Quadruped Research (for educational purpose)

Hiwonder Robots:

1. **Hiwonder PuppyPi** *(ROS-capable AI Vision Robot Dog)*

Specifications:

- **Degrees of Freedom:** 8 servos enabling dynamic leg movement via inverse kinematics.
- **Controller:** Raspberry Pi 4B or 5 (standalone, with ROS1/ROS2 support).
- **Sensors & Features:**
  - HD wide-angle camera (480p) + OpenCV AI vision (object tracking, face detection, line following)
  - Lidar/TOF SLAM, optional robotic arm.
  - IMU for posture and balancing.
- **Build:** 720 g aluminum-alloy chassis, measuring 226 × 149 × 190 mm.
- **Battery:** 7.4 V Li-Po (2200 mAh) for 1-2 hours runtime.

Pricing:

- Standard Kit with Pi 5 (4 GB): US $559.99
- Advanced/Pro packs (with arm/LiDAR): up to US $909.99
- Indian pricing: ₹74,350 (US $900) for high-end kits

Advantages:

- **Highly programmable**: Python + ROS1/2 support enables advanced robotics experiments.
- **AI+ Vision ready**: Ideal for SLAM, object tracking, and voice interactivity.
- **Modular & expandable**: Supports arm & Lidar add-ons for extended use.
- **Strong hardware**: Durable build with coreless servos, metal body capable and robust.

2. **Hiwonder ROSPug** (*Jetson Nano–based Bionic Robot Dog*)

Specifications:

- **Controller:** NVIDIA Jetson Nano running ROS.
- **Servos:** 12 high-voltage serial bus servos for stronger torque and speed.
- **Features:** Live camera feed, app/PC or gamepad control, gait parameter tuning (ripple/trot), inverse kinematics.

Pricing:

- Retail: US $1,099.99

Advantages:

- **High-performance compute**: Jetson Nano unlocks edge AI and heavy ROS workloads.
- **Stronger and smoother movement**: Four extra servos enhance gait control.
- **Advanced AI-ready**: Ideal for deep learning robotics and autonomous navigation.
- **Professional-grade**: Suited for research labs and industrial prototyping.

3. **Hiwonder MechDog**:

Specifications:

- **Controller:** ESP32 microcontroller.
- **Servos:** 8 coreless high-speed servos, 8-DoF for agile movement.
- **Sensors & Expansion:** Ports for ultrasonic, IMU; expandable with voice/vision on Pro version.

Pricing:

- Standard kit: US $299.99

Advantages:

- **Affordable starter platform**: Great for hobbyists and classrooms on a budget.
- **Lightweight and compact**: Palm-sized desktop form factor.
- **Open-source & versatile**: Supports Arduino, Scratch, and Python programming.
- **Expandable**: Sensor and mini arm add-ons available (especially in Pro variant).

Hiwonder PuppyPi Quadruped Robot Dog *(AI-Vision + ROS)*

₹1,64,610.30

Hiwonder ROSPug Quadruped Robot *(Jetson Nano, High-Torque)*

₹1,77,499.99

Hiwonder MechDog Robot Dog *(Entry-level, ESP32)*

₹38,849.99

Model	Best For	Highlights
PuppyPi	AI/SLAM experiments, robotics learning	ROS 1/2 support out of the box - Built-in **Raspberry Pi 4B** or Jetson Nano - SLAM-capable with LiDAR or OAK-D integration - Custom gait control - Modular for upgrades (arms, sensors)
ROSPug	Advanced AI robotics, research	Powered by **Jetson Nano** for AI inferencing - 12 high-torque servos - Stereo camera + depth mapping - Compatible with advanced packages like MoveIt, Nav2, and Deep Learning models - 6-axis IMU + SLAM toolkit ready
MechDog	Beginners, classrooms, quick coding	Lightweight acrylic chassis - Arduino/ESP32 based (easy to program) - Block-based coding (Scratch/Blockly) support - IR/Wi-Fi/Bluetooth remote options - Ideal for workshops and K–12 STEM education

Unitree Robotics:

1. Unitree Go1 *(Consumer/Prosumer)*

Specifications

- **6 or 12 mid-torque joints** (12 DoF); each thigh joint produces 23.7 N·m; knee joints 35.6 N·m
- **Weight & size**: 12 kg; dimensions 588×220×290 mm
- **Max speed**: Up to 4.7 m/s
- **Compute & sensors**: Built-in 16-core CPU + 384-core GPU (1.5 TFLOPS); up to five fisheye depth cameras, ultrasonic sensors, IMU; ISS side-follow and SSS obstacle avoidance.
- **Battery & runtime**: Base battery 6000 mAh; extended versions reach 1–2.5 hrs

Pricing

- **Go1 Air (base)**: US $2,700 + shipping (~US $1,000)
- **Go1 Pro**: US $3,500 (upgraded sensors/compute)
- **Go1 Edu**: US $8,500 (adds foot-force sensors, LIDAR, payload interface)

Advantages

- **High agility**: Fastest consumer-tier quadruped (4.7 m/s).
- **Intelligent navigation**: Patented side-follow mode keeps it near the user, while SSS enables obstacle avoidance.
- **AI-capable compute**: Onboard GPU enables edge AI processing hand recognition, SLAM, vision tasks.
- **Open SDK**: Supports high and low level API access, ROS compatibility (Edu), ideal for education and R&D.

