



* Copyright (c) 2023, Leopard Imaging Inc. All Rights Reserved.

Overview

This driver is designed for LI-AR0234CS-GMSL2-STEREO (Hawk) camera kit with Nvidia Jetson AGX Orin Developer kit.

This driver supports up to two LI-AR0234CS-GMSL2-STEREO cameras.

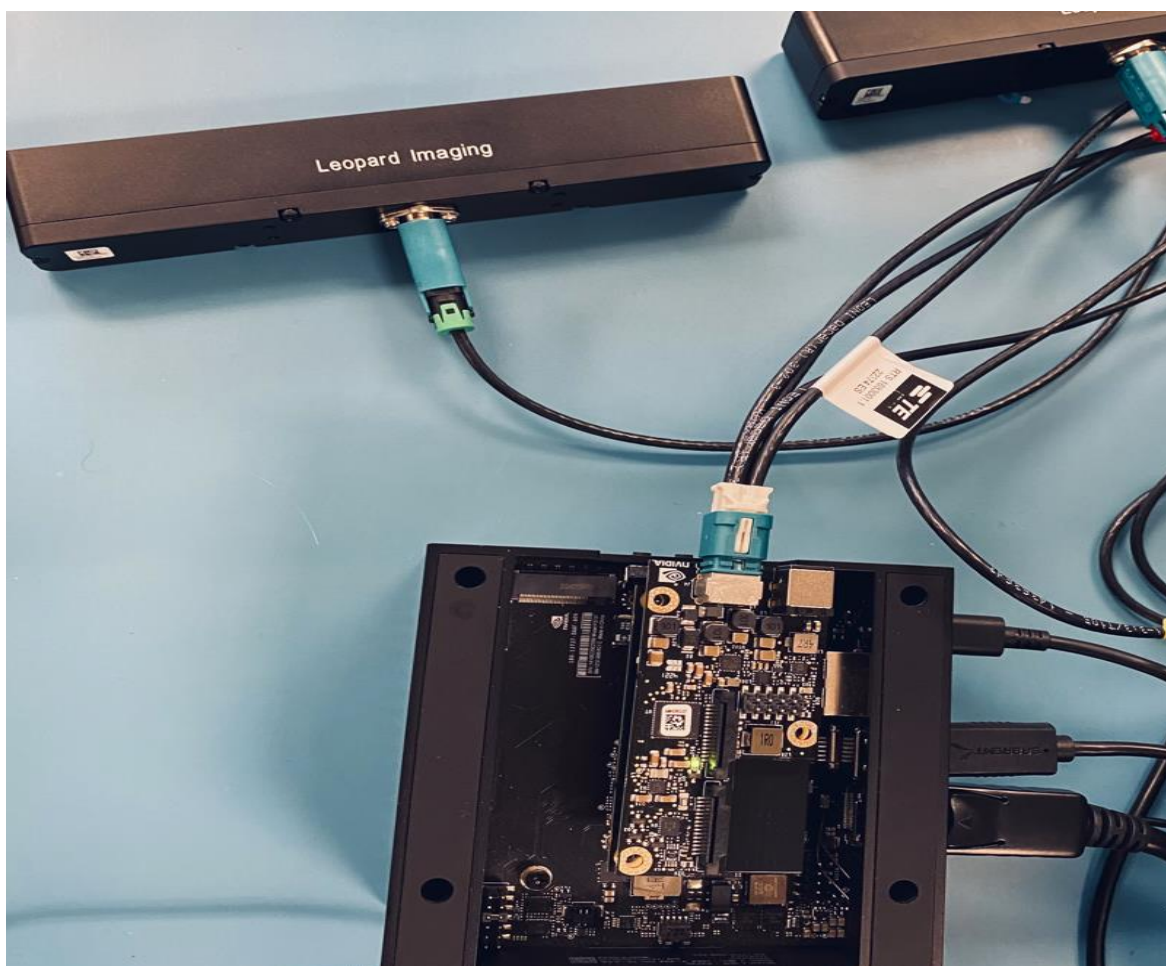
This driver supports 1920x1200@60fps.

This driver is based on R35.4.1 (Jetpack 5.1.2)

Download link

<https://www.dropbox.com/scl/fo/r07waivag6xp65w1zpi0x/h?rlkey=o0bbkd7cnzf5a699faud1tmms&dl=0>

Platform	Camera
Nvidia Jetson AGX Orin Developer kit	1 ~ 2 x LI-AR0234CS-GMSL2-STEREO camera(s)
Cable	Adapter/Carrier Board
1 x 4-in-1 Fakra cable (PN: LI-FCB-4T1-SS-2M-NP-T1)	1x E3653-A03 1 x LI-JTX1-SUB-ADPT





