Components Summary

JETSON NANO – On board Computer (Controller)

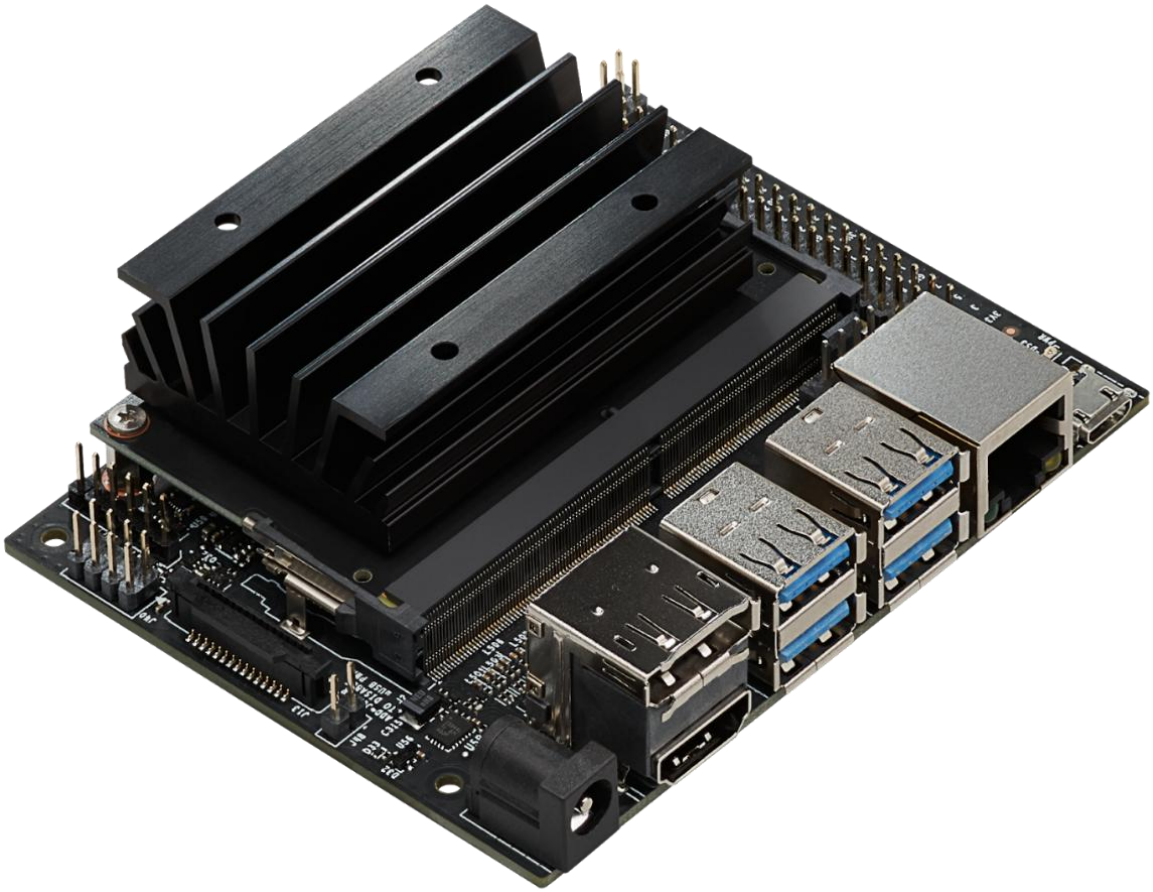
SG90 SERVO MOTOR – Actuators

IR Module – Sensing

Xbox Kinect v1 – Camera

ESP32 – Controller or acts a bridge between actuators and jetson nano.

Jetson Nano



Technical Specifications and Features

Processor:

- CPU: Quad-core ARM Cortex-A57 @ 1.43 GHz.
- GPU: 128-core NVIDIA Maxwell architecture GPU.

- Floating Point Performance: Up to 472 GFLOPS.

Memory and Storage:

- RAM: 4GB 64-bit LPDDR4, 25.6 GB/s bandwidth.
- Storage: microSD card slot for main storage.

Wireless & Connectivity (via expansion or USB):

- Ethernet: Gigabit Ethernet port.
- Wi-Fi and Bluetooth: Not onboard by default, but supported via USB dongle or M.2 module (Jetson Nano 2GB includes Wi-Fi).

