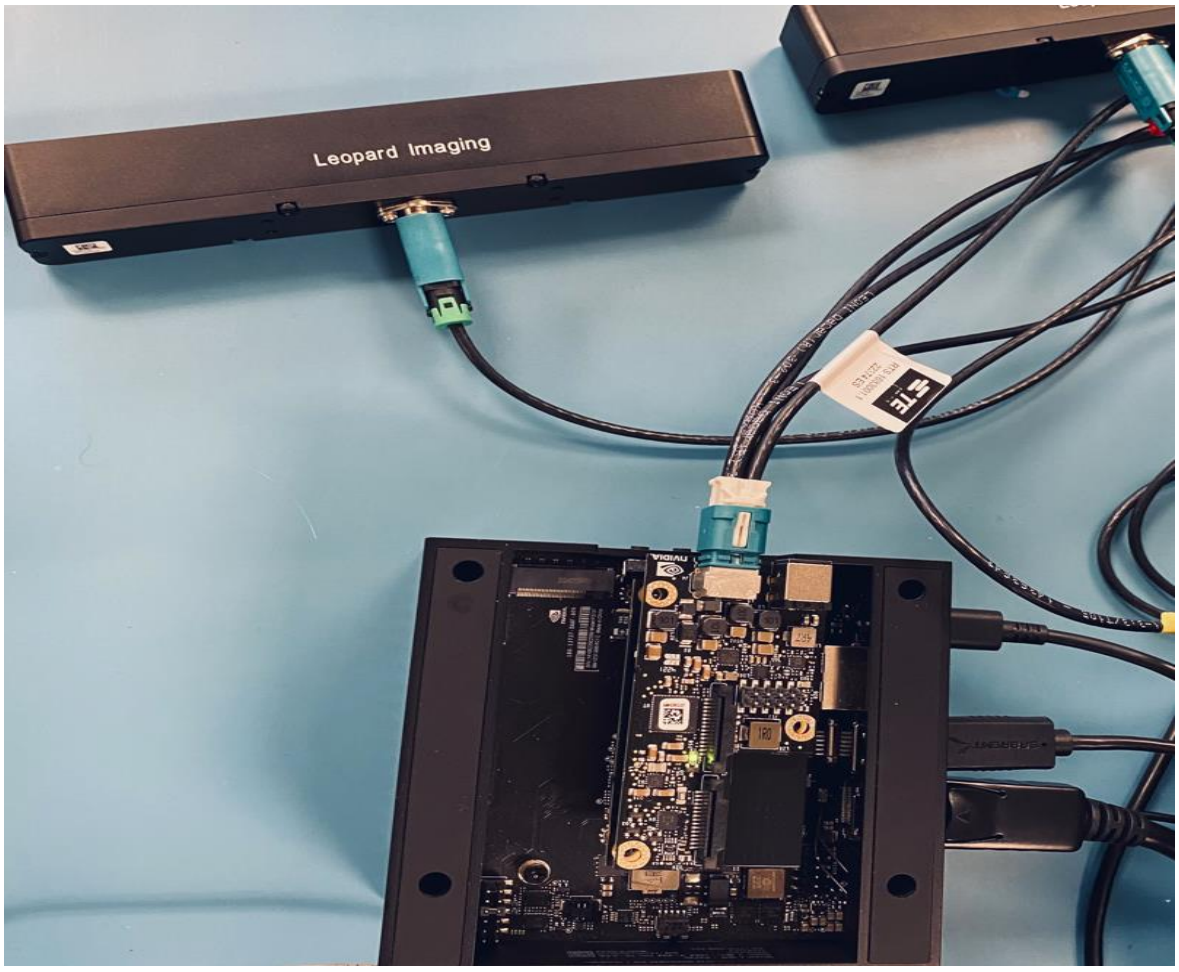
Overview

This driver is designed for LI-AR0234CS-GMSL-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 R35.5.0 (Jetpack 5.1.3)

Download link

https://www.dropbox.com/scl/fo/f7nldto73p7122v6d479x/h?rlkey=7rlge60ia85xlk5l83pt7yjhy&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
2024_03_29		03/29/2023	Xixian Xing	

Updates

Revision	Description	Release Date
2023_10_19	First Release based on R35.4.1	10/19/2023
2024_03_29	Update the driver to R35.5.0	03/29/2024

Known bugs

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

Note: You don't have to connect all two cameras. One camera (on port1) works too.