Revision	SVN version	Release Date	Author	Tested by
20231019		10/19/2023	Xingxing Gu	
Updates				
Revision	Description			Release Date
20231019	First Release based on R35.4.1			10/19/2023
Known bugs				
1. If you only have one hawk camera, you can only connect on port 1				



Setup Procedure 1/2

Hardware:

1. Nvidia Jetson AGX Orin Developer Kit x 1
2. E3653-A03 x 1
3. LI-JTX1-SUB-ADPT x 1
4. LI-AR0234CS-GMSL2-STEREO x 1 ~ 2
5. 4-in-1 Fakra cable x 1 (LI-FCB-4T1-SS-2M-NP-T1 cable is included in E3653-A03 adapter order)
6. USB 3.0 Type-C cable x 1 (for flashing OS image)
7. Monitor with HDMI cable x 1
8. Keyboard and Mouse (with USB hub) x 1

Driver installation:

1. Download the R35.4.1 OS Image (from link below) to your Ubuntu OS on Intel x64 Host PC (we are using Ubuntu 20.04/18.04; virtual machine is fine) and follow the `l4t_quick_start_guide` to install the Jetpack to Orin.

R35.4.1 OS Image: <https://www.dropbox.com/sh/w9sgruh4kgt799h/AAB2fKvTpdjy9BDCXZ6AxI9ba?dl=0>

2. Use the `sudo` command to copy the `tegra234-p3701-0000-p3737-0000.dtb` to the `/boot/dtb/kernel_tegra234-p3701-0000-p3737-0000.dtb` in your Orin platform, and use the `sudo` command again to copy the `tegra194-p2888-0001-p2822-0000.dtb` to the `boot/dtb/kernel_tegra194-p2888-0001-p2822-0000.dtb` such as the following:

```
sudo cp tegra234-p3701-0000-p3737-0000.dtb /boot/dtb/kernel_tegra234-p3701-0000-p3737-0000.dtb
sudo cp tegra194-p2888-0001-p2822-0000.dtb /boot/dtb/kernel_tegra194-p2888-0001-p2822-0000.dtb
```

Note: If the AGX Orin Devkit is 64GB version, please use below two commands to install driver.

```
sudo cp tegra234-p3701-0000-p3737-0000.dtb /boot/dtb/kernel_tegra234-p3701-0005-p3737-0000.dtb
sudo cp tegra194-p2888-0001-p2822-0000.dtb /boot/dtb/kernel_tegra194-p2888-0001-p2822-0000.dtb
```

3. Open a terminal and then use the commands below to remove the existing *.ko files (`max96712.ko` and `nv_ar0234.ko`) from the `“/lib/modules/5.10.120-tegra/kernel/drivers/media/i2c/”` directory first.

```
sudo rm /lib/modules/5.10.120-tegra/kernel/drivers/media/i2c/max96712.ko
sudo rm /lib/modules/5.10.120-tegra/kernel/drivers/media/i2c/nv_ar0234.ko
sudo rm /lib/modules/5.10.120-tegra/kernel/drivers/iio/imu/bmi088/bmi088.ko
```

4. Reboot AGX Orin, and then open a terminal and then perform the below commands.

```
sudo insmod max96712.ko
sudo insmod nv_ar0234.ko
sudo insmod bmi088.ko
```

Note:

1. The `max96712.ko`, `nv-ar0234.ko`, & `bmi088.ko` files are included in downloaded Driver's "Binaries" folder.
2. If you restart the Orin system, you must repeat these 3 commands again before using Argus Software, Gstreamer, or other camera capture applications to stream video images.



Setup Procedure 2/2

5. Then execute the command below to get live video images output.

```
nvgstcapture-1.0
```

Note:

Make sure the first camera is connected to Port 1, then the second camera connected to Port 2, and so on.



6. Use Ctrl+C to close the video and then copy “camera_overrides.isp” from you downloaded driver’s “Binaries” directory to /var/nvidia/nvcam/settings directory and then use root (sudo) commands to change the file permission and its ownership such as the following:

```
sudo cp camera_overrides.isp /var/nvidia/nvcam/settings/  
sudo chmod 664 /var/nvidia/nvcam/settings/camera_overrides.isp  
sudo chown root:root /var/nvidia/nvcam/settings/camera_overrides.isp
```

```
nvidia@nvidia-desktop:~/Downloads$ sudo cp camera_overrides.isp /var/nvidia/nvcam/settings/  
nvidia@nvidia-desktop:~/Downloads$ sudo chmod 664 /var/nvidia/nvcam/settings/camera_overrides.isp  
nvidia@nvidia-desktop:~/Downloads$ sudo chown root:root /var/nvidia/nvcam/settings/camera_overrides.isp  
nvidia@nvidia-desktop:~/Downloads$
```

7. Try "nvgstcapture-1.0" again. You should be able to see the image with better image quality

```
nvgstcapture-1.0
```



Run Camera

1. Argus software

Download the Multimedia package from the Dropbox link below and then copy it to the Orin system.