2. Unitree A1 *(Research/Professional)*

Specifications

- 12 DoF, with motors delivering 33.5 N·m torque and max speed 21 rad/s.
- Speed & endurance: Upto 3.3 m/s and upto 2.5 hrs on a charge.
- Sensors & compute**:** Built-in IMU, optional 2D/3D LIDAR, RealSense depth camera; runs on Ubuntu + ROS; optional NVIDIA TX2/NX plugin for SLAM.
- Weight & size**:** 12 kg; dimensions ~500×300×400 mm.

Pricing

- A1 Basic / Explorer**:** Approx €13,900 (US $14 k)

Advantages

- Open-source & SDK-ready: Full ROS and Unitree-legged SDK access for joint-level control optimal for researchers.
- Powerful motion: Capable of backflips, jumps, and agile maneuvers due to strong motors.
- Modular & expandable: Additional sensors, cameras, voice modules can be added.

3. Unitree Aliengo *(Industrial-grade)*

Specifications

- Performance**:** Up to 1.5 m/s; performs various athletic movements side shifting, rolling, obstacle jumps.
- Sensors & integration**:** Modular support for cameras, LIDAR, IMU; ROS-friendly for industrial tasks.
- Payload & use**:** Designed for rugged terrain inspections and industrial environments.

Pricing

- Aliengo: $50,000 – 59,000 USD

Advantages

- Designed for industry**:** Rugged build for site inspection, mapping, and autonomous patrol.
- Modular architecture: Easy add-ons for cameras, LIDAR, ROS integration.
- Stable performance: Handles slopes, stairs, varied terrain reliably.

Model Comparison at a Glance

Model	Top Speed	Compute & Sensors	Price (USD)	Ideal Use
Go1 Air	2.5 m/s	Basic SSS, depth cameras	$2,700 (+ shipping)	Hobbyist, education
Go1 Pro	3.5 - 4.7 m/s	Better sensors & compute	$3,500	Advanced users, prosumers
Go1 Edu	4.7 m/s	LIDAR, force sensors, ISS	$8,500	Labs, university research
A1	3.3 m/s	ROS, LIDAR, Intel/NVIDIA	$14,000	R&D, SLAM, autonomous tasks
Aliengo	1.5 m/s	Industrial sensors, modular	$50,000 – 60,000	Inspections, industrial use

Petoi Robots:

1. **Petoi Bittle** *(Robot Dog)*

Fig. petoi Bittle

Specifications

- Size & weight: 7.9″ × 4.3″ × 4.3″, weight 10 oz (265 - 290 g).
- Joints/DoF: 2 joints per leg + neck = 9 DoF**.**
- Electronics & actuator:
  - Custom NyBoard (Arduino Uno compatible or ESP32).
  - STM32-based feedback servos.
  - 7.4 V/1000 mAh Li-ion battery (1 hr runtime).
- Controller options**:** Arduino IDE, Python, Petoi Coding Blocks, mobile/desktop apps, optional Raspberry Pi/camera support.

Pricing

- STEM kit (plastic servos): US $269 (construction), $289 (pre-built)
- Robotics kit (metal servos): $329–339

- Bittle X variants: $279 (construction Lite), $299 (pre-built Lite) up to $469 (V2 + arm + alloy servos)

Advantages

- Compact and portable: lightweight, desktop-friendly size.
- Modular and open-source: highly extendable with code, sensors, and add ons (e.g., gripper arm).
- Educational and flexible: support for block coding, C++, Python, mobile/desktop UIs.
- Durable design: spring-loaded legs, feedback servos, safe top speeds of 40 mm/s (2 body-lengths/s); can run even faster experimentally.