Driver installation:

1. Download the R35.5.0 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.

R35.5.0 OS Image:
https://www.dropbox.com/scl/fo/xjf55q5twhc3bag494qti/h?rlkey=styaguzbmt9g45byuoq9vflau&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/5.10.192-tegra/kernel/drivers/media/i2c/max96712.ko
sudo rm /lib/modules/5.10.192-tegra/kernel/drivers/media/i2c/nv_ar0234.ko
sudo rm /lib/modules/5.10.192-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/nvca
m/settings/
nvidia@nvidia-desktop:~/Downloads$ sudo chmod 664 /var/nvidia/nvcam/settings/cam
era_overrides.isp
nvidia@nvidia-desktop:~/Downloads$ sudo chown root:root /var/nvidia/nvcam/settin
gs/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/51kjxlwtiqbxtto8vjgpb/Jetson_Multimedia_API_R35.5.0_aarch64.tbz2?rlkey=xb5l1wv7d32rfjdbnw75qz2o3&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_R35.5.0_aarch64.tbz2

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:

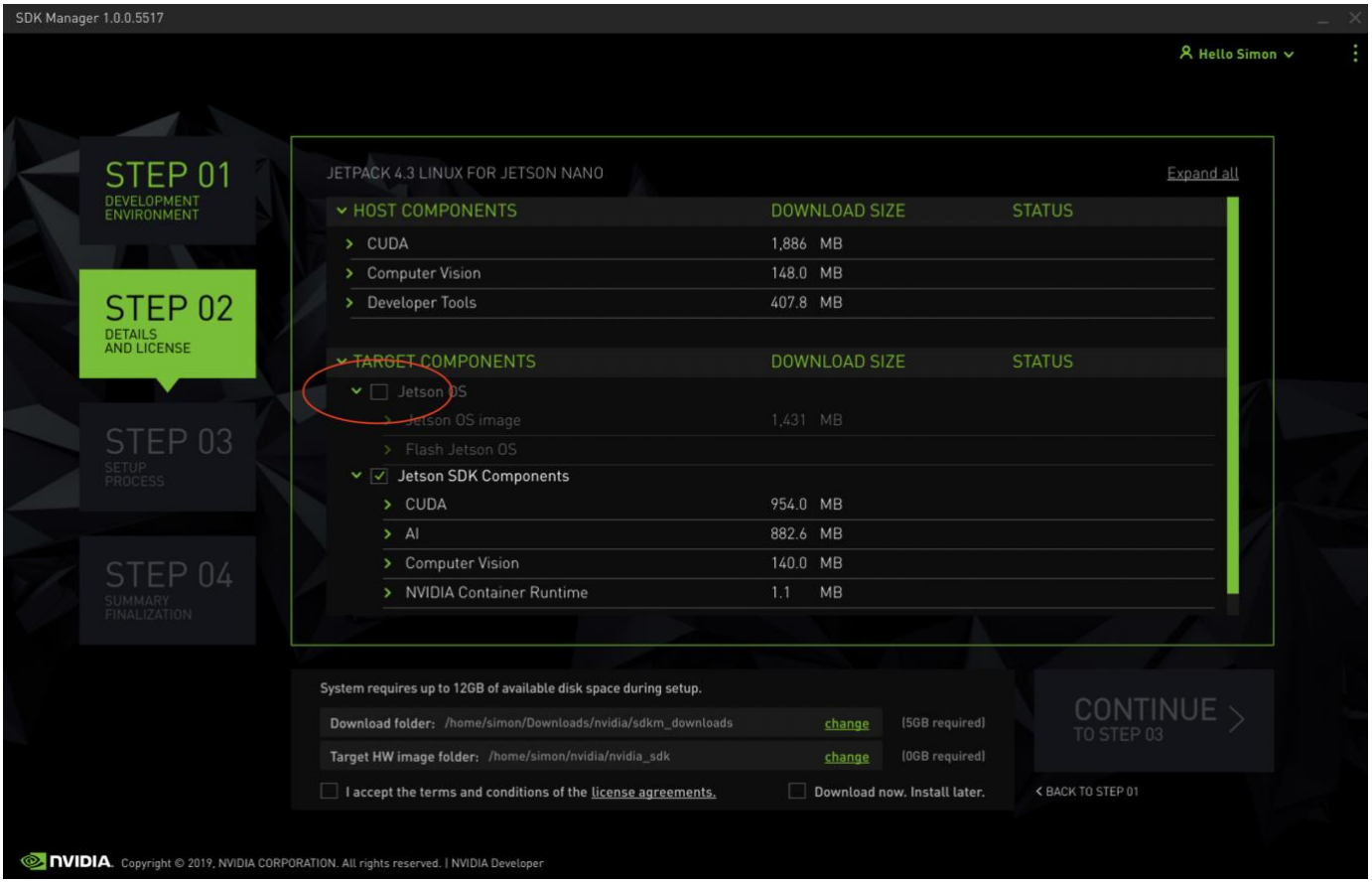
1) The 0 can be changed to 1 ~ 3 to use other lens or/and cameras.
   Video #0 is the left lens of the first Hawk camera.
   Video #1 is the right lens of the first Hawk camera.
   Video #2 is the left lens of the second Hawk camera.
   Video #3 is the right lens of the second Hawk Camera.