https://www.dropbox.com/scl/fi/6nzkpy92soj1kj172cm2g/Jetson_Multimedia_API_R35.4.1_aarch64.bz2?rlkey=2ygkdpwd88f47827f6sh0wg2&dl=0

Open a terminal, do

```
sudo apt-get update
```

```
sudo apt-get install cmake build-essential pkg-config libx11-dev libgtk-3-dev libexpat1-dev libjpeg-dev libgstreamer1.0-dev
```

Uncompress the downloaded zip file and then untar the file.

```
tar xpf Jetson_Multimedia_API_R35.4.1_aarch64.bz2
```

Under `usr/src/jetson_multimedia_api/argus/cmake` (`cd usr/src/jetson_multimedia_api/argus/cmake`), do the following:

```
cmake ..
```

```
make
```

```
sudo make install
```

```
Do "argus_camera --device=0"
```

2. Gstreamer

```
gst-launch-1.0 nvarguscamerasrc sensor-id=0 ! 'video/x-raw(memory:NVMM), width=(int)1920, height=(int)1200, framerate=30/1' ! nvvidconv flip-method=0 ! 'video/x-raw, format=(string)I420' ! xvimagesink -e
```

3. v4l2-ctl capture raw

```
v4l2-ctl -V --set-fmt-video=width=1920,height=1200,pixelformat=RG10 --set-ctrl bypass_mode=0 --stream-mmap --stream-count=1 --stream-to=ar0234cs.raw -d /dev/video0
```

Important Note:

1) The **0** can be changed to 1 ~ 3 to use other lens or/and cameras.

Video #0 is the left lens of the first Hawk camera.

Video #1 is the right lens of the first Hawk camera.

Video #2 is the left lens of the second Hawk camera.

Video #3 is the right lens of the second Hawk Camera.

2) Please use the below commands to install v4l2 if it has not been installed to the Orin system before.

```
sudo apt-get update
```

```
sudo apt-get install v4l-utils
```

3) If you rebooted Orin platform, you must re-issue the following commands in the `.ko` file directory:

```
sudo insmod max96712.ko
```

```
sudo insmod nv_ar0234.ko
```

```
sudo insmod bmi088.ko
```



Note 1/2

1. Note: If you would like to install Jetpack 5.0.2 but don't want to re-flash the whole OS image, you can uncheck the Jetson OS and install the Jetson SDK components only.

SDK Manager 1.0.0.5517

Hello Simon

STEP 01
DEVELOPMENT ENVIRONMENT

STEP 02
DETAILS AND LICENSE

STEP 03
SETUP PROCESS

STEP 04
SUMMARY FINALIZATION

JETPACK 4.3 LINUX FOR JETSON NANO

Expand all

HOST COMPONENTS	DOWNLOAD SIZE	STATUS
> CUDA	1,886 MB	
> Computer Vision	148.0 MB	
> Developer Tools	407.8 MB	

TARGET COMPONENTS	DOWNLOAD SIZE	STATUS
> <input type="checkbox"/> Jetson OS	1,431 MB	
> Jetson OS image		
> Flash Jetson OS		
> <input checked="" type="checkbox"/> Jetson SDK Components		
> CUDA	954.0 MB	
> AI	882.6 MB	
> Computer Vision	140.0 MB	
> NVIDIA Container Runtime	1.1 MB	

System requires up to 12GB of available disk space during setup.

Download folder: /home/simon/Downloads/nvidia/sdkm_downloads [change](#) (5GB required)

Target HW image folder: /home/simon/nvidia/nvidia_sdk [change](#) (10GB required)

☐ I accept the terms and conditions of the [license agreements](#). ☐ Download now. Install later.

[CONTINUE TO STEP 03](#)

[BACK TO STEP 01](#)

NVIDIA Copyright © 2019, NVIDIA CORPORATION. All rights reserved. | NVIDIA Developer

**Note 2/2****2. Compile the driver**

If you would like to recompile the driver, please follow the below steps.

Download the driver code and Tool chain from Dropbox links below.

Kernel Code:

https://www.dropbox.com/sc/fi/10hfaw3twlyi356x273em/kernel_src_R35.4.1.tbz2.tbz2?rlkey=bukoduzj78baj2zdxnimthjfp&dl=0

GCC ToolChain: <https://www.dropbox.com/s/co7inyf8wbt8nlh/aarch64--glibc--stable-final.tar.gz?dl=0>

Compile the kernel under 64-bit Ubuntu OS on Intel x64 PC. (Virtual machine is fine. We are using Ubuntu 20.04/18.04)

