pro motors with real-time torque control
Controller (Decision)	OpenCR + external PC controller
Power Management	Rechargeable lithium battery
Vision System	RGB + depth cameras with facial tracking

AI Model	Customizable AI + ROS plugins
DOF	30+ degrees of freedom

#### Key Features

- Open-source humanoid designed for research.
- Compatible with motion planning and AI experiments.
- Capable of dynamic walking and basic manipulation.
- Designed for DARPA-style challenges and disaster response.

#### Programming & Development Environment

Languages	Python, C++
Interface	ROS topics, services, serial communication
Tools	RViz, Gazebo, Rviz, THORMANG3 simulator
Framework	Robotis Framework + ROS
Vision Prog	OpenCV
OS	Ubuntu + ROS

#### Secondary Development Capabilities

- Strong community and ROS documentation.
- Ideal for academic robotics programs.
- Expandable with 3D-printed or modular parts.

### 7. ARoS

#### Technical Specifications

Parameter	Specification
Height	Approx. 1.7 meters (5.6 feet)
Controller (Motion)	Adaptive walking control unit + AI coordination
Controller (Decision)	Central AI unit with cloud sync
Power Management	Integrated lithium battery + wireless charging
Vision System	RGB-D cameras, lidar, panoramic vision



AI Model	Multimodal AI for navigation and task handling
DOF	30+ degrees of freedom

#### Key Features

- Designed for autonomous logistics and workspace assistance.
- Intelligent navigation in dynamic human environments.
- Remote operable with real-time cloud sync.
- Integrates with smart buildings and IoT networks.

#### Programming & Development Environment

Languages	Python, C++
Interface	ROS-compatible APIs + cloud dashboard
Tools	Custom Dev Tools, Gazebo, RViz
Framework	NAVER Framework + ROS modules
Vision Prog	OpenCV, PyTorch
OS	Linux (real-time capable)

#### Secondary Development Capabilities

- Supports AI research for autonomous navigation.
- Includes simulation environment and cloud-based control.
- Industrial-grade sensors and dev support.

### 8. Apollo



Technical Specifications

Parameter	Specification
Height	1.76 meters (approx. 5 feet 8 inches)
Controller (Motion)	Modular joint controllers with torque sensing
Controller (Decision)	Central AI controller + remote monitoring interface
Power Management	Swappable lithium battery packs
Vision System	RGB + Depth cameras, 360° lidar
AI Model	Apollo OS with AI task planner
DOF	40+ degrees of freedom

Key Features

- Human-safe, full-size bipedal humanoid.
- Designed for warehouse and logistics task.
- Swappable battery and modular limbs.
- Capable of lifting and carrying loads.
- Advanced balance and dynamic motion control.

Programming & Development Environment

Languages	Python, C++, ROS 2
Interface	ROS 2 APIs + custom Appttronik SDK
Tools	Gazebo, Apollo Dev Suite
Framework	ROS 2, real-time control stack
Vision Prog	OpenCV, TensorFlow
OS	Linux (real-time enabled)

Secondary Development Capabilities

- Designed for industrial-level task deployment.
- Supports vision and manipulation tasks.
- SDK and simulation suite for development.

## 9. Talos



### Technical Specifications

Parameter	Specification
Height	1.75 meters (approx. 5 feet 9 inches)
Controller (Motion)	Torque-controlled joints with full-body dynamics
Controller (Decision)	ROS-integrated high-level control
Power Management	Rechargeable battery (autonomy 2–3 hrs)
Vision System	RGB-D cameras + stereo vision
AI Model	Custom AI via ROS nodes and plugins
DOF	32+ degrees of freedom

### Key Features

- High-payload robotic arms and dexterous hands.
- Whole-body torque control for interaction.
- Suitable for collaborative research and robotics education.
- Open-source support for motion and vision modules.

### Programming & Development Environment

Category	Details
Languages	Python, C++, ROS
Interface	ROS topics, services, action clients

Tools	MoveIt, RViz, Gazebo
Framework	ROS + PAL control stack
Vision Prog	OpenCV, ROS perception stack
OS	Ubuntu Linux + ROS

### Secondary Development Capabilities

- Modular design allows hardware and software extension.
- Used in EU-funded robotics projects.
- Comprehensive documentation and ROS community support.