Display and Camera:

- Display Output: HDMI 2.0 and DisplayPort 1.2.
- Camera Interface: MIPI CSI-2 (15-pin connector for Raspberry Pi Camera Module v2).

I/O and Expansion:

- USB: 4 × USB 3.0 ports (original model), 1 × USB 2.0 micro-B (device mode), 1 × USB 2.0 (2GB version).
- GPIO: 40-pin expansion header (Raspberry Pi compatible layout).
- Other I/O: I^2C, SPI, UART, PWM, and GPIOs.

Power Supply:

- Power Input: 5V via micro-USB or barrel jack (5V⎓4A recommended for full performance).
- Power Modes: Configurable 5W or 10W modes.

Software and Development:

- OS Support: Ubuntu-based JetPack SDK with Linux4Tegra.
- Frameworks: Support for TensorFlow, PyTorch, OpenCV, Keras, Caffe, ROS, and more.
- AI SDKs: Includes NVIDIA DeepStream, CUDA Toolkit, cuDNN, TensorRT.

References

- Jetson Nano Specifications and Datasheet
- Jetson Operating System

SG90 Servo

Technical Specifications and Features

Motor Type: SG90 is a 9g micro servo motor with analog control.
Material: Gear set made from plastic (typically nylon).

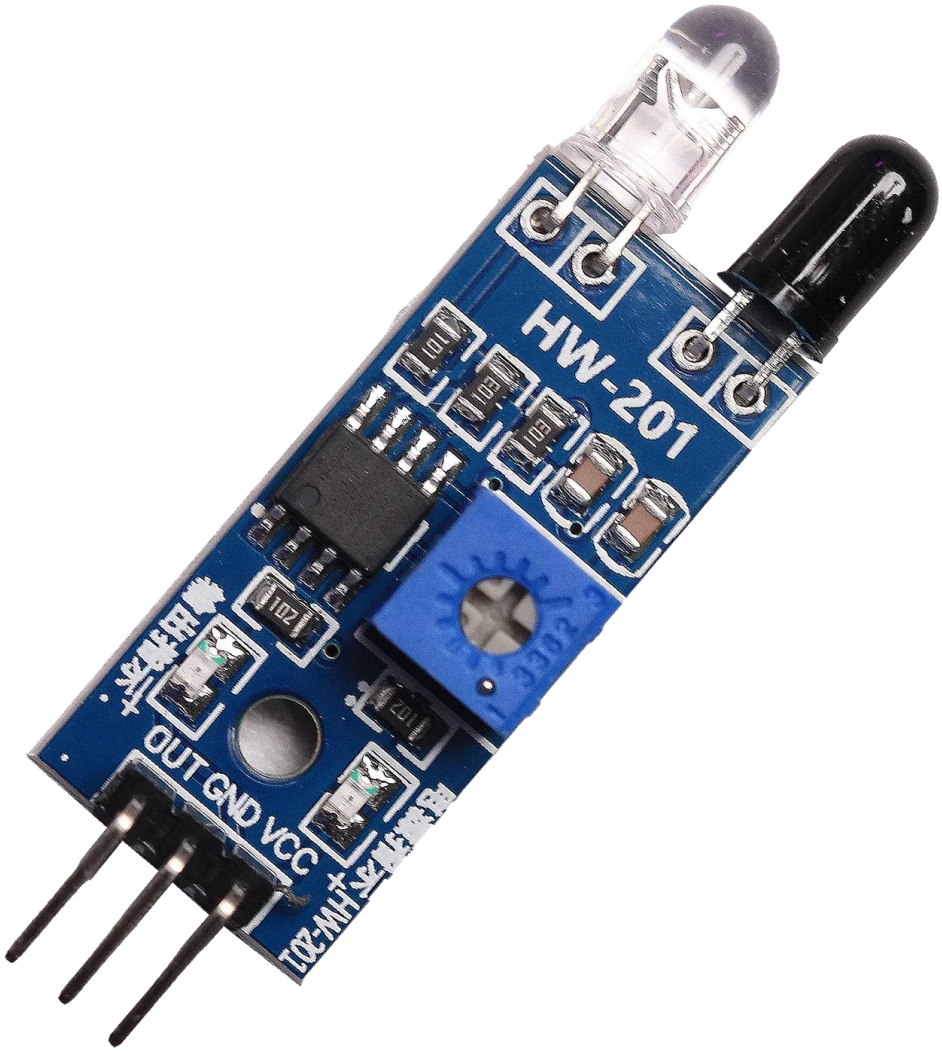
Weight and Dimensions: Weighs about 9g; dimensions approx. 22.5 × 11.8 × 31 mm.
Operating Voltage: 4.8V to 6.0V (typically 5V).
Stall Torque:

- At 4.8V: ~1.8 kg·cm
- At 6.0V: ~2.2 kg·cm
  Operating Speed:
- At 4.8V: ~0.1 s/60°
- At 6.0V: ~0.08 s/60°
  Rotation Range: ~180°, controlled via PWM signal.
  PWM Control: Standard 50Hz PWM (20 ms period), where:
- 1 ms pulse ≈ 0°
- 1.5 ms pulse ≈ 90° (neutral)
- 2 ms pulse ≈ 180°
  Connector: 3-pin female connector (Brown = GND, Red = VCC, Orange = PWM signal).

References

- SG90 Actuator Datasheet
- SG90 Working

IR Sensor (LM393)



Technical Specifications and Features

Sensor Type: Infrared reflective sensor module based on LM393 comparator.

Functionality: Detects objects or surface contrast by comparing reflected IR light intensity.

Components

- Infrared LED (Emitter)
- Photodiode or Phototransistor (Receiver)
- LM393 Comparator IC
- Trimpot (Potentiometer for sensitivity adjustment)
- Indicator LEDs (Power and Output)

Operating Voltage

- 3.3V to 5V DC (compatible with microcontrollers like Arduino, Raspberry Pi, ESP32)

Current Consumption

- Typically 10–20 mA (may vary slightly depending on module)

Detection Range

- Approximately 2 mm to 30 mm
- Most accurate for high contrast surfaces (e.g., black line on white background)

Output

- Digital Signal (High/Low logic level)
    - Output Low (0): Object detected (IR reflected)
    - Output High (1): No object detected (no IR reflection)

Interface

- Typically 3-pin or 4-pin header:

    - VCC (Power Input)
    - GND (Ground)
    - OUT (Digital Output)
    - EN (Optional Enable Pin in some variants)

Tuning

- Sensitivity adjustable via onboard trimpot
- Turning the potentiometer changes the comparator threshold, allowing fine-tuning for different distances or surface reflectivity

Applications

- Line-following robots
- Obstacle and edge detection
- Proximity sensors for automation
- Motor speed measurement (with encoder wheel)

Limitations

- Limited to short-range detection
- Susceptible to interference from strong ambient infrared sources like sunlight
- Works best in controlled lighting environments

References

- IR Sensor Datasheet
- IR Sensor Schematics

XBOX Kinect v1

Technical Specifications and Features

Sensor Type: RGB-D motion sensing input device developed by Microsoft for Xbox 360 and later used in PC applications.
Purpose: Captures depth and color data to enable body tracking, 3D scanning, and gesture recognition.

Components

- RGB Camera (Color)
- Depth Sensor (IR projector + IR camera)
- Multi-array Microphone (4 microphones)
- Tilt Motor for vertical adjustment
- Accelerometer

Operating Voltage

- Requires 12V DC input (via proprietary connector or adapter)
- USB for data connection to host (USB 2.0)

Power Consumption

- Approximately 2.5W–5W

Camera Specifications

- RGB Camera:
    - Resolution: 640×480 @ 30 FPS (default), up to 1280×1024 via unofficial mods
    - Field of View: ~57° horizontal, ~43° vertical
- Depth Camera:
    - Resolution: 320×240 @ 30 FPS
    - Depth Range: ~0.8 m to 4.0 m
    - Technology: Structured light using IR dot projector

Microphone Array

- 4 microphones with beamforming and ambient noise suppression
- Enables voice commands and sound localization

Motorized Tilt

- Automatic tilt adjustment of up to ±27°
- Controlled via software commands over USB

Interface

- Proprietary connector (Xbox 360) or USB adapter for PC use

- USB 2.0 for data
- Separate power connection (12V)