- 1) Copy compile tool “aarch64--glibc--stable-final.tar.gz” to “/opt”, and then unzip it there:
`sudo tar xpf aarch64--glibc--stable-final.tar.gz`
- 2) Copy “kernel_src_R35.4.1.tbz2” and the two patch files (do not use sudo command to copy here) to a newly created directory called “project” under “~/Downloads”(for example: `cd ~/Downloads`, `mkdir project`, `cd project`) and then do the following:
`tar xvpf kernel_src_R35.4.1.tbz2`
`sudo chown -R <user_name> kernel`
`sudo chown -R <user_name> hardware`
Note: <user_name> is the user name of your Ubuntu OS.
For example: `sudo chown -R leopard kernel`
- 3) Apply the software patch files as shown below:
`patch -p1 < ar0234_dual_hawk_gmsl2_max96712_35.4.1_Xavier_Orin_20231019_dtbs.patch`
`patch -p1 < ar0234_dual_hawk_gmsl2_max96712_35.4.1_Xavier_Orin_20231019_kernel.patch`
- 4) To install the tool in the kernel_src.tbz2 file extracted directory, execute below commands:
`sudo apt-get install flex`
`sudo apt-get install bison`
`sudo apt-get install openssl`
`sudo apt-get install libssl-dev`
- 5) To compile in the kernel_src.tbz2 file extracted directory and execute the following commands:
`export CROSS_COMPILE_AARCH64_PATH=/opt/bin/aarch64-buildroot-linux-gnu-`
`export CROSS_COMPILE_AARCH64_PATH=/opt`
`./nvbuild.sh -o $PWD/kernel_out/`
Note: /opt / is the installation path where the compiler is decompressed.

- 6) To check the important compiled result files for this camera driver:

Note: Assumed the previous kernel_src.tbz2 extracted and recompiled under “~/Downloads/project”. Finally, you can get the following files at the following paths from the “~/Downloads/project”:

- 1) **tegra234-p3701-0000-p3737-0000.dtb** under
`~/Downloads/project/kernel_out/arch/arm64/boot/dts/nvidia/tegra234-p3701-0000-p3737-0000.dtb`
- 2) **tegra194-p2888-0001-p2822-0000.dtb** under
`~/Downloads/project/kernel_out/arch/arm64/boot/dts/nvidia/tegra194-p2888-0001-p2822-0000.dtb`
- 3) **max96712.ko** under `~/Downloads/project/kernel_out/drivers/media/i2c/max96712.ko`
- 4) **nv_ar0234.ko** under `~/Downloads/project/kernel_out/drivers/media/i2c/nv_ar0234.ko`
- 5) **bmi088.ko** under `~/Downloads/project/kernel_out/drivers/media/i2c/bmi088.ko`



IMU support

1. How to access imu data in driver

Note: Enter root password mode (sudo su -) before issuing the following Linux commands.

Acc:

```
cd /sys/devices/platform/3180000.i2c/i2c-2/i2c-30/30-0069/iio:device0
cd scan_elements
echo 1 > in_accel_x_en
echo 1 > in_accel_y_en
echo 1 > in_accel_z_en
echo 1 > in_timestamp_en
cd ../buffer
echo 1 > enable
cd ..
cat in_accel_x_raw
cat in_accel_y_raw
cat in_accel_z_raw
```

geo :

```
cd /sys/devices/platform/3180000.i2c/i2c-2/i2c-30/30-0069/iio:device1
cd scan_elements
echo 1 > in_anglvel_x_en
echo 1 > in_anglvel_y_en
echo 1 > in_anglvel_z_en
echo 1 > in_timestamp_en
cd ../buffer
echo 1 > enable
cd ..
cat in_anglvel_x_raw
cat in_anglvel_y_raw
cat in_anglvel_z_raw
```




