# Robotics & Edge AI Component Catalog

Date: January 2026

Total Components: 26

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## 1. NVIDIA Jetson Orin Nano

![Placeholder: Insert Image of NVIDIA Jetson Orin Nano Here]

(Suggested Image: Top-down view of the developer kit carrier board with the module heatsink visible)

### Description

The NVIDIA Jetson Orin Nano is a compact yet powerful Edge AI computer designed for the next generation of autonomous machines. It sets a new standard for entry-level edge AI, delivering up to 80x the performance of the original Jetson Nano, enabling advanced robotic processing and simultaneous multi-model inference.

### Specifications

* **AI Performance:** Up to 40 TOPS (8GB version) / 20 TOPS (4GB version)
* **GPU:** NVIDIA Ampere architecture with 1024 CUDA cores and 32 Tensor Cores
* **CPU:** 6-core Arm Cortex-A78AE v8.2 64-bit CPU
* **Memory:** 8GB or 4GB LPDDR5 (128-bit)
* **Storage:** Supports external NVMe (M.2 Key M)
* **Power:** 7W to 15W configurable TDP
* **Interfaces:** PCIe Gen3 x4, 3x USB 3.2 Gen 2, Gigabit Ethernet

### Use Cases

* **Advanced Robotics:** Brain for autonomous mobile robots (AMRs) requiring object recognition and path planning.
* **Edge Vision:** Smart cameras for retail analytics or industrial defect detection.
* **Drones:** Onboard processing for collision avoidance and subject tracking.

### Project Data

* **Priority:** Critical
* **Target Samples:** 250
* **Difficulty:** Intermediate to Advanced
* **Projects:** Autonomous navigation, Multi-camera SLAM, Vision-guided manipulation.

### Official Resources

* [NVIDIA Jetson Orin Nano Developer Page](https://www.google.com/search?q=https://developer.nvidia.com/embedded/jetson-orin-nano-developer-kit)

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## 2. NVIDIA Jetson Nano (Classic)

![Placeholder: Insert Image of NVIDIA Jetson Nano B01 Kit Here]

(Suggested Image: Angled view of the B01 Developer Kit showing USB ports and GPIO headers)

### Description

The classic Jetson Nano is the pioneer of accessible Edge AI. While older than the Orin, it remains a staple in education and hobbyist robotics due to its massive community support and ability to run real neural networks in parallel for image classification, object detection, and segmentation.

### Specifications

* **AI Performance:** 0.5 TFLOPS (FP16)
* **GPU:** NVIDIA Maxwell architecture with 128 CUDA cores
* **CPU:** Quad-core ARM Cortex-A57 MPCore processor
* **Memory:** 4GB LPDDR4
* **Video Encode/Decode:** 4K @ 30 | 4K @ 60
* **Power:** 5W / 10W modes
* **Interfaces:** 4x USB 3.0, MIPI CSI-2 camera connectors, Gigabit Ethernet, 40-pin GPIO

### Use Cases

* **Education:** Perfect for learning the basics of AI and CUDA programming.
* **Entry-level Robotics:** Line followers with vision, basic object sorters.
* **IoT Gateways:** Intelligent home automation hubs.

### Project Data

* **Priority:** Critical
* **Target Samples:** 250
* **Difficulty:** Beginner to Intermediate
* **Projects:** Image classification, Face recognition, JetBot construction.

### Official Resources

* [NVIDIA Jetson Nano Developer Kit](https://developer.nvidia.com/embedded/jetson-nano-developer-kit)

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## 3. Raspberry Pi 5

![Placeholder: Insert Image of Raspberry Pi 5 Board Here]

(Suggested Image: Top view showing the new PCIe connector and power button)

### Description

The Raspberry Pi 5 is the latest iteration of the world's most popular single-board computer. Featuring a significant speed boost over the Pi 4, it introduces a PCI Express interface for high-speed peripherals and an in-house designed I/O controller, making it a robust central controller for complex robotic systems.

### Specifications

* **CPU:** Broadcom BCM2712, Quad-core Arm Cortex-A76 @ 2.4GHz
* **GPU:** VideoCore VII, supporting OpenGL ES 3.1, Vulkan 1.2
* **Memory:** 4GB or 8GB LPDDR4X-4267
* **Connectivity:** Dual-band 802.11ac Wi-Fi, Bluetooth 5.0 / BLE
* **Interfaces:** PCIe 2.0 x1 interface, 2x USB 3.0 (5Gbps), Gigabit Ethernet (PoE+ capable)
* **Display:** Dual 4Kp60 HDMI display output

### Use Cases

* **Robot Controller:** High-level logic controller for ROS 2 systems.
* **Media Center:** 4K video streaming and processing.
* **Desktop PC:** Capable of running a full Linux desktop environment for development.