## 10. Robothespian



### Technical Specifications

Parameter	Specification
Height	1.8 meters (approx. 5 feet 11 inches)
Controller (Motion)	Pneumatic and servo motor system
Controller (Decision)	Animatronic scripting + AI backend
Power Management	Mains powered (non-mobile)
Vision System	Facial tracking camera suite
AI Model	TTS, face tracking, custom interaction modules
DOF	20+ degrees of freedom

## Key Features

- Expressive face with screen-based animations.
- Speech synthesis and gesture coordination.
- Scripting and telepresence support.
- Ideal for exhibitions, schools, and outreach.

## Programming & Development Environment

Languages	Python, web scripting
Interface	API via browser or SDK
Tools	Web interface, visual programming tools
Framework	Custom middleware + browser-based editor
Vision Prog	Integrated suite
OS	Linux-based

## Secondary Development Capabilities

- Used in museums and educational demos globally.
- Supports multilingual speech engines.

## 11. InMoov



### Technical Specifications

Parameter	Specification
Height	Approx. 1.8 meters (modular, typically 5.9 feet)
Controller (Motion)	Arduino Mega with custom Nervo Boards
Controller (Decision)	PC-based (MyRobotLab, ROS integration)
Power Management	External power supply or battery packs (modular)
Vision System	Dual cameras (USB or Pi), optional Kinect
AI Model	MyRobotLab modules + integration with AI APIs
DOF	30+ degrees of freedom (head, arms, hands, fingers)

### Key Features

- Fully 3D-printed humanoid robot (open-source, modular).
- Natural motion with servo-powered hand and limbs.
- Multimodal integration: voice, vision, gesture.
- Compatible with speech recognition and chatbot AI.
- Ideal for maker project, education and HRI research.
- Modular development: build hands, arms, and torso separately.

### Programming & Development Environment

Languages	Python, Java, C++, JavaScript (via MyRobotLab, ROS)
Interface	MyRobotLab GUI, REST APIs, serial via Arduino
Tools	MyRobotLab, ROS, Gazebo, RViz
Framework	MyRobotLab, ROS, Arduino firmware
Vision Prog	OpenCV, PyTorch, optional Kinect support
OS	PC-based (Windows/Linux), ROS-enabled if extended

## Secondary Development Capabilities

- Open source: STL files, schematics, and firmware freely available.
- Strong global maker community for support and collaboration.
- Easily modifiable: sensor and actuator upgrades supported.
- Educational kits available through third-party vendors.
- Supports humanoid research, gesture control, and telepresence.

## 12. Walker S1



### Technical Specifications

Height	1.45 meters (approx. 4.75 feet)
Controller (Motion)	UBTECH Motion AI Engine
Controller (Decision)	AI decision-making + NLP processor
Power Management	Built-in battery with long runtime
Vision System	Stereo vision, LiDAR, RGB cameras
AI Model	AI voice assistant, navigation AI, gesture control
Degrees of Freedom	36+ degrees of freedom

### Key Features

- Bipedal humanoid with strong balance and locomotion.
- Autonomous walking and object manipulation.
- Supports interaction via voice, vision, and gestures.
- Designed for both home automation and industrial research environments.

### Programming & Development Environment

Languages	Python, C++, proprietary APIs
Interface	UBTECH SDK + ROS bridge
Tools	Custom Simulator, ROS tools
Framework	Custom AI stack + ROS modules
Vision Programming	OpenCV, TensorRT
Operating System	Linux + RTOS

### Secondary Development Capabilities

- Full-body humanoid with high manipulation ability.
- Suitable for industrial R&D, academic teaching, and smart home use.
- Supports local and cloud-based AI processing for flexibility.

## 13. Mitra





### Technical Specifications

Parameter	Specification
Height	Varies by model (Mitra: approx. 1.5 meters / ~5 feet)
Controller (Motion)	Proprietary control unit
Controller (Decision)	Onboard computer with AI inference capabilities
Power Management	Rechargeable lithium-ion battery
Vision System	RGB cameras + ultrasonic & IR sensors
AI Model	Custom AI modules for navigation, speech, and facial recognition
DOF	Limited (wheeled base, head and arm gestures depending on model)

### Key Features

- Specializes in customer-facing service robots (e.g., Mitra, Robonava).
- Voice-based interaction with multilingual support.
- Face recognition and object tracking.
- Suitable for public interaction (banks, hospitals, malls).

