

Nvidia Jetson Nano Development Kit

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Introduction to NVIDIA Jetson Nano

Developed on object detection, one of the main problems in computer vision, Jetson Nano was designed by California-based NVIDIA Technology Company (“About NVIDIA,” t.y.; Barba-Guaman, Eugenio Naranjo, Ortiz, 2020). NVIDIA Jetson family’s announced the first Jetson Nano Developer Kit at the GPU Technology Conference (GTC) in March 2019 (Salih & Gh, 2020; Franklin, 2019).

NVIDIA’s Jetson is a new integrated accelerator hardware created by the widespread use of automated learning algorithms. This kind of performance contributes to the development of applications in many areas, such as multiple sensor robots, intelligent IoT devices, and advanced Artificial Intelligence (AI) systems (Franklin, 2019). Originally designed for Internet of Things (IoT) manufacturers and creators, the Jetson Nano card is an AI computer that generates low power and is low-cost, small, and powerful, allowing a large number of AI algorithms to run in parallel (“Jetson Nano Developer Kit,” t.y.; Kurniawan, 2021). However, achieving Jetson’s full potential and achieving real-time performance involves an optimization phase for both hardware and different algorithms.

The fact that jetson nano is a small computer can be considered a daily computer. We can add sensor and actuator modules to NVIDIA Jetson Nano devices. The card provides a GPIO interface to connect to external device modules (Kurniawan, 2021).

Jetson Nano has three different models developed. These are defined as Jetson Nano A02 Developer Kit, Jetson Nano 4GB Developer Kit (B01) and Jetson Nano 2GB Developer Kit. The main difference between these two models, the A02, which was first released in March 2019, and the B01 (4GB), the second of which was released in January 2020, was that the A02 version could not boot with Intel 8260 WiFi installed. This problem has been updated with version B02 (“NVIDIA Jetson Linux,” 2019). An extra camera slot has been added to the B02 (Hao, 2020). Other features and components are the same.

When all three models are examined, the ARM A57 CPU has a 128-core Maxwell GPU, GPIOs, I2C, SPI, UART, USB, HDMI, power and fan connectivity, as well as a microSD card slot for main storage. Other input and output interfaces such as serial

communication, SPI and I2C can be accessed through the program.

The Jetson Nano Developer Kit is powered by the JetPack SDK and compatible with the artificial intelligence frameworks that are becoming popular today: we can run Pandas, Numpy, Tensorflow and Keras on an NVIDIA Jetson Nano card. By installing the OpenCV library, we can easily use NVIDIA Jetson Nano to create computer image programs. The OpenCV library provides a variety of image and video processing libraries. In addition, OpenCV consists of machine learning libraries such as facial recognition.

Programming platforms such as C/C++ and Python are supported in NVIDIA Jetson Nano image. Since this image uses operating system-based operating systems, we can install various compilers and applications, including web applications and databases.

Jetson Nano Cards and Features

The first goal for NVIDIA Jetson Nano is to create IoT solutions. Jetson Nano cards developed over time have also become available for AI applications. The developed cards cover the shortcomings of the previous card, but also bring new features.

In general, some additional hardware will be needed to run the NVIDIA Jetson Nano Developer Kit. Additional devices are provided below:

- MicroSD card with a minimum storage size of 16 GB
- MicroSD card reader to retrieve data from computer
- USB wired mouse
- USB wired keyboard
- Power adapter 5V 2A
- Micro USB cable for power adapter
- HDMI connector monitor

You can easily find these products in electronics stores.

Jetson Nano A02 Developer Kit

Launched in March 2019, the A02 has become frequently used by developers in AI applications with its low price and strong performance.