Compatibility

- Xbox 360 (native)
- PC (with Kinect for Windows SDK or OpenNI/NiTE)
- Compatible with Windows, Linux (via OpenNI/libfreenect), and ROS

Software & SDK

- Microsoft Kinect SDK (Windows)
- OpenNI & NITE (open-source alternative)
- OpenCV, PCL, and Open3D support for point cloud and image processing

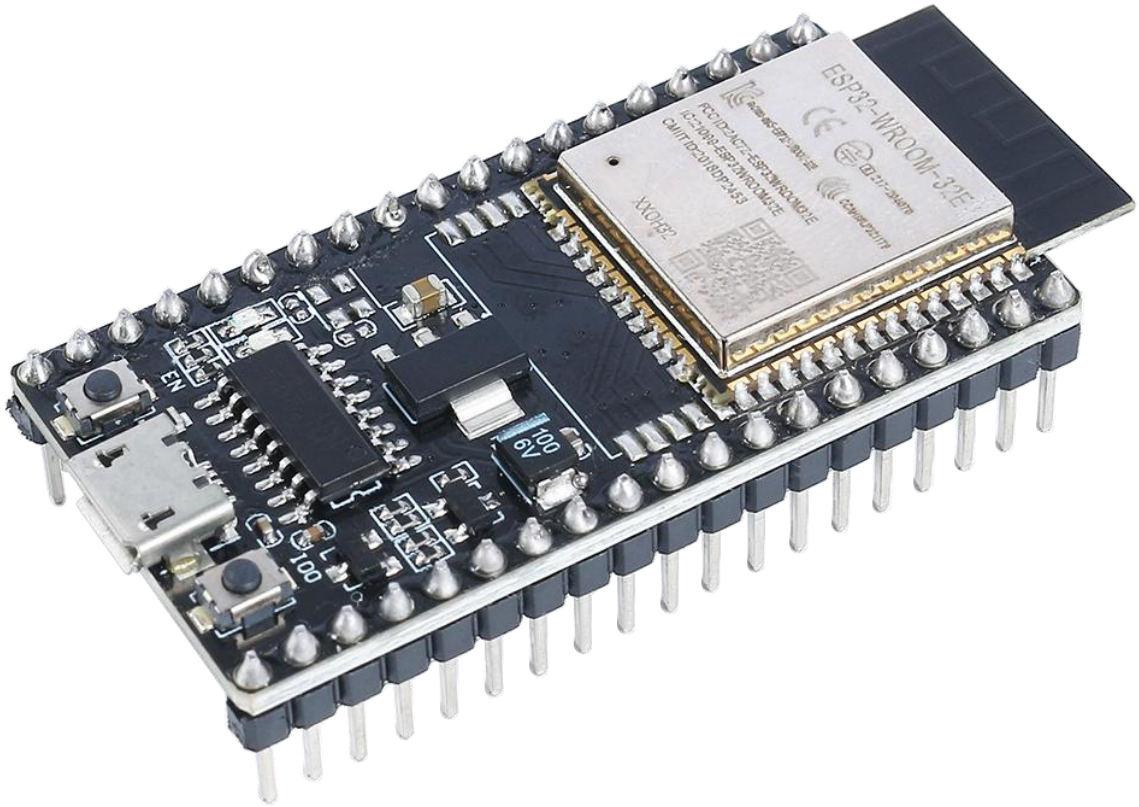
Applications

- Gesture and body tracking
- 3D scanning and point cloud generation
- Robotics and SLAM
- Voice recognition and control
- AR/VR prototyping

References

- Develop with Xbox Kinect v1
- What is Kinect?

ESP32



Technical Specifications and Features

Microcontroller: ESP32 — a low-power system-on-chip (SoC) microcontroller with integrated Wi-Fi and Bluetooth, developed by

Espressif Systems. It is widely used in IoT, robotics, and embedded systems projects.