### Project Data

* **Priority:** Critical
* **Target Samples:** 250
* **Difficulty:** Beginner to Intermediate
* **Projects:** Smart home hub, Robotics controller, IoT gateway.

### Official Resources

* [Raspberry Pi 5 Product Page](https://www.raspberrypi.com/products/raspberry-pi-5/)

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## 4. Raspberry Pi AI HAT+

![Placeholder: Insert Image of Raspberry Pi AI HAT+ Here]

(Suggested Image: The HAT mounted on top of a Raspberry Pi 5)

### Description

The AI HAT+ is an add-on board specifically designed for the Raspberry Pi 5, integrating the Hailo-8L or Hailo-8 AI accelerator. It offloads neural network processing from the Pi's CPU, allowing for high-frame-rate computer vision applications without overheating the main processor.

### Specifications

* **Accelerator:** Hailo-8L (Entry) or Hailo-8 (Performance) Neural Processing Unit
* **Performance:** 13 TOPS (Hailo-8L) or up to 26 TOPS (Hailo-8)
* **Interface:** PCIe Gen 3.0 via Raspberry Pi 5 M.2 HAT connector
* **Software:** Fully integrated with Raspberry Pi OS camera stack (libcamera)
* **Cooling:** Often includes active or passive thermal solutions

### Use Cases

* **Surveillance:** Real-time person and vehicle detection on multiple streams.
* **Robotics:** Low-latency visual odometry and object avoidance.
* **Industrial:** Quality control and anomaly detection on assembly lines.

### Project Data

* **Priority:** High
* **Target Samples:** 200
* **Difficulty:** Intermediate
* **Projects:** Accelerated object detection, Real-time pose estimation.

### Official Resources

* [Raspberry Pi AI Documentation](https://www.raspberrypi.com/documentation/accessories/ai-kit.html)

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## 5. Intel RealSense Depth Camera D435

![Placeholder: Insert Image of Intel RealSense D435 Here]

(Suggested Image: Front view showing the dual IR sensors and RGB camera lens)

### Description

The D435 is a stereo depth camera that uses active infrared projection to calculate depth, making it effective even in low-texture environments. It is the de-facto standard for academic and industrial robotics research for SLAM (Simultaneous Localization and Mapping) and obstacle detection.

### Specifications

* **Depth Technology:** Active IR Stereo
* **Depth Resolution:** Up to 1280 x 720 at 30fps
* **RGB Resolution:** 1920 x 1080 at 30fps
* **Field of View:** 87° x 58° (Depth)
* **Min. Depth Distance:** ~28 cm
* **Interface:** USB 3.1 Gen 1 Type-C
* **Shutter Type:** Global Shutter (great for moving robots)

### Use Cases

* **Navigation:** Providing depth maps for autonomous robots to detect walls and cliffs.
* **Manipulation:** allowing robotic arms to perceive the 3D shape of objects for grasping.
* **Scanning:** Creating 3D point clouds of rooms or objects.

### Project Data

* **Priority:** Critical
* **Target Samples:** 250
* **Difficulty:** Intermediate to Advanced
* **Projects:** 3D object scanning, Obstacle avoidance, SLAM mapping.

### Official Resources

* [Intel RealSense D435 Datasheet](https://www.intel.com/content/www/us/en/architecture-and-technology/realsense-overview.html)

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## 6. RPLIDAR A1

![Placeholder: Insert Image of RPLIDAR A1 Here]

(Suggested Image: The rotating lidar unit with the red belt drive visible)

### Description

The RPLIDAR A1 is a low-cost, 360-degree 2D laser scanner (LIDAR). It works by rotating a laser triangulation system. It is widely used in hobbyist and educational robotics for creating 2D floor plans (maps) and autonomous navigation.

### Specifications

* **Range:** 0.15 meters to 12 meters
* **Scanning Angle:** 360 Degree
* **Sample Rate:** 8000 Hz
* **Scan Rate:** 5.5 Hz (adjustable)
* **Resolution:** < 1% of distance range
* **Interface:** UART / USB via adapter

### Use Cases

* **SLAM:** Generating 2D maps of indoor environments (Gmapping, Cartographer).
* **Obstacle Avoidance:** Detecting legs, walls, and furniture for mobile bases.
* **Multitouch:** Creating large interactive touch walls by detecting finger interruptions.