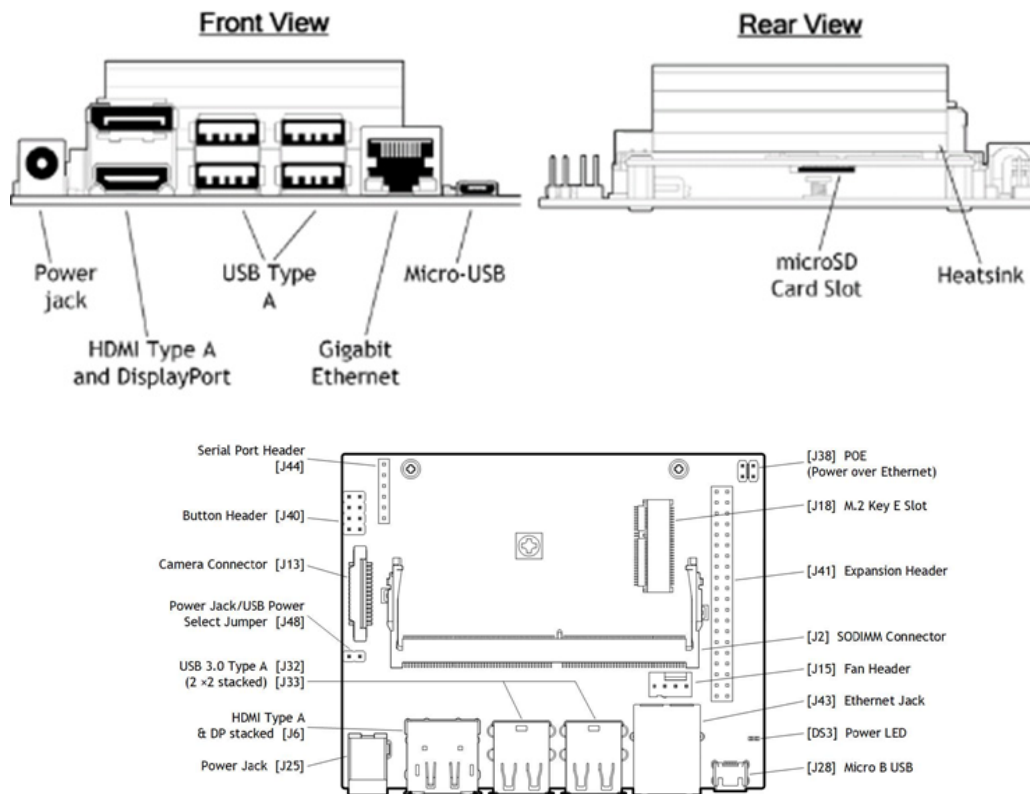


Figure1. NVIDIA Jetson Nano Developer Kit Module and Carrier Card

Specifications;

- Quad-core ARM A57 CPU
- 128-core Maxwell GPU
- 4GB 64-bit Memory | 25.6 GB/s
- 3 USB ports
- Power over Ethernet (PoE)
- 5V DC Power Input
- Fan Connector
- Camera Connector
- HDMI port
- DisplayPort

Jetson Nano B01 (4GB) Developer Kit

NVIDIA has just updated its Jetson Nano; In January 2020, it launched a new model, the

Jetson Nano B01 development card (Kurniawan, 2021; Jackson, 2020). With the updates made, the carrier card has been improved while supporting new interfaces and hardware.

Lending to the hardware ISP (Image Signal Processor) available in all Jetson Nano B01 variants, the NVIDIA libargus interface provides an application-engraved video stream with mosaic removal, color correction, and white balance algorithms (“Development Kits Nvidia,” t.y.). Display Source provides a default configuration file for the ISP. Using the GStreamer interface for libargus, the app can interface with NVIDIA’s unchanging Jetson ecosystem software buildup, which includes efficient integration of powerful image processing frameworks such as DeepStream, Visionworks, and others (“NVIDIA Jetson Nano,” t.y.).

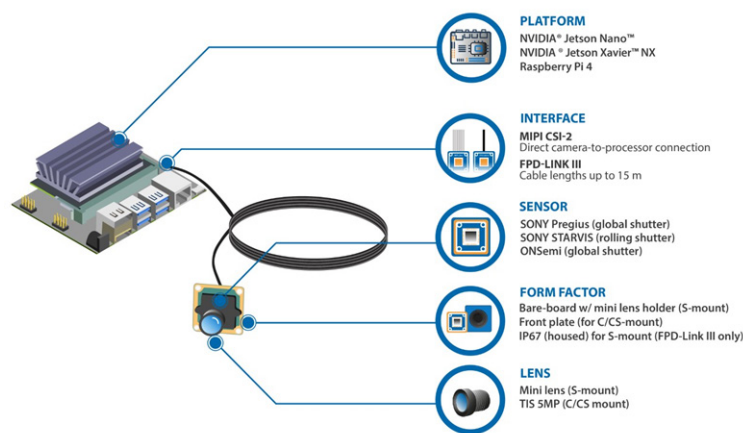


Figure 2. Jetson Nano 4GB

With updates to Jetson Nano, Jetpack 4.3 was launched into the economy market with TensorRT 6.0.1 and cuDNN 7.6.3 libraries that helped improve artificial intelligence inference performance by 25%. Using the GPU + CPU hardware encoder/decoder, VPI (Vision Programming Interface) accelerates 4K video or multiple 1080P video feeds (up to 8x at a time) and performs multiple tasks of ML (Machine Learning) algorithms, such as image detection recognition and monitoring (Jackson, 2020).