AR0234CS-GMSL2-STEREO-R35.4.1-AGX-ORIN_20231019_Driver_Guide

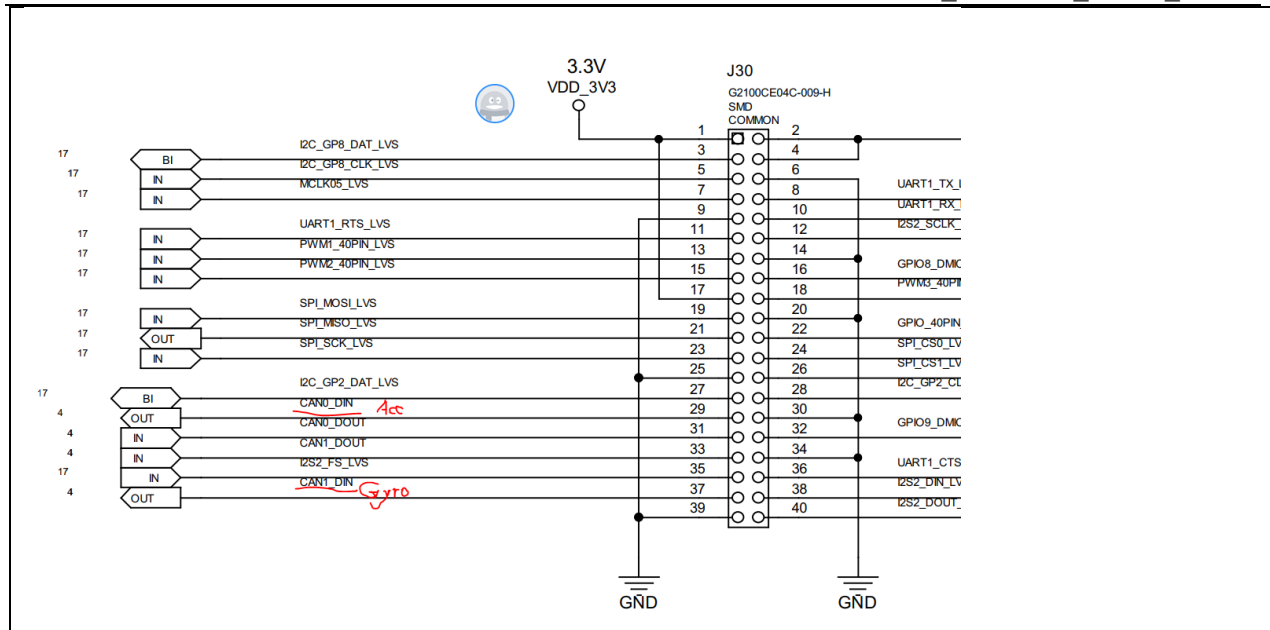
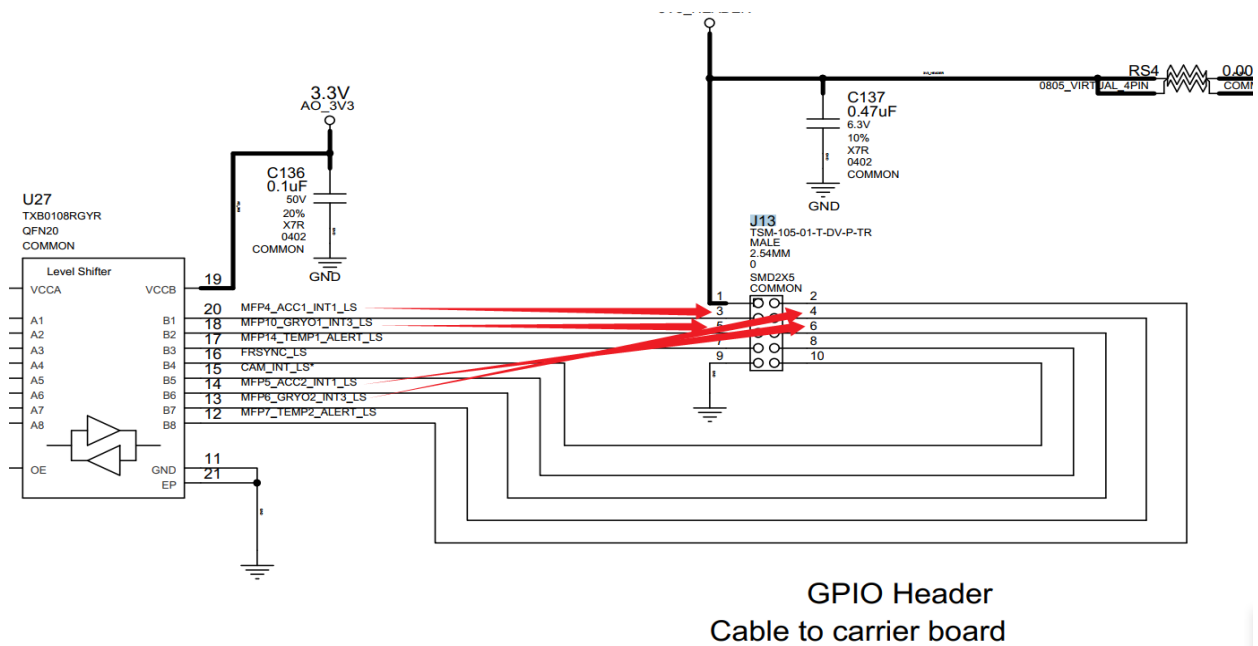


Figure 1: IMU used pins in jetson AGX Orin's pinout header is shown in this picture.



GPIO Header
Cable to carrier board

Figure 2: IMU used pins in E3653-A03 adapter board's J13 header is shown in this picture.