Processor

- Dual-core Xtensa® 32-bit LX6 microprocessor (can also be configured as single-core)
- Clock Speed: up to 240 MHz
- Performance: up to 600 DMIPS
- Ultra-low-power co-processor for sensor monitoring during sleep

Memory

- SRAM: 520 KB
- ROM: 448 KB
- External Flash Support: Up to 16 MB (typically 4MB in Dev Boards)

Connectivity

- Wi-Fi: IEEE 802.11 b/g/n
- Bluetooth: v4.2 BR/EDR and BLE
- Ethernet MAC Interface
- SPI, I^2C, I^2S, UART, CAN

GPIO

- Total GPIO Pins: 34
- Most pins support PWM, ADC, DAC, SPI, I^2C, UART
- 12-bit SAR ADC (up to 18 channels)
- 2 × 8-bit DAC

- Capacitive Touch: 10 inputs
- Hall Sensor and Temperature Sensor built-in

Timers and PWM

- 4 × 64-bit Timers
- 2 × 32-bit Timers
- PWM for up to 16 channels (LEDC)

Power Supply

- Operating Voltage: 2.2 V to 3.6 V (typically 3.3V)
- Deep Sleep Current: <5 µA
- Power Modes: Active, Modem Sleep, Light Sleep, Deep Sleep, Hibernation

Storage

- SPI Flash (external): 4 MB to 16 MB (depending on board)
- Optional microSD card support via SPI

Security

- Hardware acceleration for encryption (AES, SHA-2, RSA, ECC, etc.)
- Secure boot and Flash encryption
- Random Number Generator

Development and Programming

- Programming Interfaces: USB-UART, JTAG
- Programming Languages: C/C++ (Arduino IDE, ESP-IDF), MicroPython, Lua

- Tools & SDKs:
    - Arduino Core for ESP32
    - Espressif IDF (official SDK)
    - PlatformIO

Dimensions (Common Dev Boards)

- ESP32 DevKit v1: ~51mm × 25mm
- NodeMCU-32S: ~48mm × 25mm

Applications

- IoT Devices and Home Automation
- Wireless Sensor Networks
- Wearables
- Robotics and Drones
- Smart Agriculture
- Voice Assistants (ESP32-LyraT)