2. Petoi Nybble *(Robot Cat)*

Specifications

- Size & weight**:** 250 × 107 × 140 mm (10″ × 4.2″ × 5.5″), weighing 320 g.
- Joints/DoF:
  - Standard Nybble: 11 joints (11 DoF).
- Electronics & materials:
  - NyBoard V1 (Arduino Uno-compatible) with I²C, UART, IR, Bluetooth/Wi-Fi support
  - 11 coreless alloy-gear servos, max 8.4 V
  - IMU (MPU6050), RGB NeoPixel LEDs, buzzers, Grove ports
  - Puzzle-like wood/3D printed frame, 3–4 hr assembly
- Performance: Speed ~1.5 km/h walk, 2 km/h run
- Programming & platforms: Same as Bittle block coding, C++, Python, Arduino, Raspberry Pi

Pricing

- Nybble Kit: approx US $269–435
  - Standard: ~$269–299
  - Nybble Q (metal servos, pre-built): US $435–515

Advantages

- **Expressive & lifelike**: 11 joints allow nuanced motions; LEDs and sensors enhance interactivity.
- **Excellent educational tool**: supports STEAM learning, affordable and open-source.
- **Advanced sensing**: includes IMU, ultrasonic, IR—great for interactive programming.
- **Highly extensible**: supports Pi integration, custom modules, OpenCat ecosystem.

Comparison

Feature	Bittle X ($279–469)	Nybble ($269–515)

DoF	9 (legs + neck)	11 (more articulation)
Weight	265–290 g	320 g
Assembly time	40–90 min (basic), 1 hr (X)	3–4 hr
Design	Injection-molded plastic or puzzles	Wood/3D puzzle frame
Unique perks	Arm add-on, voice control, feedback servos	Balance sensing, expressive poseable limbs
Best for	Compact robot dog, speed, gripper extensions	Rich educational/bio-inspired cat motions

Mini Pupper Robots:

1. **Mini Pupper** *(Open-Source ROS Robot Dog)*

Specifications

- **Degrees of Freedom:** 12 DoF (three servos per leg) for agile, biologically-inspired movement.
- **Size & Weight:** Approx. 209 × 109 × 165 mm; weighs ~500–560 g.
- **Processor & Control:**
  - **Raspberry Pi 4B/Compute Module 4** running Ubuntu/ROS (1 & 2 supported).
  - Each leg has its own microcontroller enabling closed-loop control with position, velocity, and torque feedback (Pro versions).
- **Sensors:** Optional Lidar or Raspberry Pi camera/OAK-D Lite for SLAM and vision.
- **Battery:** ~800–1000 mAh Li-Po, offering roughly 1 hour of operation

Pricing Options

- **Research Basic Kit (parts only):** ~US $279
- **Full Kit (pre-assembled):** ~$499–564
- **Pro/Pro II Versions (closed-loop servos, full feedback):** Upto $649
- **Sourcing components yourself:** Estimated $600–1000

Advantages

1. **Open-Source Design & Expandability**
   Full access to hardware CAD, ROS software, and community-built extensions
2. **ROS & SLAM-Enabled**
   Built for real-world robotic functions: mapping, navigation, object tracking, and integration with AWS RoboMaker
3. **Robust 12-DoF Closed-Loop Control**
   Higher agility and fluid motion through torque/position feedback per leg—rare at this price
4. **Modular & AI Capable**
   Compatible with optional Lidar, camera modules, and equipped for OpenCV and AI vision tasks
5. **Educational & Research-Proven**
   Used in university robotics courses (e.g. Temple University) for autonomous movement and coursework
6. **Compact & Desktop-Friendly**
   Lightweight, palm-sized, and easy to set up (assembly in ~1 hour)

XGO Mini2 (Desktop Quadruped with Arm):

Specifications

- Degrees of Freedom: 12 DoF (4 legs × 3 joints each) + 3-DoF gripper arm.
- Compute & Control: Raspberry Pi CM4 (2 GB or 4 GB RAM) as "brain" + ESP32-based servo controller.
- Sensors & AI Features:
  - 6-axis IMU, joint angle + current sensors
  - Camera, mic, speaker, LCD screen
  - Supports visual (face, QR code, emotion), voice, and gesture recognition.
- Build & Dimensions:
  - Aluminum-alloy chassis; Mini2: 915 g and Lite2: 610 g.
  - Mini2 size: 270×150×180 mm; Lite2: 250×145×170 mm.
- Battery & Runtime:
  - Mini2: 2× 18650 Li-ion (3500 mAh) = 2 hr
  - Lite2: 2× 18650 (2500 mAh) = 1 hr

Pricing

- **XGO Lite 2**: US $449 Kickstarter; US $449–749.
- **XGO Mini 2**: US $749 Kickstarter; US $999.