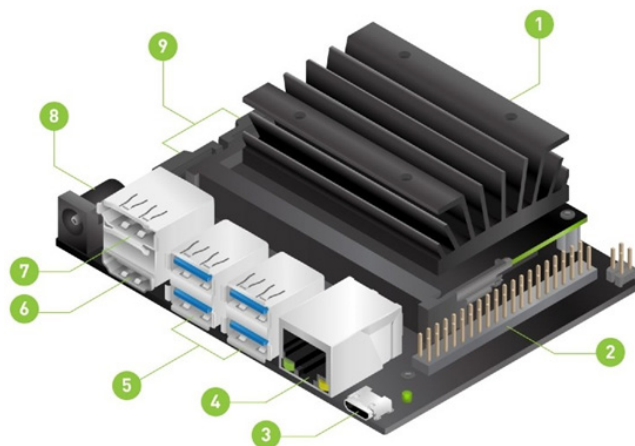


Figure 3. NVIDIA Jetson Nano B01 (4GB)

Specifications;

- 1) MicroSD card slot for main storage
- 2) 40-pin expansion head
- 3) Micro-USB port for 5V Power input or data transfer
- 4) Gigabit Ethernet port
- 5) USB 3.0 ports (x4)
- 6) HDMI output port
- 7) DisplayPort connector
- 8) DC Barrel jack for 5V power input
- 9) MIPI CSI camera connectors (x2) that create the appropriate environment for binocular applications such as stereo recording, depth detection, 3D object tracking and image consolidation

Jetson Nano 2GB Developer Kit

In October 2020, NVIDIA launched the more economically viable Jetson Nano 2GB developer kit (Hao, 2020). Jetson Nano 2GB provides an efficient environment for hands-on teaching and learning in the AI and robotics community.

Jetson Nano 2GB developer actively enables videos, open source projects, AI frameworks and models for applications such as image classification, object detection, partitioning and speech. These start with an introductory “Hello AI World”, continue with robotics projects such as the open source NVIDIA JetBot AI robot platform, and advance to the next stage of robotics development with NVIDIA Isaac™. These resources are supported by NVIDIA JetPack™, which includes the same CUDA-X™ software and tools used by experts from all over the world to each Jetson Nano 2GB developer. JetPack includes a known Linux environment and facilitates progress with its service to cloud-based technologies such as containerization and orchestration (“NVIDIA Jetson Nano,” t.y.). The Jetson Nano 4GB Development kit is shown in Figure 4:

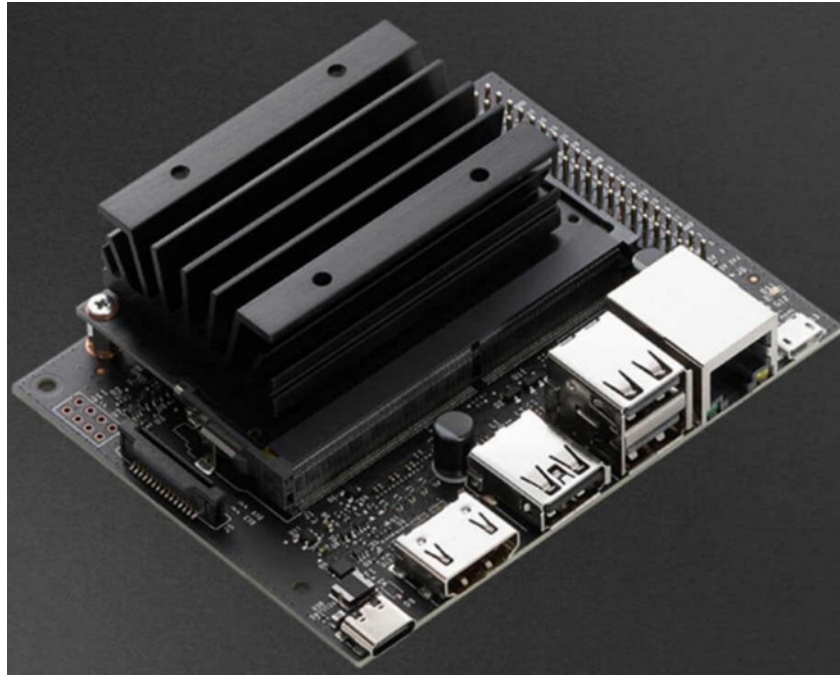


Figure 4. NVIDIA Jetson Nano 2GB Developer Kit

Compared to Jetson Nano B01 (4GB);

- Camera slot (J49) removed.
- Dc barrel jack changed to USB Type-C port.
- USB Type-A ports have been changed.
- The display port has been removed.
- PoE - Power port over Ethernet (J38) removed.
- M.2 Key E slot (J18) removed.

Jetson Nano Module

The Jetson Nano module comes with the form factor and availability of users, the guarantees they need to put special carrier cards on the line. The B01 developer kit carrier motherboard is now compatible with the new Jetson Nano module for those who want to design a product (“Jetson Nano Module,” t.y.).

This carrier motherboard has been updated to support the production of the Jetson Xavier NX Module, which will go on sale in March 2020 (“Jetson Nano Module,” t.y.).

The Jetson Nano is a small, powerful computer for embedded applications and AI IoT that demonstrates the power of modern AI in this \$99 (1KU+) module (“Jetson Nano Developer,” 2019).



Figure 5. Jetson Nano Module

Chapter 3. Installation and Operation

The NVIDIA Jetson Nano can be thought of as a minicomputer. Some hardware and software items such as mouse, keyboard and monitor are needed.

3.1. Hardware Preparation

The Jetson Nano Developer Kit needs a microSD card as the boot device and for main storage. For projects it is necessary to have a card large enough and fast; The recommended minimum is 32 GB UHS-1 card. A microSD card reader is required to work with the computer to read and write files. Figure 6.



Figure 6.. MicroSD card and NVIDIA Jetson Nano

Generally, some additional hardware will be needed to operate the computer. Power adapter 5V, 2A, Micro USB cable for power adapter, monitor with HDMI connector are some of them.

After the hardware needs are met, the necessary software can be installed to make the NVIDIA Jetson Nano work.

Installing Software

NVIDIA Jetson Nano uses its own operating system to run its applications. This operating system is based on Ubuntu Linux.

It needs the Etcher tool to upload the NVIDIA image file to a microSD card. This tool is available for Windows, Linux and macOS.

Installation Steps

1. Insert your microSD card with the reader into your computer.
2. Start flashing the image file by selecting the image file. Select the NVIDIA image file (ZIP file). Then choose your microSD card.
3. You can now start transferring the NVIDIA Jetson Nano image to your microSD card. Click Flash. You will be asked to give permission to the administrator to flash the image. This process takes a few minutes to complete.
4. You will get confirmation after it finishes flashing. Figure 3-2 shows the completion of the flashing image with the Etcher application. If you have finished flashing the image file, you can remove your microSD card from your computer. Then you can put it on the NVIDIA Jetson Nano device.

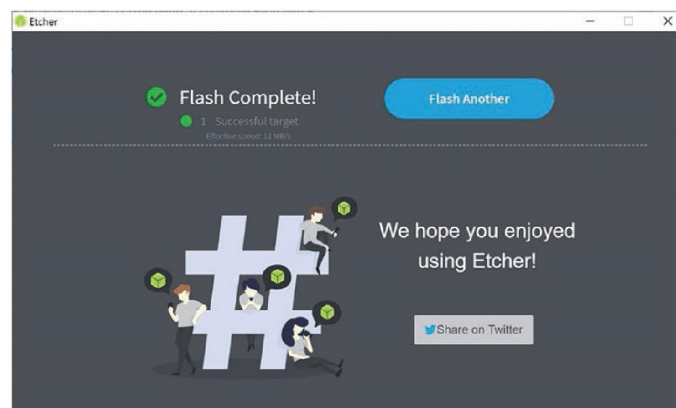


Figure 7. Flashing Jetson Nano Developer Kit SD Card Image

Run NVIDIA Jetson Nano

After transferring the NVIDIA Jetson Nano image to the microSD card, you can insert the card into the NVIDIA Jetson Nano card. Figure 8 shows a microSD card installed in an NVIDIA Jetson Nano.

