Nano-backpack instructions

Barth, Alexander
M.Sc. Student Computer Engineering

Wagner, Royden
M.Sc. Student Computer Engineering

Institute for Computer Engineering (ZITI)

University of Heidelberg

Contents

List of Figures

List of Source codes

List of Tables

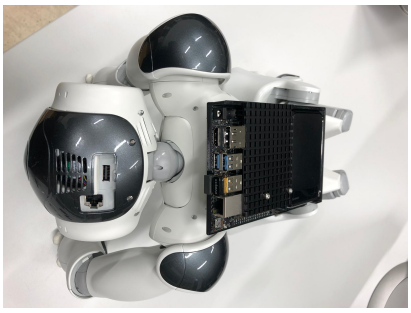
1 Step-by-step

This section provides step-by-step instruction for using the Nano-backpack on NAO starting with the mounting. To use the project on another Jetson Nano, follow the structure described in `https://github.com/roydenwa/nano-backpack`.

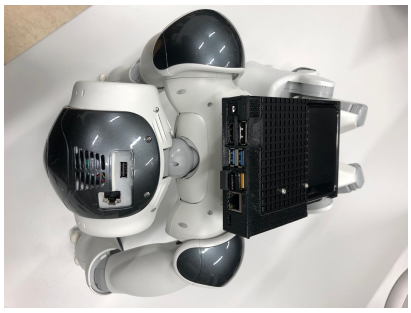
1.1 Hardware

To mount the Nano-backpack onto the NAO robot follow the steps shown in Fig. 1

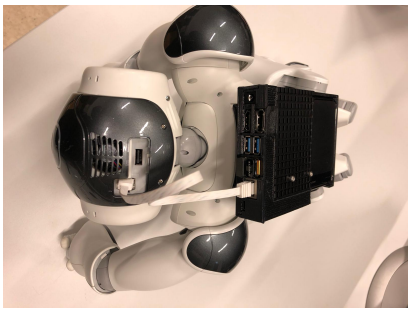
(i) Lower backpack part



(ii) Nano and powerbank



(iii) Upper backpack part



(iv) Ethernet cable

Figure 1: Mounting steps

1. Remove the battery cover and instead fix the printed backpack with screws on the back of the robot.
2. Insert the Nano and the powerbank into the backpack.
3. Close the Nano-backpack with the upper backpack part.
4. Connect NAO with it's Nano-backpack by using the flat ethernet cable.*

* This step completes the installation of the hardware, but may be done later, as described in the step-by-step part for software.

1.2 Software

This subsection focuses on the software but requires several steps with hardware included.

1. Connect the Nano to it's power supply.
   Note: Do not connect the ethernet cable yet.

2. Start NAO by pressing it's chest button.
   Note: Continue with the following steps so that NAO's boot process is finished when required.

3. Wait until the wlan adapter lights up blue.
   The boot process is finished and Nano's wlan is ready for your connection.

4. Connect to Nano's wlan.
   Name: *nano-bp*
   Password: *12345678*

5. Connect to Nano via SSH.
   Command: *ssh nao-bp@192.168.12.1*
   User password: *nao9*

6. Run the *dnsmasq* batch script to setup the network sharing with NAO correctly.
   Command: *sudo bash run_dnsmasq.sh*

7. Connect NAO with it's Nano-backpack using the ethernet cable.
   Note: NAO's default IP is 192.168.2.37.

8. Run the dockerimage. For more information on using Docker see Section 2.
   Command: *docker run –rm -it -p 80:80 nano-backpack*

2 Development environment

On the Nano are docker and python available and contain the app to remote control NAO via web application. The dockerfile contains the commands necessary while building the dockerimage. To build and start the dockerimage navigate to the working directory of the app and execute the following commands shown in Listing 1. Docker runs an application coming with an user interface which can be used for testing.

```
1 # build dockerimage
2 docker build -t "nano-backpack" .
3 # start dockerimage
4 docker run --rm -it -p 80:80 nano-backpack
5
6 # start development server without docker
7 python app.py
```

Listing 1: Start development server

The app should now run at `192.168.12.1`. After changes to the UI5-frontend a manual restart of the app is required. Disabling browser caching is not working on chrome, so firefox or edge should be used instead for development.