### Project Data

* **Priority:** Critical
* **Target Samples:** 250
* **Difficulty:** Intermediate
* **Projects:** 2D SLAM mapping, Autonomous navigation, Room scanning.

### Official Resources

* [Slamtec RPLIDAR A1 Product Page](https://www.slamtec.com/en/Lidar/A1)

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## 7. YDLIDAR X4

![Placeholder: Insert Image of YDLIDAR X4 Here]

(Suggested Image: The compact circular LiDAR unit with blue/black housing)

### Description

Similar to the RPLIDAR, the YDLIDAR X4 is a competitive 2D LiDAR solution. It offers a balance of performance and price, often used as an alternative in ROS-based robot navigation stacks.

### Specifications

* **Range:** 0.12 meters to 10 meters
* **Scanning Angle:** 360 Degree
* **Sample Rate:** 5000 Hz
* **Scan Frequency:** 6Hz - 12Hz
* **Interface:** USB / UART
* **Motor:** Integrated Brushless Motor (longer life than belt drives)

### Use Cases

* **Education:** Teaching LIDAR principles in university labs.
* **Service Robots:** Cleaning robots or delivery bots needing 2D perception.
* **Environment Scanning:** Rapid layout generation for real estate.

### Project Data

* **Priority:** High
* **Target Samples:** 200
* **Difficulty:** Beginner to Intermediate
* **Projects:** Budget SLAM, Robot navigation, Educational robotics.

### Official Resources

* [YDLIDAR X4 Documentation](https://www.google.com/search?q=https://www.ydlidar.com/products/view/5.html)

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## 8. Unitree Go2 Quadruped Robot

![Placeholder: Insert Image of Unitree Go2 Robot Here]

(Suggested Image: Side profile of the Go2 robot dog standing)

### Description

The Unitree Go2 is a high-performance bionic quadruped robot (robot dog). It features an advanced sensing system including a 4D LiDAR (hemispherical view) and onboard AI processing, capable of traversing complex terrains like stairs, rocks, and grass.

### Specifications

* **Dimensions:** ~0.7m x 0.3m x 0.4m
* **Payload:** ~8kg (walking payload)
* **Speed:** Max speed approx. 2.5 - 3.5 m/s
* **Sensors:** Unitree 4D LiDAR L1, wide-angle cameras
* **Battery:** Long endurance intelligent battery (approx 1-2 hours)
* **Connectivity:** Wi-Fi 6, Bluetooth, 4G (optional)

### Use Cases

* **Inspection:** Monitoring industrial sites, pipelines, or dangerous environments.
* **Research:** Developing algorithms for legged locomotion and reinforcement learning.
* **Logistics:** Last-mile delivery in unstructured terrain.

### Project Data

* **Priority:** High
* **Target Samples:** 200
* **Difficulty:** Advanced
* **Projects:** Legged robotics research, Terrain navigation, Autonomous exploration.

### Official Resources

* [Unitree Go2 Product Page](https://shop.unitree.com/)

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## 9. Autonomous Mobile Manipulator

![Placeholder: Insert Image of Mobile Manipulator Robot Here]

(Suggested Image: A wheeled robot base with a 6-axis robotic arm mounted on top)

### Description

This component refers to a class of robots that combine a mobile base (AMR) with a robotic arm. This allows the robot to not only move to a location but also interact with the environment (e.g., opening doors, picking up items). Examples include the Robotnik RB-KAIROS or Clearpath Ridgeback with a manipulator.

### Specifications

* **Drive System:** Mecanum (Omnidirectional) or Differential Drive
* **Manipulator Payload:** Typically 3kg to 10kg depending on the arm
* **Navigation:** 2D LiDAR + 3D Depth Cameras
* **Software Stack:** ROS / ROS 2 Navigation Stack + MoveIt 2 (Motion Planning)
* **Battery:** High capacity 24V or 48V LiFePO4 banks

### Use Cases

* **Mobile Picking:** Retrieving items from warehouse shelves.
* **Machine Tending:** Moving between CNC machines to load/unload parts.
* **Healthcare:** Assistive robots for fetching objects for patients.