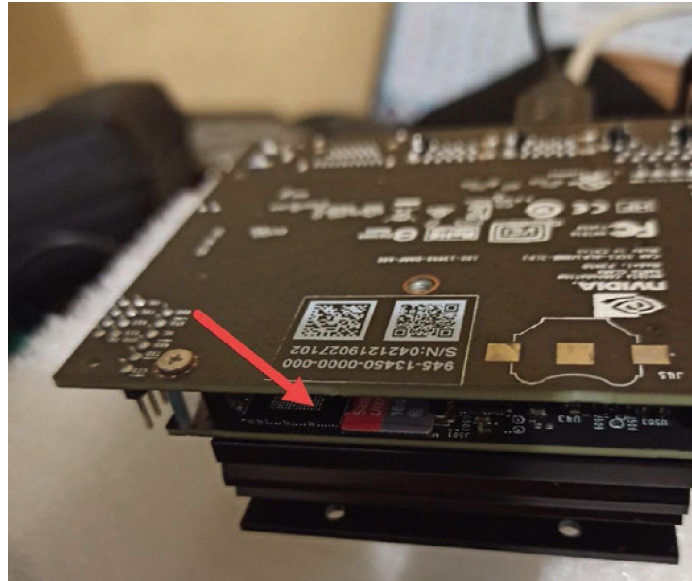


Figure 8. Installing microSD Card in NVIDIA Jetson Nano

With it, the keyboard, mouse and monitor are attached to the NVIDIA Jetson Nano device. It uses DC jack power or micro USB power with a 5V, 2A power adapter to pump power to the NVIDIA Jetson Nano. Figure 9

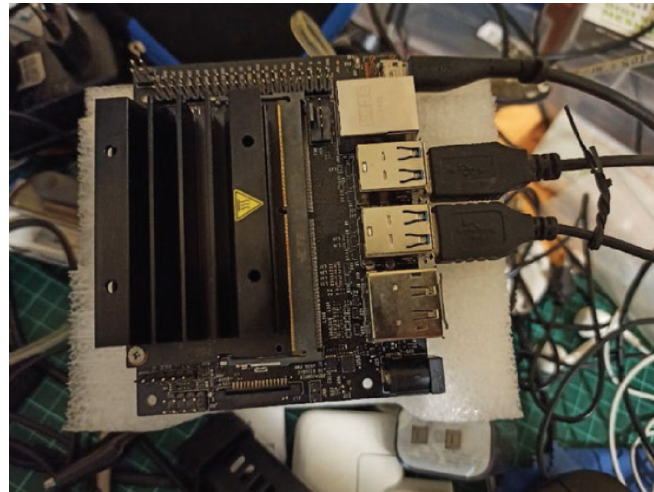


Figure 9. Plug in Keyboard, Mouse, Monitor and Power Adapter

Configure NVIDIA Jetson Nano Software

You can configure NVIDIA Jetson Nano for the first time after plugging in the power adapter. You must accept the required agreement to continue using the NVIDIA Jetson Nano device

After accepting the agreement, click the continue button. However, you will be asked to select a language for all text on the screen. You can also set the keyboard type and time zone for the local area. Finally, you must create your required account for NVIDIA

Jetson Nano. Enter the full name, username and password. Also set the authentication model. It is recommended that you use the Require my password to login option.

If your NVIDIA Jetson Nano is connected to the internet via a LAN cable or Wi-Fi module, you can connect to the internet. Then you can update the NVIDIA Jetson Nano software.

After performing all the operations, you will see the NVIDIA Jetson Nano desktop. This desktop is based on Ubuntu Linux. Figure 10. With the end of the process, you can create and edit files, surf the Internet, chat, etc. You can perform activities you do on any computer, such as.