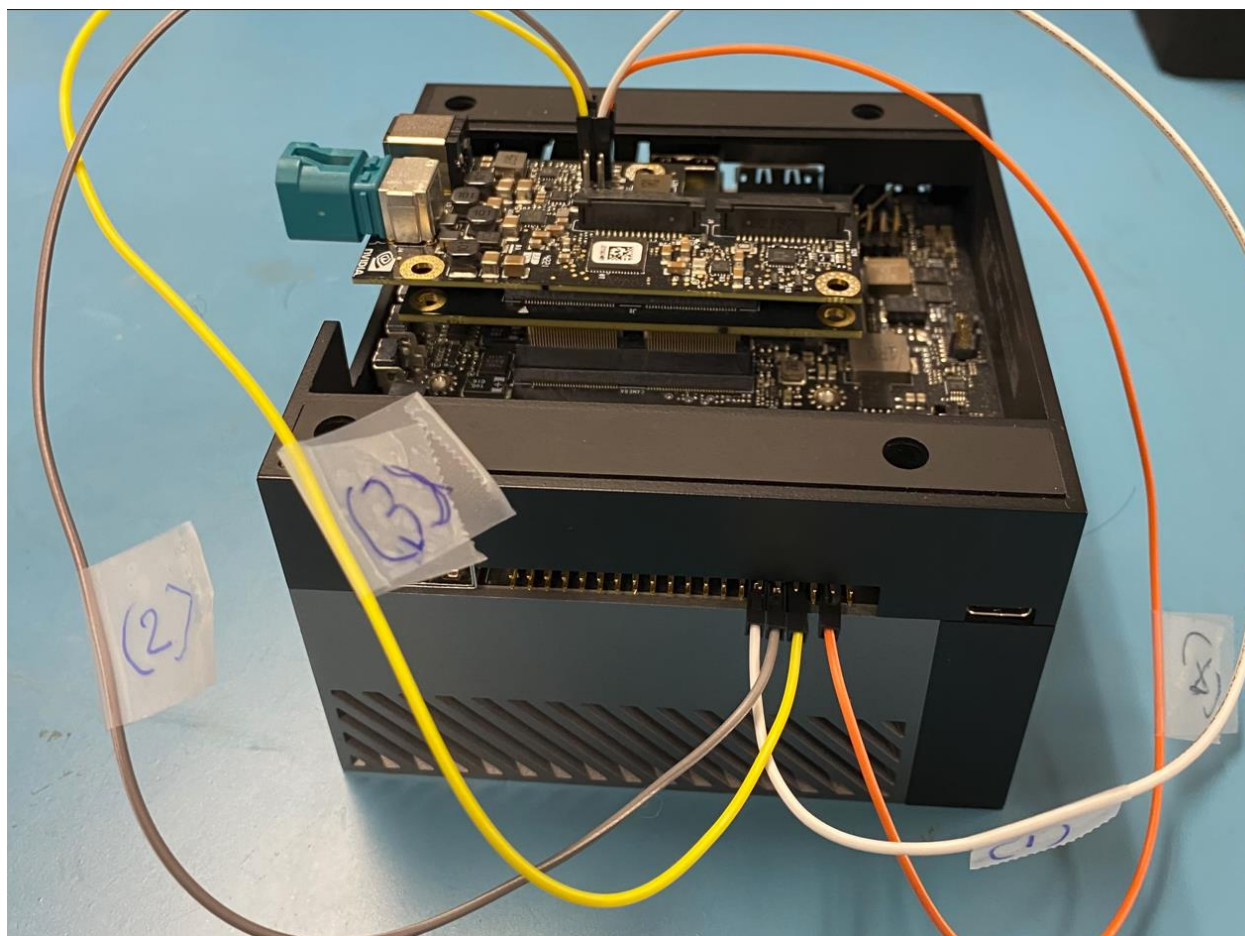


Figure 3: This picture shows the physical IMU test wire connections on the Jetson AGX Orin system with E3653-A03 adapter board.

The detailed explanation for wire 1, 2, 3, 4 connections are described in the following image (Figure 4).



AR0234CS-GMSL2-STEREO-R35.4.1-AGX-ORIN_20231019_Driver_Guide

Connect wires from E3653 header to the 40 pin header on Jetson AGX Orin system as the following:

Wire_4: From Pin 3 (MFP4_ACC1_INT1_LS) from J13 header of E2653-A3 to pin 37 (CAN1_DIN) of Orin's 40-pin header
Wire_3: From Pin 6 (MFP5_ACC2_INT1_LS) from J13 header of E2653-A3 to pin 33 (CAN1_DOUT) of Orin's 40-pin header
Wire_2: From Pin 4 (MFP6_GRY02_INT3_LS) from J13 header of E2653-A3 to pin 31 (CAN0_DOUT) of Orin's 40-pin header
Wire_1: From Pin 5 (MFP10_GRY01_INT3_LS) from J13 header of E2653-A3 to pin 29 (CAN0_DIN) of Orin's 40-pin header

Note:

(A) Details about J13 header of E3653-A3 adapter on Orin system:

J13 header from E3653-A3 adapter with 4x1 cable connector on the left.