The provided code base of the webapp and Docker can easily be reused, modified or extended and thus be adapted to future requirements. In this way more NAOqi services can be added. An example is the *ALVideoDevice*, which can be combined with the ready-to-use depth estimation for video stream input.

For accessing the internet with Nano a lan connection is recommended. There may be difficulties with the Nano's wlan connection when it's network is set up.

3 NAOqi-SDKs

This table shows an overview of different Naoqi SDKs. The limitation due to ARM results from using Jetson Nano. The rating is based on the created system architecture or one of it's preliminary stages.

Table 1: NAOqi-SDKs

Release	**Language**	**Operates**	**Notes**
Official	C++		Not tested
	JS Qi2	✓	
	JS QiMessaging	✓	
	Python	×	Not suitable for ARM
Third-party	JS Node-naoqi	✓	See yorkie on GitHub
	ROS	×	Deprecated, also see Python

The testing of further packages is left to future work.

4 Data

This section summarizes useful data which is used above. The following appendix also contains the data sheets for the Nano and its battery.

Model data for printing the backpack and it's cover, as well as all codes used can be found at `https://github.com/roydenwa/nano-backpack`.

Table 2: Data and commands

App	Location	`192.168.12.1`
Docker	Build command	docker build -t "nano-backpack" .
	Run command	docker run –rm -it -p 80:80 nano-backpack
NAO	Default ip	192.168.2.37
SSH	Command	ssh nao-bp@192.168.12.1
User	Name	nao-bp
	Password	nao9
Wlan	Name	nano-bp
	Password	12345678

Appendix A:

NVIDIA

DATA SHEET

NVIDIA Jetson Nano System-on-Module

Maxwell GPU + ARM Cortex-A57 + 4GB LPDDR4 + 16GB eMMC

Maxwell GPU ◊

128-core GPU | End-to-end lossless compression | Tile Caching | OpenGL® 4.6 | OpenGL ES 3.2 | Vulkan™ 1.1 | CUDA® | OpenGL ES Shader Performance (up to): 512 GFLOPS (FP16)
Maximum Operating Frequency: 921MHz

CPU

ARM® Cortex®-A57 MPCore (Quad-Core) Processor with NEON Technology | L1 Cache: 48KB L1 instruction cache (I-cache) per core; 32KB L1 data cache (D-cache) per core | L2 Unified Cache: 2MB | Maximum Operating Frequency: 1.43GHz

Audio

Industry standard High Definition Audio (HDA) controller provides a multichannel audio path to the HDMI interface.

Memory

Dual Channel | System MMU | Memory Type: 4ch x 16-bit LPDDR4 | Maximum Memory Bus Frequency: 1600MHz | Peak Bandwidth: 25.6 GB/s | Memory Capacity: 4GB

Storage

eMMC 5.1 Flash Storage | Bus Width: 8-bit | Maximum Bus Frequency: 200MHz (HS400) | Storage Capacity: 16GB

Boot Sources

eMMC and USB (recovery mode)

Networking

10/100/1000 BASE-T Ethernet | Media Access Controller (MAC)

Imaging

Dedicated RAW to YUV processing engines process up to 1400Mpix/s (up to 24MP sensor) | MIPI CSI 2.0 up to 1.5Gbps (per lane) | Support for x4 and x2 configurations (up to four active streams).

Operating Requirements

Temperature Range (T_j): -25 – 97C* | Module Power: 5 – 10W | Power Input: 5.0V

Display Controller

Two independent display controllers support DSI, HDMI, DP, eDP:

- MIPI-DSI (1.5Gbps/lane): Single x2 lane | Maximum Resolution: 1920x960 at 60Hz (up to 24bpp)
- HDMI 2.0a/b (up to 6Gbps) | DP 1.2a (HBR2 5.4 Gbps) | eDP 1.4 (HBR2 5.4Gbps) | Maximum Resolution (DP/eDP/HDMI): 3840 x 2160 at 60Hz (up to 24bpp)

Clocks

System clock: 38.4MHz | Sleep clock: 32.768kHz | Dynamic clock scaling and clock source selection