### Programming & Development Environment

Languages	Python, C++
Interface	SDKs and APIs available on request (proprietary)
Tools	Web-based control panels, mobile apps
Framework	Custom middleware
Vision Prog	OpenCV, TensorFlow (for AI processing)
OS	Linux-based

### Secondary Development Capabilities

- API integration for business workflows (e.g., CRM, ERP systems).
- Cloud connectivity for updates and analytics.
- Customizable UI/UX for specific use cases.

14. Mitri



Technical Specifications

Parameter	Specification
Height	Approx. 1.5 meters (~5 feet)
Controller (Motion)	Proprietary motion control unit
Controller (Decision)	Embedded system with AI processing
Power Management	Rechargeable lithium-ion battery (6–8 hrs operation)
Vision System	RGB cameras, ultrasonic sensors
AI Model	Face recognition, voice AI, cloud-assisted NLP
DOF	Limited (head movement, display gestures)

Key Features

- Human-like appearance with expressive movements.
- Face detection and recognition with audience analytics.
- Multilingual voice interaction and speech synthesis.
- Touchscreen interface for service applications.
- Widely used in hospitals, banks, receptions, and expos.

## Programming & Development Environment

Languages	Python, C++
Interface	HTTP APIs, proprietary SDK
Tools	Web dashboard, mobile control app
Framework	Custom middleware
Vision Prog	OpenCV, TensorFlow (server-side)
OS	Linux-based

## Secondary Development Capabilities

- Real-time control via web interface.
- Data analytics and integration with CRM or ERP.
- Custom app deployment via cloud.
- Can be used as a teaching platform for HRI and AI.

## 15. SE01 (EngineAI)



### Technical Specifications

Parameter	Specification
Height	Approx. 1.7 meters (~5.6 feet)
Processor	Intel CPU + NVIDIA Jetson (Orin/Nano)
Sensors	Stereo cameras, depth camera, LiDAR, microphones, 360° vision
Power Management	High-capacity lithium, ~2 hours operation, hot-swappable
AI Model	End-to-end neural control (imitation + reinforcement learning)
DOF	32 DOF total

### Key Features

- Natural and realistic human-like movement
- Capable of advanced physical maneuvers (flipping, running).
- Designed for research, robotics education, and AI experimentation.

### Programming & Development Environment

Languages	Python, C++
Interface	Full SDK + custom APIs
Tools	Simulator, telemetry tools
Framework	Custom engine with neural controller
Vision Prog	OpenCV, TensorFlow (server-side)
OS	Linux-based

### Secondary Development Capabilities

- Ideal for AI learning-based control studies.
- Mechanical and electrical expansion supported.
- Human-scale mobility testing and imitation learning models.

**List of robots with price:**

Robot	Height (ft)	Cost (INR)	SDK / Modifiability	Country of origin	Indian Distributors	Contact Info
Lingxi X2 (Agibot)	~4.3	₹11.5L – ₹46.5L+	Very High	China	-	Website: <a href="https://www.agibot.com/">https://www.agibot.com/</a>
Pepper (SoftBank Robotics)	~4	₹26.5L	Moderate	Japan	IRoboTech or SakRobotix	Email: <a href="mailto:contact@irobottech.com">contact@irobottech.com</a> Phone: +91-44-4380-5783
TIAGo (PAL Robotics)	~4+	₹16.6L – ₹41.5L+	High	Spain	PAL Robotics Asia representatives	Website: <a href="https://pal-robotics.com">https://pal-robotics.com</a> Email: <a href="mailto:info@pal-robotics.com">info@pal-robotics.com</a>
Sanbot Elf (Qihan Technology)	~3.6	₹10L – ₹12.5L	Moderate	China	Expert Hub Robotics Solutions	Website: <a href="https://experthubrobotics.com/jaya-bhatia">https://experthubrobotics.com/jaya-bhatia</a>
Walker X (UBTECH Robotics)	~4.75	₹34.3L	High	China	-	Website: <a href="https://www.ubtrobot.com">https://www.ubtrobot.com</a>
THORMANG3 (Robotis)	~4.9	₹22L – ₹35L (est.)	High	South Korea	-	Website: <a href="http://www.robotis.com">http://www.robotis.com</a>
ARoS (NAVER Labs)	~5.6	₹45L – ₹55L (est.)	High	South Korea	-	Website: <a href="https://www.naverlabs.com">https://www.naverlabs.com</a>
Apollo (Apptronik)	~5.8	₹48L+ (est.)	Very High	USA	-	Website: <a href="https://www.apptronik.com">https://www.apptronik.com</a>
Talos (PAL Robotics)	~5.9	₹50L+ (est.)	Very High	Spain	-	Email: <a href="mailto:info@pal-robotics.com">info@pal-robotics.com</a>
Robothespian (Engineered Arts)	~5.11	₹35L – ₹40L (est.)	Moderate	UK	-	Email: <a href="mailto:info@engineeredarts.com">info@engineeredarts.com</a>
InMoov	~5.3	₹1.2L-1.5L (est.)	Very High/ open source	France	-	Website: <a href="https://inmoov.fr/">https://inmoov.fr/</a>