### Project Data

* **Priority:** High
* **Target Samples:** 200
* **Difficulty:** Advanced
* **Projects:** Mobile manipulation, Warehouse automation, SLAM with manipulation.

### Official Resources

* [ROS Mobile Manipulation (Generic Info)](https://www.google.com/search?q=https://ros-mobile-manipulation.github.io/)

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## 10. Quadcopter Drone (Dev Kit)

![Placeholder: Insert Image of Quadcopter Development Drone Here]

(Suggested Image: A carbon fiber drone frame with exposed flight controller and propellers)

### Description

A programmable drone platform designed for development rather than just photography. It typically utilizes a flight controller like Pixhawk or Cube, running ArduPilot or PX4 firmware, and includes mounting points for companion computers (like Jetson Nano) to enable AI flight.

### Specifications

* **Frame:** F450 or similar carbon fiber wheelbase
* **Flight Controller:** Pixhawk 4 / Cube Orange
* **Motors:** Brushless DC Motors (e.g., 2312 size)
* **Telemetry:** 433MHz or 915MHz radio link
* **Payload Capacity:** 500g - 1.5kg (enough for a companion computer and sensors)

### Use Cases

* **Search and Rescue:** Autonomous searching of forest canopies.
* **Agriculture:** NDVI mapping and crop monitoring.
* **Inspection:** Inspecting wind turbines or bridge infrastructure autonomously.

### Project Data

* **Priority:** High
* **Target Samples:** 200
* **Difficulty:** Intermediate to Advanced
* **Projects:** Aerial object detection, Autonomous navigation, Drone swarms.

### Official Resources

* [PX4 Autopilot Guide](https://px4.io/)

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## 11. Robotic Arm Kit (6-DOF)

![Placeholder: Insert Image of 6-DOF Robotic Arm Kit Here]

(Suggested Image: Desktop robotic arm with a gripper tool attached)

### Description

A desktop-sized 6-Degree-of-Freedom (DOF) robotic arm. 6 degrees of freedom allows the gripper to reach any point (x, y, z) at any orientation (roll, pitch, yaw), mimicking the flexibility of a human arm.

### Specifications

* **DOF:** 6 (Base, Shoulder, Elbow, Wrist Pitch, Wrist Roll, Wrist Yaw)
* **Actuators:** High-torque serial bus servos (digital)
* **Reach:** 300mm - 500mm
* **Payload:** 250g - 500g
* **Control:** USB, UART, Python API, ROS support

### Use Cases

* **Education:** Teaching forward and inverse kinematics.
* **Sorting:** Picking colored blocks or objects from a conveyor.
* **Remote Operation:** Teleoperation tasks using a joystick or digital twin.

### Project Data

* **Priority:** High
* **Target Samples:** 200
* **Difficulty:** Intermediate
* **Projects:** Pick-and-place, Vision-guided manipulation, Assembly tasks.

### Official Resources

* [Interbotix / DFRobot Arm Resources (Example)](https://www.dfrobot.com/)

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## 12. Arduino GIGA R1 WiFi

![Placeholder: Insert Image of Arduino GIGA R1 WiFi Here]

(Suggested Image: The large rectangular Arduino board with the STM32 chip and USB-C port)

### Description

The Arduino GIGA R1 WiFi is a powerhouse microcontroller designed for ambitious makers. It maintains the popular Mega form factor but features a dual-core STM32 processor, 76 GPIOs, and built-in Wi-Fi/Bluetooth, bridging the gap between basic microcontrollers and single-board computers.

### Specifications

* **Microcontroller:** STM32H747XI Dual Core
* **Cores:** Cortex-M7 @ 480 MHz + Cortex-M4 @ 240 MHz
* **Memory:** 2MB Flash, 1MB RAM
* **Connectivity:** Wi-Fi 802.11b/g/n, Bluetooth Low Energy
* **I/O:** 76 GPIO, 12 Analog Input, 2 DAC, Camera connector

### Use Cases

* **Real-time Control:** Managing high-speed motors and reading sensors with strict timing.
* **Audio Processing:** Machine learning on audio data (MicroML).
* **IoT:** Connected sensor nodes sending data to the cloud.

### Project Data

* **Priority:** High
* **Target Samples:** 200
* **Difficulty:** Beginner to Intermediate
* **Projects:** Sensor networks, Motor control, IoT devices, Robot controllers.