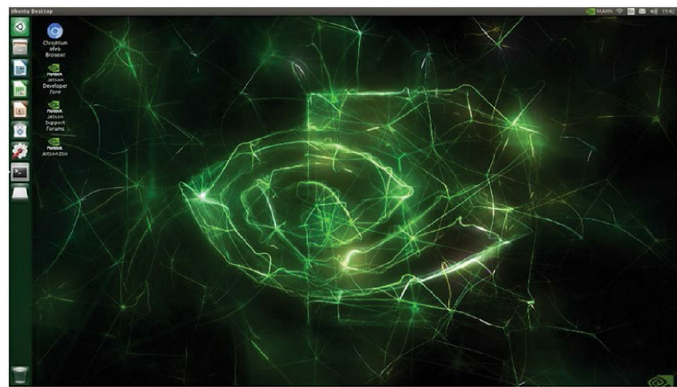


Figure 10. NVIDIA Jetson Nano Desktop

Since the NVIDIA Jetson Nano image is built from Ubuntu, you can use Terminal for administrative tasks such as creating/editing files and folders or compiling and executing programs.

You can find the NVIDIA Jetson Terminal by clicking Search at the top left. Type “Terminal” to see the terminal application. After clicking on the Terminal icon, you will get the Terminal application as seen in Figure 11.

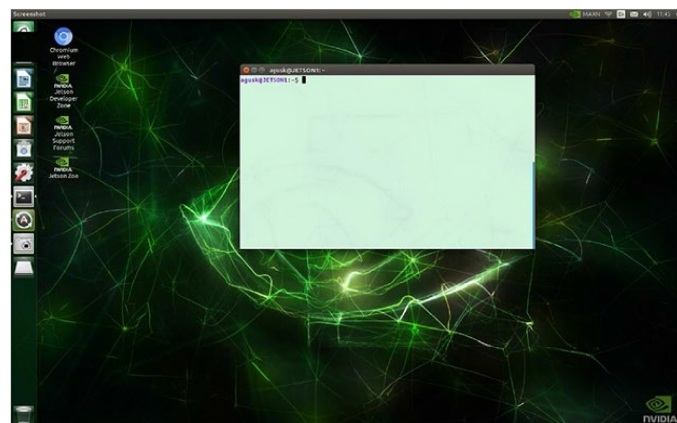


Figure 11. Terminal Application

Thus, you can perform administrative tasks using Terminal. You can manually reboot

the NVIDIA Jetson Nano Operating System. You can click the Settings icon in the upper right corner of the NVIDIA Jetson Nano desktop.

You can also restart NVIDIA Jetson Nano via Terminal. You can open Terminal by pressing the CTRL and T keys at the same time. After opening Terminal you can type the command: `sudo reboot`. The NVIDIA Jetson Nano device will automatically reboot. You should make sure to save all data before rebooting.

If you no longer need to use NVIDIA Jetson Nano, you can shut down using the shutdown command, either from the Shutdown option in the confirmation dialog, or using Terminal if needed.

NVIDIA Jetson Nano Programming

NVIDIA provides the option to use the Jetson Nano card in two ways. Projects can be developed by trading with the Linux-based Ubuntu interface or transactions can be made via Jupyter Notebook IDLE using a computer.

There are SDKs required to install software on Jetson Nano:

- JetPack SDK
- DeepStream SDK

JetPack SDK

The NVIDIA JetPack SDK is one of the most comprehensive systems used to build AI applications. It also includes samples, documentation, and developer tools for both the host and developer kit, and supports higher-level SDKs such as DeepStream for video analysis and Isaac for robotics.

There are two options for using the JetPack SDK: in the first option; Without using equipment such as screens and keyboards, jetson nano card can be connected to computer via USB and projects can be realized with Jupyter Notebook interface. In the second option, after installing the JetPack system, jetson nano development card can perform projects by connecting the screen to the HDMI input, keyboard and mouse to the USB ports.

DeepStream SDK

Built for both developers and businesses, deepstream SDK offers seamless development for AI-based video, audio and video analytics with widely used segmentation models such as state-of-the-art SSD, FasterRCNN, YOLO, MaskRCNN.

With Deepstream, multi-GPU, multi-stream, and grouping support, you can get the

best possible performance using NVIDIA TensorRT for high efficiency. It offers the possibility to run locally on PyTorch and TensorFlow and PyTorch with DeepStream on models. DeepStream can be developed in languages such as C/C++ or Python.

Editor Tools

Jetson Developer Kits support a wide range of development environments. Most developers on a Linux platform work with IDE or can be moved to Jetson. One of the most popular IDE's is Visual Studio Code from Microsoft. Visual Studio Code is commonly referred to as VSCode. VSCode offers a free-source version to professional developers and there are many programming language options.