Advantages

1. **Robust Construction**
   Solid aluminum alloy frame and reliable bus serial servos—more metal, less plastic – "satisfyingly well-made"
2. **AI & Vision-Ready**
   Built-in camera, touchscreen, microphone and speaker; supports edge AI vision, voice and gesture recognition.
3. **High Mobility**
   12 DoF with omnidirectional motion, multi-gait control (trot, walk, high-walk), and 6-axis stabilization .
4. **Programmable & Open-Source**
   Supports Blockly, Python, ROS; built on Raspberry Pi OS + xgoedu/xgolib Python SDK; highly modifiable .
5. **Interactive Gripper Arm**
   3-DoF gripper enables object manipulation (pick & place), uncommon at this scale .
6. **Educational and Hobbyist Focus**
   Desktop-sized, intuitive teach-by-hand mode, Blockly coding interface—suited for learning and prototyping

Feature	Hiwonder (PuppyPi/ROSPug/ MechDog)	Unitree (Go1/A1/ Aliengo)	Mini Pupper	Petoi (Bittle/Nybble)
Audience	Middle to advanced hobbyists, educational labs, ROS users	Consumer-grad e to industrial users, research labs	Hobbyists, students, ROS beginners	Beginners to intermediate educational users
Compute Platform			Raspberry Pi 4B / CM4, full ROS 2	
Degrees of Freedom (DOF)	8–12 DOF (varies per model)	12+ DOF, load-capable joints	12 DOF (3 per leg)	Bittle: 9–11 DOF, Nybble: 11 DOF
Sensors and Vision	IMU, camera, Lidar, optional SLAM, app/PC interface	Stereo/depth cameras, ultrasonic, IMU, SLAM (Edu), obstacle-avoid	Optional Lidar, camera, open-source SLAM	Optional IMU, camera, voice modules
Applications	ROS development, SLAM, AI prototyping.	High-speed running, follow mode, industrial inspection, R&D	Academic research, ROS education, AI vision on budget	Coding, STEM learning, playful motion demos
Build and Design	Metal or acrylic, modular, expandable (arms, sensors)	Rugged aluminum, enterprise grade joints, payload ready	3D-print frame, open source hardware/ software	Plastic/wood with spring loaded legs
Price Range				
Customization and Extensibility	High (especially with ROS), supports new sensors	Very high open SDK, ROS/Edu, mountable sensors/arms	High open-source ROS, swap sensors	Moderate block & Python code, add-ons available

Lite 3 Quadruped Robot Dog *(Unitree Robotics)*

Specifications:

Category	Details
Weight	13 kg
Payload Capacity	Up to 7 kg
Top Speed	3.3 m/s (12 km/h)
Battery Life	Up to 4–5 hours (modular battery)
Charging Time	2 hours
Sensors	IMU, joint encoders, optional LiDAR, depth cameras
Control	ROS support, SDK available (C++, Python), app-based remote control
Communication	Wi-Fi, Bluetooth, and optional 4G/5G modules
Degrees of Freedom	12 DOF
Terrain Capability	Handles uneven terrain, stairs, slopes
Dimensions	Approx. 645 × 290 × 400 mm

Pricing:

- **Base price**: Starts around **$2,700–$3,200 USD**
- Additional cost for **LiDAR, AI camera, computing modules**, etc.
- Final price varies depending on configuration and accessories

(Prices fluctuate based on distributor and region; Indian price ~₹2.5–3 lakh excluding tax/customs)

Advantages:

Area	Advantages
Affordability	One of the most affordable research-grade quadrupeds
Modularity	Add-on options for cameras, LiDAR, AI modules
Open Source	ROS support, SDKs in Python & C++, compatible with Gazebo & ROS2
Agility	Good dynamic motion, walk/trot/gallop support

Area	Advantages
Compact Size	Ideal for indoor labs, classrooms, and mobile research setups
Battery & Performance	Long battery life for its size, with swappable packs
Community	Active user community and documentation support from Unitree

Lite3 Quadruped

1.Mechanical Design:

- **Structure:** Lightweight yet strong body made of **aluminum alloy and carbon fiber**, ensuring a high strength-to-weight ratio.
- **Joints/Legs:** Each of the four legs has **3 Degrees of Freedom (DoF)**, allowing for motion in pitch and roll.
- **Compact form factor:** Designed for both **indoor and outdoor** usage.

Size & Weight:

- **Weight:** Approx. 12 kg
- **Dimensions:** Around 0.7 m (length) × 0.3 m (width) × 0.4 m (height) — varies slightly by version.

2. Working Principle

Locomotion: Uses **gait algorithms** (trot, pace, bound, etc.) for walking, running, and turning. **Inverse kinematics** and **trajectory planning** allow each leg to move with precision.Dynamic balance is maintained using **IMU data** and force feedback from legs.

Control Architecture: **Low-level controller:** Handles motor torque, velocity, and position control. **High-level controller:** Manages navigation, stability, path planning using AI algorithms. Real-time feedback loop ensures **stability** and **obstacle negotiation**.

3. Actuators Used

Deep Robotics Lite3 uses **high-performance servo motors**, typically: **Type: Brushless DC (BLDC) motors** with **planetary gearboxes**.