Pinouts of E2653-A3 with the top view and 4x1 cable on the left side direction:

2, 1
(Wire_2) 4, 3 (Wire_4)
(Wire_3) 6, 5 (Wire_1)
7, 7
10, 9

Note: Pin 1 of E3653-A3 is VCC 3.3 V

Pin 9 of E3653-A3 is GND.

Required connections:

Pin 3 of E3653-A3 is MFP4_ACC1_INT1_LS
Pin 5 of E3653-A3 is MFP10_GRY01_INT3_LS
Pin 4 of E3653-A3 is MFP6_GRY02_INT3_LS
PIN 6 of E3653-A3 is MFP5_ACC2_INT1_LS

(B) Details about 40 pin header on Orin:

The 40-pin header for Jetson AGX Orin system can be found from the following web link:

https://developer.nvidia.com/embedded/learn/jetson-agx-orin-devkit-user-guide/developer_kit_layout.html

From 40 pin header on Orin: Viewing from two USB connector on left side and one USB connector on right side of this header

2,4,6,8,10,12,14,16,18,20,22,24,26,28,30,32,34,36,38,40
1,3,5,7, 9,11,13,15,17,19,21,23,25,27,29,31,33,35,37,39

Note: Pin 1 of Orin's 40 pin header is 3.3 V

Pin 39 of Orin's is GND.

Required connections:

Pin 37 of Orin's 40 pin is CAN1_DIN
Pin 33 of Orin's 40 pin is CAN1_DOUT
Pin 31 of Orin's 40 pin is CAN0_DOUT
PIN 29 of Orin's 40 pin is CAN0_DIN

Figure 4: Above picture shows the details of the wire connections for IMU test on Jetson AGX Orin system with E3653-A03 adapter board,



3D Depth Support

The two LI-AR0234CS-STEREO-GMSL2-30 camera can also stream mono color 3-D Depth images as in using the “vpi_demo_stereo” application.

Note 1:

Make sure the following commands are issued before in Orin system without power cycle.

```
sudo insmod max96712.ko
sudo insmod nv_ar0234.ko
sudo insmod bmi088.ko
```

Note 2:

We assumed that you already installed “HOST COMPONENTS” that contains the “Computer Vision” (VPI components) from Note ½ section of this driver.

First install the “vpi_demo” samples using the following Linux commands:

```
cd /opt/nvidia/vpi2/bin
./run_demo.sh
./vpi_install_sample.sh
```

Note: If there is any pop-up dialog window that shows additional installation files are needed, please write them down on a piece paper and then install them as guided.

Next, from the “/opt/nvidia/vpi2/bin” directory in Orin system, issue the following Linux command to launch Nvidia’s vpi_demo_stereo application window.

```
cd /opt/nvidia/vpi2/bin
./vpi_demo_stereo
```

Finally, select the menu option “Window” -> “Camera” and choose “HAWK1” and then “HAWK2” to display the 3D depth images that are captured from the two LI-AR0234CS-STEREO-GMSL2-30 cameras as shown in figure 5 and 6.