Walker S1(UBTECH Robotics)	~4.75	₹34.3 Lakhs	High	China	-	Website: <a href="https://www.ubtrobot.com">https://www.ubtrobot.com</a>
Mitra (Invento Robotics)	~5	₹10L – ₹18L	Moderate	India	Invento Robotics	Website: <a href="http://www.invento.in">www.invento.in</a> Email: <a href="mailto:contact@invento.in">contact@invento.in</a>
Mitri (Invento Robotics)	~5	₹10L – ₹18L	Moderate	India	Invento Robotics	Website: <a href="http://www.invento.in">www.invento.in</a> Email: <a href="mailto:contact@invento.in">contact@invento.in</a>
SE01 (EngineAI)	~5.6	₹15 L – ₹21 L	High (Full SDK, neural AI)	China	-	Website: <a href="http://engineai.cn">engineai.cn</a>

### Comparison between Unitree G1and Lingxi X2

Feature	Unitree G1	Lingxi X2
Height	1.32 m (~4.3 ft)	1.3 m (~4.3 ft)
Weight	~35 kg	~33.8 kg
Degrees of Freedom (DOF)	Base: 23 DOF; EDU: up to 43 DOF	28 DOF
Mobility	Bipedal, can run (7 km/h), jump, foldable	Bipedal, stable walking, stunt-capable (bike, hoverboard)
Arm Manipulation	Available in EDU version with 3-finger hand	No hands; general bipedal interaction
Vision System	Depth camera + LiDAR + RGB + 4-mic array	Visual Language Model (VLM) + photonic vision
AI Model	UnifoLM imitation learning (EDU)	WorkGPT (custom LLM for task execution)
Programming Language	Python, C++ (full SDK only in EDU version)	Python, C++, ROS2
Development Interface	EDU: SDK, APIs; Basic: Limited/RC only	Full SDK (WorkGPT SDK, ROS, HTTP API)
Tools & Frameworks	Gazebo, ROS, OpenCV (EDU only)	Gazebo, RViz, OpenCV, Xyber API
Battery / Power	9000 mAh, ~2 hrs, hot-swappable	Xyber-BMS system, integrated battery
OS	Linux (real-time patched)	RTOS (low level) + Linux (high level)

Use Cases	Research, imitation learning, AI mobility	R&D, confined industrial spaces, AI communication
Cost (INR)	~₹13 L (base), EDU versions higher	₹11.5 L – ₹46.5 L+ (based on config)

Top 3 robots:

Robot	Country of origin	Cost (INR)	Secondary Development Strength	Why It’s Chosen
InMoov	France	₹1.2L – ₹1.5L (est.)	Very High (open-source, modular, ROS/MyRobotLab support).	Most affordable; ideal for education, research, and customization.
SE01 (EngineAI)	China	₹15L – ₹21L(est.)	High (neural control, SDK, imitation learning support).	Advanced capabilities and realistic motion at mid-tier pricing.
TIAGo (PAL Robotics)	Spain	₹16.6L – ₹41.5L+(est.)	High (modular design, ROS 1/2, MoveIt, Gazebo).	Strong community and industrial-grade dev tools for applied research and HRI.