Each leg has 3 actuators:

- **Hip abduction/adduction**
- **Hip flexion/extension**
- **Knee flexion/extension**

4. Sensors Used

Inertial Sensors:

- **IMU (Inertial Measurement Unit):**
  - 9-axis (Accelerometer + Gyroscope + Magnetometer)
  - For balance, orientation, and posture control

Vision Sensors:

- **RGB or Depth Camera** (optional module)
  - SLAM, object tracking, environment mapping
  - Used in AI-driven navigation and perception

Force & Position Sensors:

- **Joint encoders:**
  - Measure joint angles precisely
  - Help in gait generation and feedback control
- **Force sensors / torque sensors**:
  - Detect foot-ground interaction forces
  - Used for **compliant control** and adjusting step strategy

Connectivity:

- Wi-Fi / Bluetooth / Ethernet
- Remote control via PC/tablet/smartphone
- SDK support for Python/C++ and ROS for advanced users

5. Software & Programming Interface

- **Real-Time OS or Linux-based controller**
- Compatible with **ROS (Robot Operating System)**
- Offers APIs for:
  - Gait control
  - Sensor data streaming
  - AI module integration
- **Simulators** available for virtual testing (e.g., Gazebo)

6. Applications

- Research in **legged robotics**, **gait optimization**, and **autonomous navigation**
- Robotics education and development platform
- Environmental exploration and surveillance
- AI-based real-world behavior training (e.g., object tracking, person following)

X30 QUadraped marvick tactical:

- **Dimensions & Weight:**
  Measures approximately **1 m × 0.7 m × 0.47 m** and weighs around **56 kg** (with battery) .
- **Environmental Durability:**
  - **Temperature Range:** Operates reliably from **–20 °C to +55 °C**.
  - **Ingress Protection:** Rated **IP67**, making it robust against dust and water.
- **Mobility Features:**
  Design allows rapid traversal of **45° inclines**, **obstacles ≥20 cm**, and **open-riser industrial stairs**, courtesy of its advanced leg-joint mobility .

. Working Mechanism

- **Locomotion & Terrain Handling:**
  Powered by **bionic-style leg joints** with control from motion-planning algorithms. Combined with AI-based "fusion perception," it nimbly navigates darkness, intense flickering light, and monotonous environments .
- **Power & Autonomy:**
  Offers **2.5–4 hours** of continuous work and covers **~10 km per charge**, with quick-switch battery packs that boost endurance by ~25% under load . It also supports **autonomous docking and charging**, with advanced positioning even in challenging work zones .

Actuators

- **Leg Assembly:**
  Each of the four legs includes multiple **servo-driven joints**, likely using **high-torque BLDC motors with onboard gearboxes and position control**. This setup supports:
  - Climbing, descending, obstacle traversal
  - Smooth, precise gait and posture adjustments

Sensors & Perception

- **LiDAR Array:**
  Typically outfitted with **2 front and 2 rear 360° LiDAR units**, enabling SLAM, mapping, and obstacle avoidance ..
- **Camera Systems:**
  Includes at least one **wide-view RGB camera**, often paired with thermal or depth sensors for enhanced situational awareness in low-light conditions.
- **IMU / Internal Sensors:**
  Onboard IMU likely supports dynamic posture adjustments and stability during movement.
- **Proximity & Collision Systems:**
  Fusion of visual and distance data enables effective avoidance of moving and static obstacles
  .

Feature	X30 Standard	X30 Pro (advanced variant)
Weight	~56 kg	~59 kg
Top Speed	≥ 4 m/s	≤ 4.95 m/s
Payload	~20 kg	~20 kg
Battery Life	2.5–4 h (≈10 km)	Same

Feature	X30 Standard	X30 Pro (advanced variant)
Locomotion	Climb ≤ 45°, step ≥ 20 cm	Same
Protection	IP67; –20 °C to +55 °C	Same
Sensing	4×360° LiDAR + RGB camera	Plus front/rear LiDAR, optional RTK/GPS, Intel 11th gen CPU
Comms & SW	Ethernet, Wi-Fi, ROS/Ubuntu	Adds USB, RS-232/485, 4G/5G, GPS/Beidou, RTK & industrial SDK

Applications

With its rugged build, sensory suite, and dynamic agility, the **X30 excels in**:

- **Industrial inspections** (power stations, pipelines, tunnels)
- **Search & rescue** missions in harsh or hazardous environments
- **Security patrols** and surveillance—both day and night
- **Mapping & surveying** using SLAM and LiDAR systems
- **Emergency response**, thanks to quick-deploy battery design and AI-driven autonomy

unitree B2:

Construction & Physical Specs

- **Body & Dimensions**
  - Weight: ~60 kg (battery included)
  - Standing size: 1098 × 450 × 645 mm; folded: ~880 × 460 × 330 mm.
- **Structural Design**
  - Rugged modular chassis with 12 DoF (3 DoF per leg) and robust mechanical joints for agility and load-bearing.
- **Gear & Protection**
  - IP67-rated, able to operate in temperatures from –20 °C to +55 °C.
- **Battery System**
  - 45 Ah lithium pack (~2.25 kWh), hot-swappable, supports autonomous docking/charging.