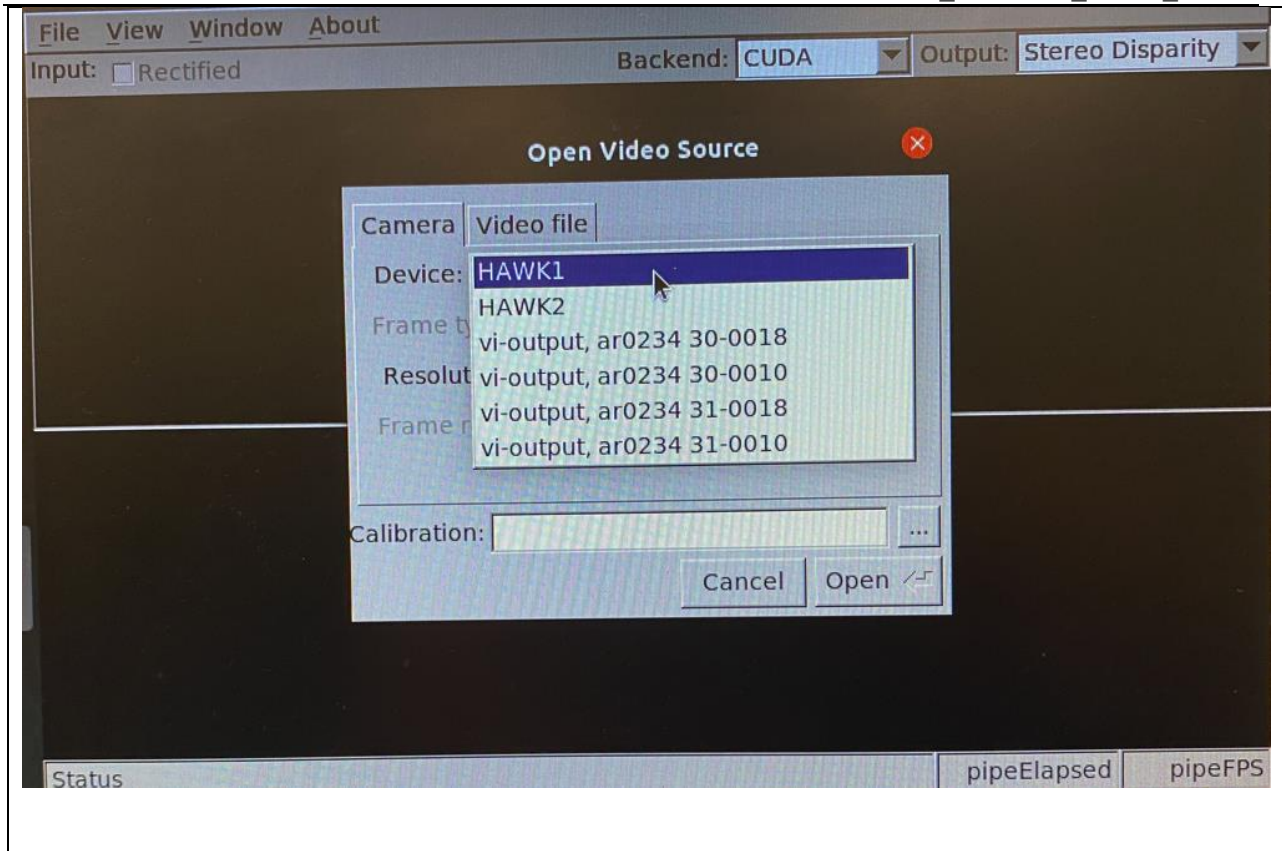


Figure 5: The “vpi_demo_stereo” application window’s selections for using two HAWK1 and HAWK2 cameras to stream 3D depth images from two LI-AR0234CS-STEREO-GMSL2-30 cameras.

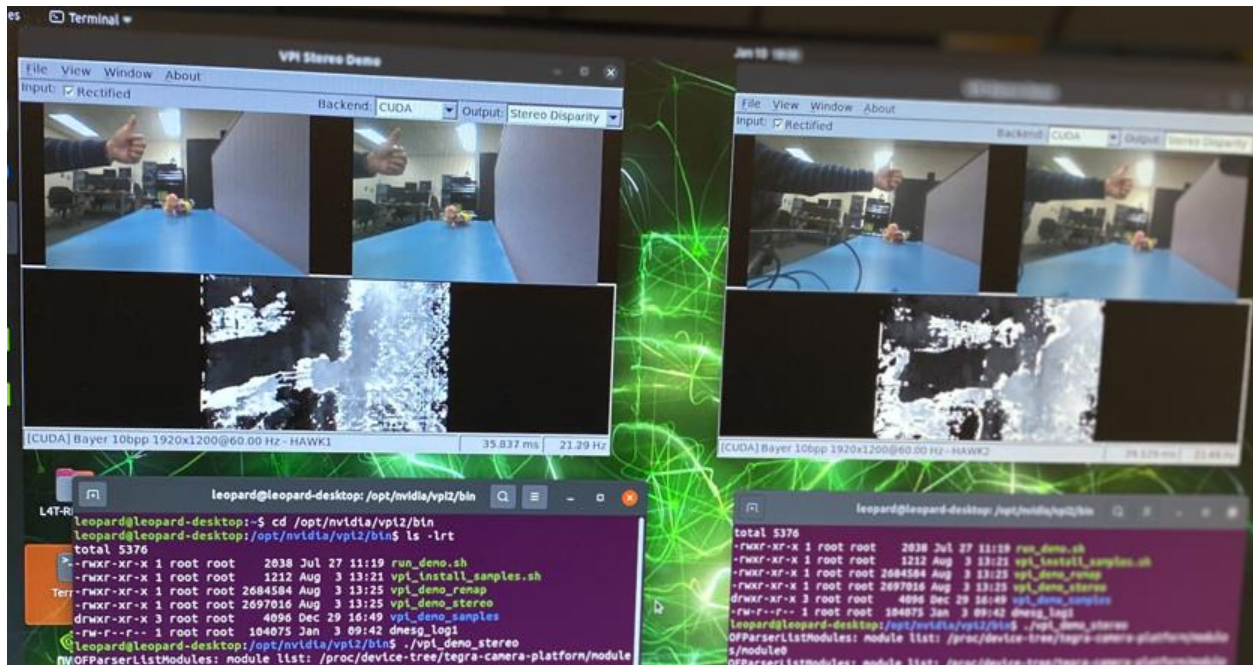


Figure 6: Mono color 3D depth images displayed from two Hawk cameras (LI-AR0234CS-STEREO-GMSL2-30) using the “vpi_demo_stereo” application.