### Official Resources

* [Arduino GIGA R1 WiFi Store Page](https://www.google.com/search?q=https://store.arduino.cc/products/arduino-giga-r1-wifi)

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## 13. AI Camera Module

![Placeholder: Insert Image of AI Camera Module Here]

(Suggested Image: Compact camera PCB with a large lens, often attached to a ribbon cable)

### Description

This refers to specialized camera modules designed for embedded AI, such as the IMX219 (8MP) or IMX477 (High Quality). Some "AI Cameras" (like OAK-D or Luxonis) have onboard processors, but in this context, it often refers to the sensor module used by the Jetson/Pi to perform the AI logic.

### Specifications

* **Sensor:** Sony IMX219 or IMX477
* **Resolution:** 8MP (3280 x 2464) or 12MP
* **Interface:** MIPI CSI-2
* **Lens:** Often interchangeable (M12 mount) or fixed focus
* **Features:** Low latency, raw Bayer output for ISP processing

### Use Cases

* **Object Tracking:** High-speed tracking of balls or targets.
* **Face ID:** Security access systems.
* **Edge Inspection:** Checking labels or defects on products.

### Project Data

* **Priority:** High
* **Target Samples:** 200
* **Difficulty:** Intermediate
* **Projects:** Edge AI vision, Drone object detection, Smart surveillance.

### Official Resources

* [Arducam / Waveshare Camera Modules](https://www.arducam.com/)

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## 14. Raspberry Pi Camera Module 3

![Placeholder: Insert Image of Raspberry Pi Camera Module 3 Here]

(Suggested Image: The official camera board with the Raspberry Pi logo and autofocus lens)

### Description

The latest official camera from Raspberry Pi. It is built around the Sony IMX708 sensor and features powered autofocus, High Dynamic Range (HDR), and improved low-light performance compared to its predecessors.

### Specifications

* **Sensor:** Sony IMX708
* **Resolution:** 12 Megapixels
* **Focus:** Powered Autofocus (PDAF)
* **FOV:** Standard (75°) or Wide (120°) variants
* **Video:** 1080p50, 720p100
* **Interface:** CSI-2

### Use Cases

* **Photography:** Time-lapse or wildlife cameras.
* **Code Scanning:** QR code and barcode reading with autofocus.
* **General Vision:** Standard input for OpenCV projects on Raspberry Pi.

### Project Data

* **Priority:** Medium
* **Target Samples:** 100
* **Difficulty:** Beginner
* **Projects:** Computer vision, Time-lapse, Object detection.

### Official Resources

* [Raspberry Pi Camera Module 3](https://www.raspberrypi.com/products/camera-module-3/)

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## 15. Dell Precision Workstation

![Placeholder: Insert Image of Dell Precision Tower Here]

(Suggested Image: A sleek black workstation tower)

### Description

A high-performance desktop workstation is essential for "backend" robotics work. It is used to train the large AI models that eventually run on the edge devices (Jetsons/Pis) and to run heavy physics simulations (Isaac Sim, Gazebo) that edge devices cannot handle.

### Specifications

* **CPU:** Intel Xeon W-Series or High-end Core i9
* **GPU:** NVIDIA RTX 6000 Ada or multiple RTX 4090s
* **RAM:** 64GB to 512GB ECC Memory
* **Storage:** 2TB+ NVMe SSDs (RAID capable)
* **OS:** Ubuntu Linux 22.04 / 24.04 LTS (Certified)

### Use Cases

* **Deep Learning Training:** Training YOLO, ResNet, or Transformer models.
* **Simulation:** Running "Digital Twins" of robots in photorealistic environments.
* **Dataset Management:** Processing terabytes of video logs.

### Project Data

* **Priority:** Medium
* **Target Samples:** 100
* **Difficulty:** Intermediate
* **Projects:** AI model training, Dataset processing, Simulation.

### Official Resources

* [Dell Precision Workstations](https://www.dell.com/en-us/shop/workstations-isv-certified/sc/workstations)

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## 16. 3D Printer

![Placeholder: Insert Image of FDM 3D Printer Here]

(Suggested Image: A printer like the Prusa MK4 or Bambu Lab X1 printing a part)

### Description

An indispensable tool for robotics. Fused Deposition Modeling (FDM) printers create custom mechanical parts, sensor mounts, chassis components, and enclosures rapidly, allowing for iterative hardware design.