Feature	Details
Locomotion	Max speed > 5–6 m/s; handles stairs, inclines > 45°, jumps up to 1.6 m and crosses 40 cm obstacles.
Load Capability	Can support 120 kg standing; carries > 40 kg while walking
Operational Modes	Mode 1: manual motion control; Mode 2: AI-driven autonomous movement that adapts gait in real time
Endurance	Unloaded: > 5 h (~20 km); with 20 kg: ~4 h (~15 km)

Actuators

- **Joint Motors**
  - Custom Unitree-designed hollow-shaft BLDC motors with dual encoders .
  - Provide precise torque control and fast response for dynamic movement and stability.
- **Modular Actuation**
  - Each leg has 3 actuated joints (hip, thigh, calf) allowing complex gaits and terrain negotiation.

Sensors & Perception

- **LiDAR**
  - 3D LiDAR (Helios 5515, automotive-grade ~32-channel): delivers 360° point-cloud maps for SLAM and obstacle avoidance .
- **Depth Cameras**
  - Dual Intel RealSense D435i for front and rear depth perception .
- **Optical Cameras**
  - Two RGB visual cameras for object detection and environmental awareness .
- **IMU & Joint Encoders**
  - Onboard IMU for dynamic stabilization, plus high-resolution encoders in each joint for accurate positioning .

Computing & Control

- **Onboard Hardware**
  - Standard: Intel Core i5 (motion control) + i7 (development)
  - Optional: NVIDIA Jetson Orin NX module for advanced AI processing (e.g., SLAM, vision, RL.
- **Software & Networking**
  - Supports Wi-Fi 6, Bluetooth 5.2, Ethernet, USB 3.0; ROS-based control, API available in C++/Python.

Ditting s10 dingo:

- **Size & Weight**: Compact size (~38 × 25 × 25 cm) and lightweight (~3 kg), roughly the size of a shoebox—portable and ideal for lab use .
- **Chassis**: Modular 3D-printed body with strategic cutouts to mount additional sensors and components—user-friendly for modifications .
- **Power System**: Runs off a single LiPo battery, offering about **25 minutes** of runtime and enough room for add-on hardware.

Working & Control

- **Actuation**: Each of the four legs uses **3 high-torque servo motors**, arranged to minimize leg inertia and improve movement smoothness .
- **Locomotion**: Achieves **0.3 m/s** top speed and can strafe or change direction seamlessly; overall agility is supported by full state feedback in both joint and task spaces .

- **Control Electronics**: Core control via a **Raspberry Pi**, complemented by an **Arduino Nano** for interfacing with analog sensors and peripherals .
- **User Interface**: Dual control options—wireless gamepad control (e.g., PlayStation controller) or keyboard; real-time feedback via an onboard LCD and emergency motor cut-off button .
- **Simulation Support**: Includes full **Gazebo** simulation with URDF/CAD models to streamline development and testing .

Actuators

- **Servo Motors**: Twelve DC servos total (3 per leg) rated at ~35 kg·cm torque, fan-cooled for sustained operation .
- **Mechanical Layout**: Vertically stacked motor configuration reduces moment of inertia, enhancing responsive and precise leg movement.

Sensors & Feedback

- **Joint Encoders**: Built-in within servo motors to enable precise joint-space control and accurate gait maintenance across legs .
- **Analog Peripherals**: Arduino Nano supports integration with additional sensor types (e.g., range finders, IMUs) for extended projects .
- **Simulation Sensors**: Virtual sensors modeled in Gazebo for safe, simulated testing—crop-ready for real-world transfers .

Software & Ecosystem

- **Operating System**: Runs Ubuntu with **ROS Noetic**, offering full ROS compatibility .
- **Control Nodes**: Includes a joystick node and ROS topics for commanding joint/task positions; toggles between manual (joystick) and autonomous control .
- **Open-Source Tools**: Provides full CAD models, BOM, ROS drivers, and simulation environment.

Xiaomi cyberdog:

- **Form Factor & Materials**
  - 1st-gen CyberDog (2021): approx. 77 cm × 35 cm × 40 cm, 14 kg.
  - 2nd-gen CyberDog 2 (2023): more compact (~56 × 34 × 48 cm), ~8.9 kg .
  - Rigid body of carbon fiber, aluminum, and ABS.
- **Compute Core**
  - Powered by **NVIDIA Jetson Xavier NX**:
    • 6-core Carmel ARM CPU, 384 CUDA cores, 48 Tensor cores. Supports embedded AI and perception .
  - Storage: onboard SSD (32–128 GB); 2nd-gen includes eMMC + SSD .