Multi-Stream HD Video and JPEG

Video Decode

- H.265 (Main, Main 10): 2160p 60fps | 1080p 240fps
- H.264 (BP/MP/HP/Stereo SEI half-res): 2160p 60fps | 1080p 240fps
- H.264 (MVC Stereo per view): 2160p 30fps | 1080p 120fps
- VP9 (Profile 0, 8-bit): 2160p 60fps | 1080p 240fps
- VP8: 2160p 60fps | 1080p 240fps
- VC-1 (Simple, Main, Advanced): 1080p 120fps | 1080i 240fps
- MPEG-2 (Main): 2160p 60fps | 1080p 240fps | 1080i 240fps

Video Encode

- H.265:2160p 30fps | 1080p 120fps
- H.264 (BP/MP/HP): 2160p 30fps | 1080p 120fps
- H.264 (MVC Stereo per view): 1440p 30fps | 1080p 60fps
- VP8: 2160p 30fps | 1080p 120fps

JPEG (Decode and Encode): 600 MP/s

Peripheral Interfaces

xHCI host controller with integrated PHY: 1 x USB 3.0, 3 x USB 2.0 | USB 3.0 device controller with integrated PHY | EHCI controller with embedded hub for USB 2.0 | 4-lane PCIe: one x1/2/4 controller | single SD/MMC controller (supporting SDIO 4.0, SD HOST 4.0) | 3 x UART | 2 x SPI | 4 x I2C | 2 x I2S: support I2S, RJM, LJM, PCM, TDM (multi-slot mode) | GPIOs

Mechanical

Module Size: 69.6 mm x 45 mm | PCB: 8L HDI | Connector: 260 pin SO-DIMM

Note: Refer to the software release feature list for current software support; all features may not be available for a particular OS.

◊ Product is based on a published Khronos Specification and is expected to pass the Khronos Conformance Process. Current conformance status can be found at www.khronos.org/conformance.

* See the *Jetson Nano Thermal Design Guide* for details. Listed temperature range is based on module T_j characterization.

Appendix B:

AINOPE®

- ***AINOPE - Machen Sie Produkte und bieten Sie Dienstleistungen mit Herz***

AINOPE widmet sich der Entwicklung, Herstellung und dem Verkauf von Peripheriegeräten für 3C- und Mobiltelefone. Verlassen Sie sich auf ein starkes Forschungs- und Entwicklungsteam und mehr als 15 Jahre harte Arbeit. Wir haben erfolgreich verschiedene heiße Produkte auf den Markt gebracht und mehr als 1000000 Käufer bedient. Viel Spaß beim Einkaufen mit AINOPE. Wir geben stets unser Bestes, um Ihnen ein hervorragendes Einkaufserlebnis zu bieten.

- **Spezifikationen:**

Kapazität: 5000mAh

Eingang: 5V/ 2A Micro USB / USB C

Ausgang: 5V/2A USB A

Abmessung: 3,7 x 2,3 x 0,5in / 94 x 58 x 13mm

Gewicht: 117 g /4.12oz

Lieferumfang: 1 x 5000mAh Powerbank, 1 x Micro USB Kabel, 1 x User Handbuch

- **Ladezustand Einfach zu Wissen:**

Wenn 1%-25% Energie hat, leuchtet eine LED.

Wenn 25%-50% Energie hat, leuchten zwei LEDs.

Wenn 50%-75% Energie hat, leuchten drei LEDs.

Wenn 75%-100% Energie hat, leuchten vier LEDs.

Appendix C:

NVIDIA© Jetson Nano™ Thermal Transfer Plate

- Designed to fit the NVIDIA® Jetson Nano™ production modules
- NVIDIA® Jetson Nano™ production module does not include a thermal transfer plate
- CTI provides Thermal transfer plate that users can integrate into a custom chassis or to other interface material for further cooling
- Dimensions: 61mm x 40mm x 4.2mm

Request Info/Quote | Download Manual | Download 3D Model

NVIDIA ELITE PARTNER

Part #: XHG310

Description | Specifications | Ordering Information | Custom Design

Specifications

Compatibility	NVIDIA Jetson Nano
Dimensions	61mm x 40mm x 4.2mm
Weight	28g
Mounting Fasteners	M3.0X0.5, Ultra Low Profile 6.0mm long, Alloy Steel
Mounting Fasteners Torque Rating	3.1 in-lb