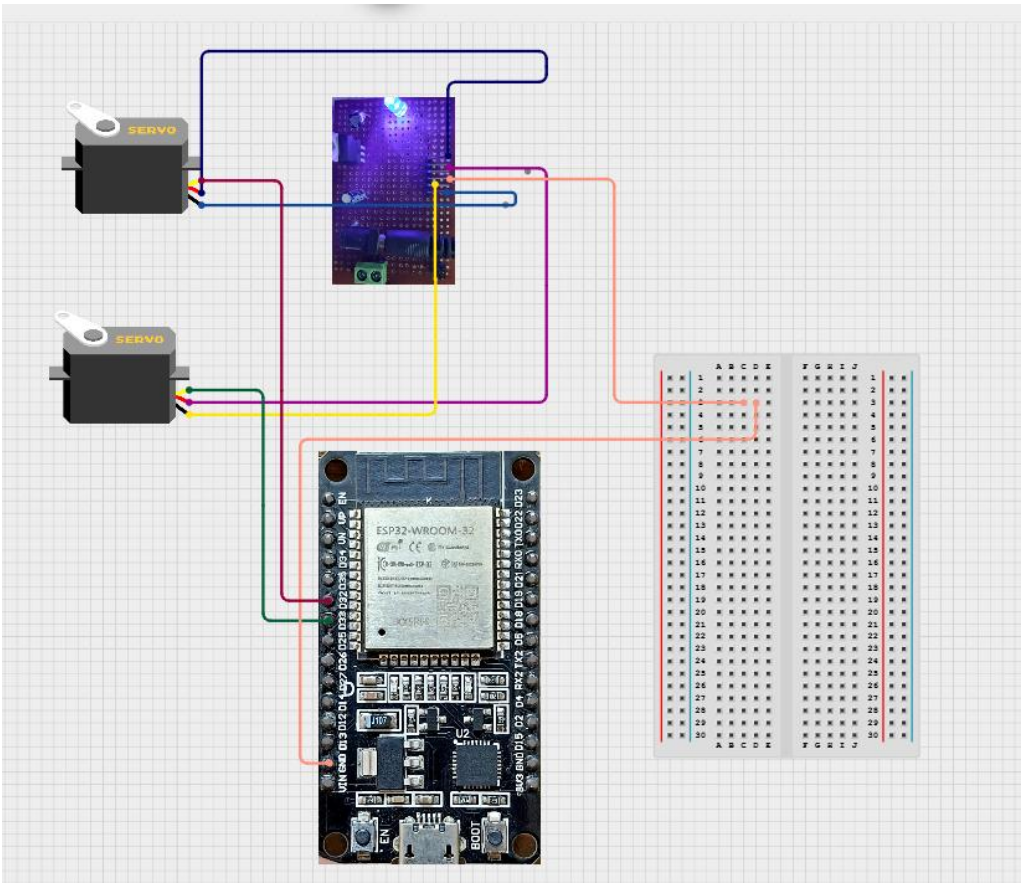
Limitations

- 3.3V logic (not 5V tolerant)
- Some GPIOs have specific boot functions — care needed during design
- High-frequency operations may require attention to power and grounding

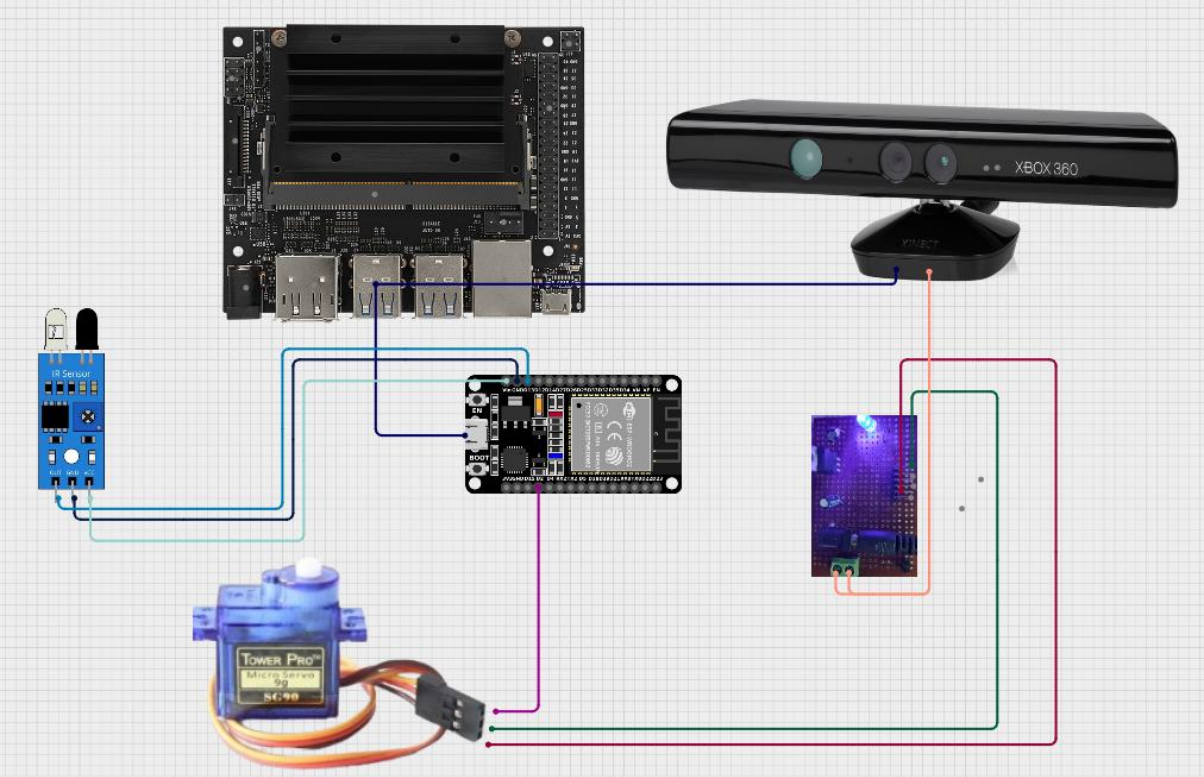
References

- Espressif Official Datasheets and Technical Reference Manual
- ESP32 DevKit v1 Schematic

CONNECTION DIAGRAM



This is the connection laid between the *ESP32* two servos (used one instead of two in the project), the servos are powered through a buck convertor and a common ground is established between the buck convertor and *ESP32* microcontroller. The buck convertor is used to convert 12v to 5v.



The above diagram shows the entire connection between the *Jetson* board and the actuation system which consists of the IR sensor, *SG90* Servo. The IR senses and control the movement of the actuator while the *Kinect* effectively maps the space.