### Specifications

* **Technology:** FDM / FFF
* **Build Volume:** Typically ~250 x 210 x 210 mm
* **Materials:** PLA, PETG (durable), TPU (flexible), ABS/ASA
* **Nozzle:** 0.4mm standard (hardened steel for carbon fiber)
* **Bed Leveling:** Automatic Mesh Leveling

### Use Cases

* **Prototyping:** Testing fit and form of new robot designs.
* **Custom Mounts:** Attaching a LiDAR to a robot that wasn't designed for it.
* **Replacement Parts:** Printing broken gears or brackets on demand.

### Project Data

* **Priority:** Low
* **Target Samples:** 50
* **Difficulty:** Beginner to Intermediate
* **Projects:** Custom robot parts, Sensor mounts, Drone frames.

### Official Resources

* [Prusa Research / Bambu Lab (Examples)](https://www.prusa3d.com/)

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## 17. Jetson Thor Humanoid Platform (Project GR00T)

![Placeholder: Insert Image of Humanoid Robot or Jetson Thor Chip Here]

(Suggested Image: Concept art of the Project GR00T humanoid or the Thor SoC)

### Description

Jetson Thor is a specialized computing platform designed specifically for humanoid robots. It is optimized for the complex needs of bipedal locomotion, balancing, and human-robot interaction, acting as the brain for next-gen humanoids.

### Specifications

* **Architecture:** NVIDIA Blackwell
* **Performance:** 800 TFLOPS (8-bit floating point AI)
* **Engine:** Transformer Engine for running multimodal generative AI models
* **Safety:** Functional safety features for human interaction
* **Simulation:** Designed to work with Isaac Lab

### Use Cases

* **General Purpose Robots:** Humanoids that can perform household chores.
* **Elder Care:** Assistive robots that can navigate homes and help humans.
* **Research:** Developing "Generalist Robot 00 Technology" (GR00T).

### Project Data

* **Priority:** High
* **Target Samples:** 200
* **Difficulty:** Advanced
* **Projects:** Humanoid research, Bipedal walking, Human interaction.

### Official Resources

* [NVIDIA Project GR00T](https://www.google.com/search?q=https://nvidianews.nvidia.com/news/foundation-model-isaac-robotics-platform-gr00t)

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## 18. JetBot Kit

![Placeholder: Insert Image of JetBot Robot Here]

(Suggested Image: Small two-wheeled robot with a camera and Jetson Nano on top)

### Description

JetBot is an open-source educational robot based on the Jetson Nano. It is affordable and easy to assemble, making it the standard "Hello World" project for AI robotics. It demonstrates basic concepts like data collection, model training, and autonomous inference.

### Specifications

* **Chassis:** 3D printed or acrylic
* **Drive:** Differential drive (2 DC Motors)
* **Camera:** IMX219 8MP
* **Power:** USB Power Bank
* **Software:** Jupyter Notebooks running directly on the robot

### Use Cases

* **Collision Avoidance:** Training a neural network to identify "free space" vs "blocked".
* **Object Following:** Tracking a person or ball using vision.
* **Road Following:** Staying inside lane markers.

### Project Data

* **Priority:** Medium
* **Target Samples:** 100
* **Difficulty:** Beginner
* **Projects:** Line following, Object following, AI learning.

### Official Resources

* [JetBot Official Documentation](https://jetbot.org/)

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## 19. JetAuto Robot

![Placeholder: Insert Image of JetAuto Robot Here]

(Suggested Image: Mecanum wheeled robot car with a robotic arm)

### Description

JetAuto is an advanced ROS educational robot car powered by Jetson Nano/Orin. It features Mecanum wheels for omnidirectional movement (strafing sideways) and usually includes a robotic arm and LiDAR, making it a complete mobile manipulation research platform on a small scale.

### Specifications

* **Wheels:** 4x Mecanum Wheels
* **Sensors:** Lidar, Depth Camera, Microphone Array
* **Actuators:** Serial Bus Servos for the arm
* **OS:** Ubuntu + ROS / ROS 2
* **Features:** Map navigation, color sorting, voice control

### Use Cases

* **Omni-motion:** Navigating tight spaces by moving sideways.
* **Voice Control:** "Hey Robot, go to the kitchen."
* **Integrated Systems:** Combining navigation and manipulation in one task.

### Project Data

* **Priority:** Medium
* **Target Samples:** 100
* **Difficulty:** Intermediate
* **Projects:** Omnidirectional navigation, Vision-guided manipulation.