.Working & Control

- **Gaits & Speed**

    - Modes: walk, trot, run, jump, backflip, stand-up on hind legs.
    - Performance: up to ~3.2 m/s (11.5 km/h) in 1st-gen; CyberDog 2 runs at ~1.6 m/s
- **Autonomy & Navigation**
    - Real-time SLAM mapping, obstacle avoidance, human/object tracking, gesture and voice command .
    - Hybrid control (voice, app, remote control, ROS integration).

. Actuators

- **Custom BLDC "CyberGear" Motors**
    - 12 actuators (3 per leg), quasi-direct-drive with planetary gears.
    - Torque: ~32 N·m, 220–320 rpm, enabling agile actions like flips and jumps .

Sensor Type	Description
Vision Cameras	AI interactive, fisheye (wide-angle), Intel RealSense D450/D430 depth cameras .
Ultrasonic & ToF	Range sensing for short-distance obstacle detection
IMU + Geomagnetic	Orientation and stability support via IMU; directional tracking via geomagnetic sensor
GPS Module	Used for outdoor navigation (1st-gen)
Touch & Ambient Light	Inputs for interaction and environment sensing
Microphone Array (6 mics)	Voice command input and localization via sound
Optical Flow Meter	Tracks movement relative to ground

In total, 1st-gen had 11 sensors; 2nd-gen expanded to up to 19, adding LiDAR, additional ToF, ultrasonic sensors, UWB, and force sensing .

Lynx M20:

- **Hybrid Mobility:** Combines wheeled and legged locomotion — wheels can drive for speed or lock for legged movement over obstacles.
- **Compact & Portable:** Only **33 kg**, portable by one person; dimensions approx. 820×430×570 mm.
- **Robust Build:** Rated **IP66**, operable from **–20 °C to +55 °C**; ideal for dust, water, heat, and cold exposure.
- **Joint Flexibility:** Features dual-leg configurations —
    - *Front-elbow/rear-knee* for narrow spaces (≥50 cm),
    - *Full-elbow* for stair/step climbing (up to 25 cm continuously, 80 cm single-step) .

. Working & Performance

- **Speed & Endurance:**
    - Max speed: up to **5 m/s** (lab), operational max **2 m/s** (~7.2 km/h.
    - Runtime: **~2.5 hr** (with 15 kg payload), **3 hr** unloaded (~12–15 km range) ,.
    - Hot-swappable batteries enable continuous missions .
- **Terrain Handling:**

- Conquers 45° slopes, 80 cm obstacles, stairs 25 cm, wetlands, rubble, sand, snow, pipelines, and tunnels
- Operates with AI motion control and SLAM for posture adaptation and environment awareness .

Actuators

- **Wheel-Leg Mechanism:** Each leg ends in a wheel that can rotate or lock, driving motion via wheel rotation or leg lifting for gait adaptation.
- **Motor System:** Uses high-torque, brushless motors with onboard gearing (likely planetary), engineered for quick switching between drive and leg modes; supports up to 50 kg max payload and rugged operation.

Sensors & Perception

- **LiDAR:** Dual **96-line 360°×90°** LiDARs (~860k pts/s) enable full surround mapping and real-time obstacle avoidance .
- **Cameras & Lighting:** Twin wide-angle cameras with bidirectional lighting support navigation in low light and enable RF video streaming.
- **IMU & Joint Encoders:** Integrated IMU and encoders fuel dynamic gait control and posture adaptation through sensor fusion.
- **Compute & Interface:** Equipped with dual octa-core industrial CPUs (16 GB RAM + 128 GB storage each), Gigabit Ethernet, RF comms, OTA updates, and modular expansion ports .

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5. Applications & Advantages

- **Payload & Mission Suitability:** Supports 15 kg operational payload; max 50 kg; suitable for inspection, logistics, emergency response, firefighting, scientific exploration .
- **Adaptability to Confined & Hazardous Sites:** Thrives in tight corridors (≥50 cm), broken terrain, wet/dusty environments, nighttime operations — reducing human risk.
- **Smart Autonomy:** AI-driven posture adjustment, terrain-aware gait control, SLAM-based navigation, OTA upgrades, and optional auto-charging/rescue modes.