To set up VSCode, you can set up by opening Terminal and typing the following codes:

```
$ sudo -s
```

```
$ . <( wget -O - https://code.visualstudio.com/download
)
```

```
exit
```

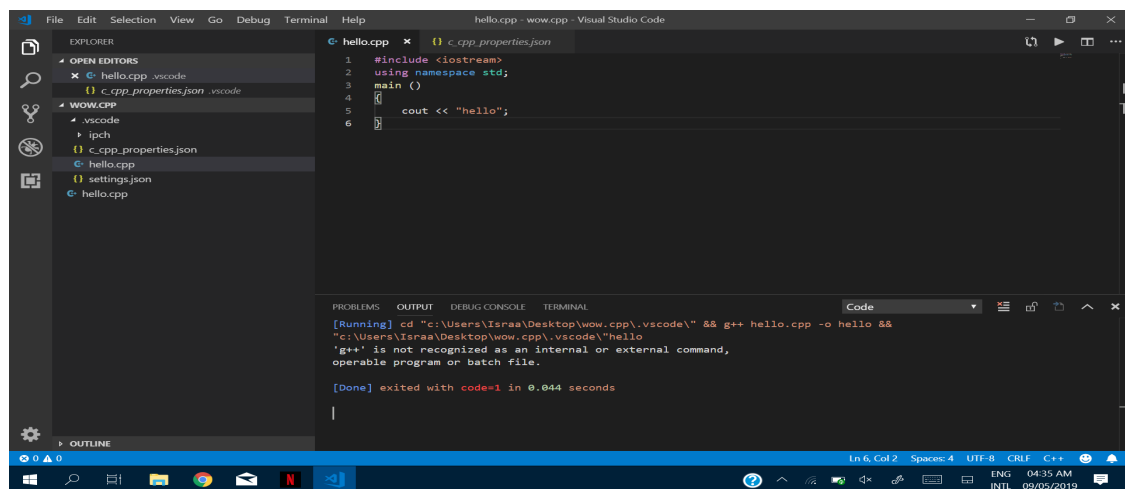


Figure 12. Visual Studio Vode

C/C++ Programming

You can create programs for C/C++ on your NVIDIA Jetson Nano. The NVIDIA Jetson Nano image includes the GCC compiler, so you can use it to compile C/C++.

Python Programming

Python is one of the programming languages frequently used by developers in data processing and data science applications. You can also create hardware programs using

Python libraries if necessary.

To write Python scripts in Jetson Nano, you can use visual studio code or jupyter notebook compiler programs after the required Python version is installed.

Node.js Programming

Node.js, a JavaScript-based programming language, is generally used in web applications and is a cross-platform. Nvidia Jetson Nano is easy to use with Node.js.

Jetson Nano I/O Programming

The Jetson Nano Development Kit has a 40-pin expansion head that carries several GPIO pins that can be used to perform microcontroller-level tasks similar to Raspberry Pi boards. These digital pins can give 20 Microampers (μA). Therefore, a transistor is needed to burn an Led. We can add pins and necessary devices and sensors and actuators to NVIDIA Jetson Nano devices. At NVIDIA Jetson Nano, we also mentioned in the introduction that it provides GPIO pins for UART, PWM, SPI, I2S and I2C.

GPIO Support on Jetson Nano Developer Kit

The Jetson Nano Developer Kit has a J41 expansion head with pins similar to the Raspberry Pi. The following pinout diagram shows different uses of pins.

Sysfs	Name	Pin	Pin	Name	Sysfs
	3.3V DC	1	2	5V DC	
	I2C_2_SDA	3	4	5V DC	
	I2C_2_SCL	5	6	GND	
gpio216	AUDIO_MCLK	7	8	UART_2_TX	
	GND	9	10	UART_2_RX	
gpio50	UART_2_RTS	11	12	I2S_4_CLK	gpio79
gpio14	SPI_2_SCK	13	14	GND	
gpio194	LCD_TE	15	16	SPI_2_CS1	gpio232
	3.3V DC	17	18	SPI_2_CS0	gpio15
gpio16	SPI_1_MOSI	19	20	GND	
gpio17	SPI_1_MISO	21	22	SPI_2_MISO	gpio13
gpio18	SPI_1_SCK	23	24	SPI_2_CS0	gpio19
	GND	25	26	SPI_2_CS1	gpio20
	IC2_1_SDA	27	28	I2C_1_SCL	
gpio149	CAM_AF_EN	29	30	GND	
gpio200	GPIO_PZO	31	32	LCD_BL_PWM	gpio168
gpio38	GPIO_PE6	33	34	GND	
gpio76	I2S_4_LRCK	35	36	UART_2_CTS	gpio51
gpio12	SPI_2_MOSI	37	38	I2S_4_SDIN	gpio77
	GND	39	40	I2S_4_SDOOUT	gpio78