### Official Resources

* [Hiwonder JetAuto Product Page](https://www.hiwonder.com/products/jetauto)

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## 20. JetAcker Robot

![Placeholder: Insert Image of JetAcker Robot Here]

(Suggested Image: Car-like robot with steering front wheels)

### Description

Unlike differential drive robots that turn like tanks, JetAcker uses Ackerman steering geometry (like a real car). This makes it an ideal platform for researching self-driving car algorithms where non-holonomic constraints (cannot turn in place) must be considered.

### Specifications

* **Steering:** Ackerman Geometry (Servo controlled steering)
* **Drive:** Rear wheel drive
* **Suspension:** Often includes shock absorbers
* **Sensors:** Camera + Lidar
* **Simulation:** Often verified in Gazebo before deployment

### Use Cases

* **Autonomous Driving:** Simulating parking and lane changing.
* **Outdoor Navigation:** Better stability at higher speeds than differential drive bots.
* **ROS 2 Navigation:** Implementing TEB (Time Elastic Band) local planners.

### Project Data

* **Priority:** Medium
* **Target Samples:** 100
* **Difficulty:** Intermediate
* **Projects:** Outdoor navigation, Terrain mapping, Search and rescue.

### Official Resources

* [Hiwonder JetAcker Product Page](https://www.hiwonder.com/)

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## 21. Ultrasonic Sensors (HC-SR04)

![Placeholder: Insert Image of HC-SR04 Sensor Here]

(Suggested Image: Small module with two silver cylinders resembling eyes)

### Description

The HC-SR04 is the most common and affordable distance sensor. It works by emitting an ultrasonic sound pulse and measuring the time it takes to bounce back (Time of Flight). While simple, it provides reliable backup collision detection for transparent surfaces (glass) that LIDARs miss.

### Specifications

* **Range:** 2cm to 400cm
* **Accuracy:** ~3mm
* **Measuring Angle:** 15 degree
* **Voltage:** 5V DC
* **Interface:** GPIO (Trigger and Echo pins)

### Use Cases

* **Backup Sensors:** Stopping a robot before it backs into a wall.
* **Glass Detection:** Seeing windows that IR/Laser sensors pass through.
* **Fluid Level:** Measuring water level in a tank.

### Project Data

* **Priority:** Medium
* **Target Samples:** 100
* **Difficulty:** Beginner
* **Projects:** Obstacle avoidance, Distance measurement, Parking assist.

### Official Resources

* [SparkFun HC-SR04 Guide](https://www.sparkfun.com/products/15569)

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## 22. IMU Sensors (9-DOF)

![Placeholder: Insert Image of IMU Sensor Breakout Board Here]

(Suggested Image: Tiny PCB chip, e.g., BNO055 or MPU9250)

### Description

An Inertial Measurement Unit (IMU) is critical for robot balance and localization. A 9-DOF IMU combines an Accelerometer (linear motion), Gyroscope (rotation), and Magnetometer (magnetic north) to determine exactly how the robot is oriented in space.

### Specifications

* **Components:** 3-axis Accel, 3-axis Gyro, 3-axis Mag
* **Communication:** I2C or SPI
* **Fusion:** Often requires Kalman Filter or Madgwick Filter to merge data
* **Frequency:** High update rates (100Hz - 1000Hz)

### Use Cases

* **Odometry:** Helping a robot know how far it turned even if wheels slip.
* **Stabilization:** Keeping a drone level or a two-wheeled robot upright.
* **Heading:** Determining North for outdoor navigation.

### Project Data

* **Priority:** Medium
* **Target Samples:** 100
* **Difficulty:** Intermediate
* **Projects:** Drone stabilization, Robot orientation, SLAM enhancement.

### Official Resources

* [Adafruit 9-DOF IMU Breakouts](https://www.adafruit.com/category/54)

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## 23. Motor Drivers

![Placeholder: Insert Image of L298N or TB6612FNG Module Here]

(Suggested Image: Red or Black PCB with screw terminals and a heat sink)

### Description

Microcontrollers cannot provide enough power to drive motors directly. Motor drivers act as the muscle, taking low-power logic signals from the Arduino/Pi and switching high-power current from the battery to the motors.