Robot	Sensors	Actuators	Localization & Mapping
Lite 3	IMU, Depth camera, LiDAR, Ultrasonic, AI vision	High-torque servo motors	SLAM-based using depth + LiDAR + visual inertial odometry
X30 (Maverick Tactical)	3D LiDAR, Night vision camera, GPS, IMU	Hydraulic/electric hybrid actuators	LiDAR+IMU fusion, supports rugged terrain mapping and GPS-assisted SLAM
Unitree B2	3D LiDAR, Depth camera, IMU, TOF sensors	High-performance brushless joint motors	Visual-Inertial SLAM with real-time obstacle detection

Robot	Sensors	Actuators	Localization & Mapping
Ditting S10 Dingo	Depth camera, LiDAR, IMU, GPS	Industrial-grade servo motors	LiDAR+Visual SLAM with precise motion planning
Xiaomi CyberDog	AI camera, 4 stereo cameras, ultrasonic sensor, IMU	High-speed servo motors	Visual SLAM with Intel RealSense and AI-assisted path planning
Lynx M20	LiDAR, 3D depth camera, IMU	DeepRobotics modular drive actuators	Advanced SLAM, terrain-adaptive gait control with high-frequency sensor feedback

1. Defense and Tactical Operations

Robots: X30, Unitree B2, Lynx M20

Uses:

- Surveillance & reconnaissance in hostile terrain
- Payload delivery in warzones
- Patrolling and mapping dangerous or GPS-denied environments
- Night operations with thermal and IR cameras

2. Search & Rescue Missions

Robots: Lite 3, Ditting S10 Dingo, Unitree B2

Uses:

- Navigating through rubble, collapsed structures, or post-disaster zones
- Mapping environments and locating survivors with thermal vision or depth sensors
- Carrying medical kits or emergency supplies

3. Industrial Inspections

Robots: Lynx M20, Unitree B2

Uses:

- Pipeline, refinery, and power plant inspection (especially in hard-to-reach places)
- Replacing human presence in dangerous zones (chemical, nuclear, etc.)
- Performing repetitive and hazardous inspections with autonomous SLAM capabilities

4. Research & Development

Robots: Lite 3, Xiaomi CyberDog, Unitree B2

Uses:

- AI, SLAM, control algorithm development (e.g., gait optimization)
- Real-time sensor fusion, vision-based obstacle avoidance
- Education and robotics research platforms in academic institutes

5. Companion & Entertainment

Robots: Xiaomi CyberDog

Uses:

- Human-robot interaction experiments
- Gesture and voice-controlled pet-like robots
- Experimental platforms for household robotics and social AI

Feature / Robot	Lite 3 (AI Powered)	X30 (Maverick Tactical)	Unitree B2	Ditting S10 Dingo	Xiaomi CyberDog	Lynx M20 (Deep Robotics)
Purpose	AI research, education, prototyping	Tactical ops, rugged terrain	Industrial, military, research	Search & rescue, inspection	Companion, consumer AI	Industrial, hazardous environments
Weight	12–15 kg	20–25 kg	50 kg	30–40 kg	14 kg	45–55 kg
Payload Capacity	5 kg	10 kg	Up to 40 kg	10–15 kg	3 kg	Up to 20 kg
Top Speed	1.5 m/s	2.5–3 m/s	3.3 m/s	2.5 m/s	3.2 m/s	2.0–2.5 m/s
Battery Life	1–1.5 hrs	2 hrs	4–6 hrs	2–3 hrs	1.5–2 hrs	3–4 hrs
Control Modes	App, PC, Autonomous (ROS)	Remote, Autonomous, Pre-programmed	Remote, App, Autonomous (ROS)	App, ROS	App + voice + gesture	App, Remote, ROS
Sensors	Depth cam, IMU, GPS	LIDAR, IMU, GPS	LIDAR, depth camera, GPS, IMU	LIDAR, camera, IMU	Camera, mic, IR, ToF, IMU	LIDAR, stereo cam, thermal cam
AI Features	Yes (edge AI)	Limited onboard AI	Advanced AI, perception, SLAM	Object detection, terrain nav.	Face + gesture + voice recog.	Advanced perception + mapping
SLAM/Mapping	Basic 3D SLAM	GPS + LIDAR	LIDAR + Visual SLAM	LIDAR + visual odometry	No (basic obstacle avoidance)	Full Visual SLAM
Environment	Indoor/flat outdoor	Harsh terrain, military field use	Industrial, outdoor	Post-disaster, uneven terrain	Indoor/domestic only	Construction, factories, outdoors
Water/Dust Resistance	IP54 approx.	IP65+	IP67	IP65 approx.	IP53 approx.	IP67

Feature / Robot	Lite 3 (AI Powered)	X30 (Maverick Tactical)	Unitree B2	Ditting S10 Dingo	Xiaomi CyberDog	Lynx M20 (Deep Robotics)
Platform Openness	ROS/SDK Open	Partial	Full SDK + ROS2 support	Limited	Partial SDK	SDK + ROS support
Approx. Price (INR)	₹3–5 lakhs	₹12–15 lakhs	₹18–25 lakhs	₹10–15 lakhs	₹1.2–1.5 lakhs	₹20–30 lakhs (depending config)