Figure 12. Pinout Diagram for J41 Expansion Head in Jetson Nano Developer Kit

As the diagram shows, other pins except I2C communication pins are directly connected to the Jetson Nano module. I2C pins are connected to a mid-range gear shifter to change the voltages in the module from 1.8V to 3.3V in the standard I2C interface. These are 3

and 5 pins (I2C SDA pins) and 27 and 28 pins (I2C SCL pins). The 8 and 10 pins are the UART transmitter (TX) and receiver (RX) pins, respectively.

The card also provides two 3.3V (pin 1 and 17) and two 5V (pin 2 and 4) power supplies. The expansion head also has multiple floor pins.

Some sources have given that the expansion header only has 2 PWM channels directly connected to hardware PWM controllers, but the Jetson Nano module is not naturally configured to identify the connection to the PWM hardware. Therefore, to use PWM hardware, the system must be configured to provide functionality to PinMux PWM pins. The documentation provided by NVIDIA describes the relevant steps.

References

- About NVIDIA, (t.y.). <https://www.nvidia.com/tr-tr/about-nvidia/>
- Barba-Guaman, L., Eugenio Naranjo, J., & Ortiz, A. (2020). Deep Learning Framework for Vehicle and Pedestrian Detection in Rural Roads on an Embedded GPU. *Electronics*, 9(4), 589. <http://dx.doi.org/10.3390/electronics9040589>.
- Salih, T.A., Gh. M.B. (2020). A novel Face Recognition System based on Jetson Nano developer kit, *IOP Conf. Ser.: Mater. Sci. Eng.* 928 032051.
- Franklin, D. (2019). Jetson Nano Brings AI Computing to Everyone. Erişim adresi <https://developer.nvidia.com/blog/jetson-nano-ai-computing>
- Jetson Nano Developer Kit. (t.y.). <https://developer.nvidia.com/embedded/jetson-nano-developer-kit>
- Kurniawan, A. (2021). IoT Projects with NVIDIA Jetson Nano: AI-Enabled Internet of Things Projects for Beginners, Apress.
- NVIDIA Jetson Linux Driver Package, (2019, 9 October) <https://docs.nvidia.com/jetson/14t/>
- Hao, T.K. (2020, 14 October). Nvidia Jetson Nano Developer Kit A02 vs B01 vs 2GB. <https://tutorial.cytron.io/2020/10/14/nvidia-jetson-nano-developer-kit-a02-vs-b01-vs-2gb/>
- Jackson, L. (2020, 17 March). Jetson Nano B01 vs A02: What's New for the Compute on Module (CoM) and Carrier Board. <https://www.arducam.com/nvidia-jetson-nano-b01-update-dual-camera/>
- Development Kits Nvidia Jetson Nano. (t.y.). <https://www.theimagingsource.com/embedded-vision/development-kits/nvidia-jetson-nano/>
- NVIDIA Jetson Nano 2GB Developer Kit WiFi. (t.y.). <https://openzeka.com/urun/nvidia-jetson-nano-2gb-developer-kit/>

NVIDIA Jetson Nano 2GB Developer Kit. (t.y.). <https://tr.aliexpress.com/i/1005001827026370.html>

Jetson Nano Module. (t.y.). <https://developer.nvidia.com/embedded/jetson-nano>

Jetson Nano Developer Kit User Guide (2019, 17 November). <https://www.veribilimiokulu.com/yapay-zeka-uygulama-gelistirme-karti-nvidia-jetson-nano-2/>

DeepStream SDK. (t.y.). <https://developer.nvidia.com/deepstream-sdk>

How to Use GPIO Pins on Jetson Nano Developer Kit. (2020, 23 June). Erişim adresi <https://maker.pro/nvidia-jetson/tutorial/how-to-use-gpio-pins-on-jetson-nano-developer-kit>

Nvidia Jetson Nano. (t.y.). <https://www.nvidia.com/tr-tr/autonomous-machines/embedded-systems/jetson-nano/>

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