### Specifications

* **Type:** H-Bridge (allows forward and reverse control)
* **Chips:** L298N (Old, inefficient), TB6612FNG (Efficient), BTS7960 (High Power)
* **Control:** PWM (Pulse Width Modulation) for speed, Digital pins for direction
* **Voltage:** typically 5V to 24V motor supply

### Use Cases

* **Locomotion:** Driving the main wheels of a robot.
* **Actuation:** Moving a linear actuator or a gripping mechanism.
* **Pumps:** Controlling water pumps in automated gardening.

### Project Data

* **Priority:** Medium
* **Target Samples:** 100
* **Difficulty:** Beginner to Intermediate
* **Projects:** Robot locomotion, Motor speed control, Automation.

### Official Resources

* [Pololu Motor Driver Carrier Boards](https://www.pololu.com/category/11/brushed-dc-motor-drivers)

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## 24. Power Supplies

![Placeholder: Insert Image of LiPo Battery and Buck Converter Here]

(Suggested Image: A blue LiPo battery pack next to a small voltage regulator board)

### Description

Robots require portable energy. Lithium Polymer (LiPo) or Li-Ion (18650) batteries are standard due to their high energy density. However, raw battery voltage changes as it drains, so Voltage Regulators (Buck Converters) are needed to provide a stable 5V for the computer and 12V for motors.

### Specifications

* **Battery Type:** LiPo (Soft pack, high current) or Li-Ion (Cylindrical, safer)
* **Voltage:** 2S (7.4V), 3S (11.1V), 4S (14.8V)
* **Capacity:** Measured in mAh (e.g., 2200mAh to 10000mAh)
* **Regulation:** DC-DC Buck Converters (Step-down)

### Use Cases

* **System Power:** Keeping the Jetson/Pi running without rebooting.
* **Motor Power:** Providing high current bursts for acceleration.
* **Safety:** Battery Management Systems (BMS) to prevent fire.

### Project Data

* **Priority:** Low
* **Target Samples:** 50
* **Difficulty:** Beginner
* **Projects:** Mobile robots, Portable systems, Battery management.

### Official Resources

* [Battery University (Educational Resource)](https://batteryuniversity.com/)

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## 25. Breadboards and Jumper Wires

![Placeholder: Insert Image of Breadboard with Wires Here]

(Suggested Image: White breadboard with colorful wires connected to an Arduino)

### Description

The fundamental tools for prototyping. Solderless breadboards allow you to connect components temporarily to test circuits. Jumper wires (Male-to-Male, Male-to-Female) connect the breadboard to the robot's computer and sensors.

### Specifications

* **Pitch:** Standard 2.54mm (0.1 inch)
* **Rails:** Power rails (+ and -) and Signal rows
* **Wire Types:** Dupont wires with square connectors
* **Durability:** Good for temporary prototyping, not for final vibrating robots.

### Use Cases

* **Testing:** Verifying a sensor works before soldering it.
* **Learning:** Understanding circuit diagrams physically.
* **Debugging:** Quickly swapping connections to fix errors.

### Project Data

* **Priority:** Low
* **Target Samples:** 50
* **Difficulty:** Beginner
* **Projects:** Circuit prototyping, Sensor testing, Learning electronics.

### Official Resources

* [SparkFun Breadboard Tutorial](https://learn.sparkfun.com/tutorials/how-to-use-a-breadboard/all)

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## 26. ROS 2 (Robot Operating System)

![Placeholder: Insert Image of ROS 2 Logo Here]

(Suggested Image: The ROS 2 logo containing nine dots in a grid)

### Description

ROS 2 is not hardware, but it is the single most critical "component" of modern robotics. It is an open-source set of software libraries and tools that help you build robot applications. It handles the communication between the Lidar, the Camera, the Wheels, and the AI Brain.

### Specifications

* **Distributions:** Humble Hawksbill (LTS), Jazzy Jalisco (Latest LTS)
* **Middleware:** DDS (Data Distribution Service) for real-time communication
* **OS Support:** Ubuntu Linux, Windows, macOS
* **Architecture:** Nodes, Topics (Pub/Sub), Services, Actions

### Use Cases

* **Fusion:** Taking data from Lidar and Camera to create a map.
* **Navigation:** Calculating a path from A to B while avoiding obstacles.
* **Fleet Management:** Coordinating multiple robots in a warehouse.

### Project Data

* **Priority:** Critical
* **Target Samples:** 500
* **Difficulty:** Advanced
* **Projects:** Autonomous Navigation (Nav2), Manipulator Control (MoveIt 2), Sensor Fusion.

### Official Resources

* [ROS 2 Documentation](https://docs.ros.org/)