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 5.1.3 but don’t want to re-flash the whole OS image, you can uncheck the Jetson OS and install the Jetson SDK components only.



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/scl/fi/223jc02ed1b59v1l0oc1d/kernel_srcR35.5.0.tbz2?rlkey=irw6p2qpuhaf19rra79xcpw29&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 arrch64--glibc--stable-final.tar.gz

2) Copy "kernel_src_R35.5.0.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 xvfp kernel_src_R35.5.0.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_20240329_dtbs.patch
   patch -p1 < ar0234_dual_hawk_gmsl2_max96712_35.4.1_Xavier_Orin_20240329_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.btz2 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_y_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_y_raw
```

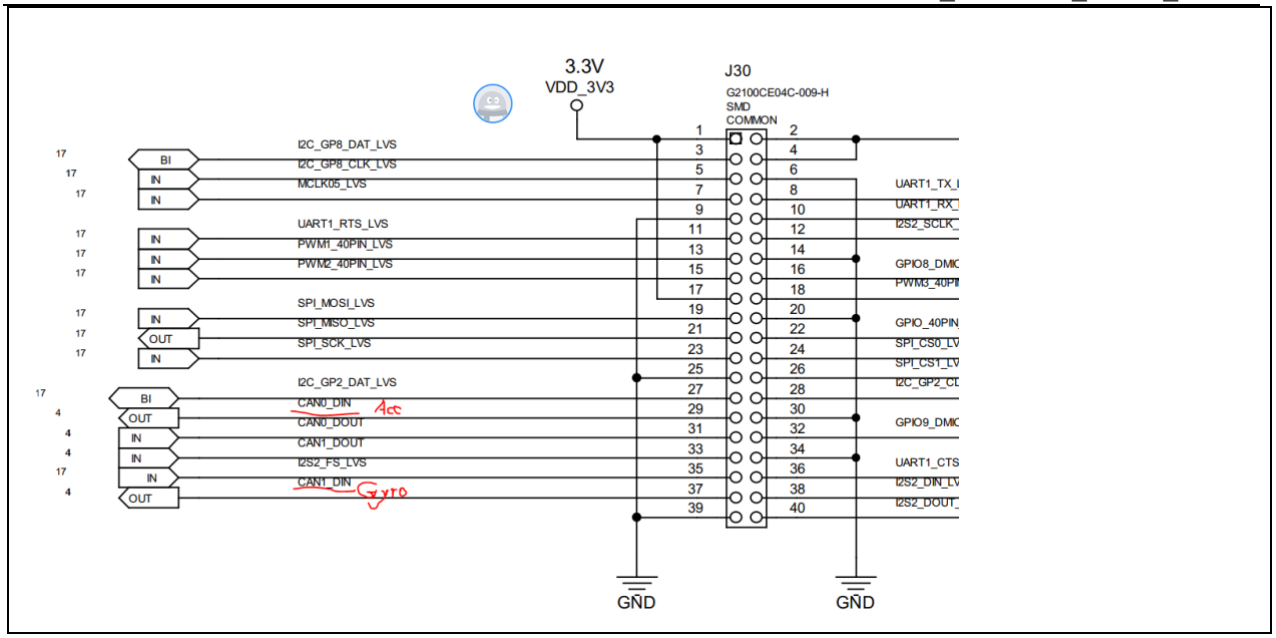


Figure 1: IMU used pins in jetson AGX Orin's pinout header is shown in this picture.

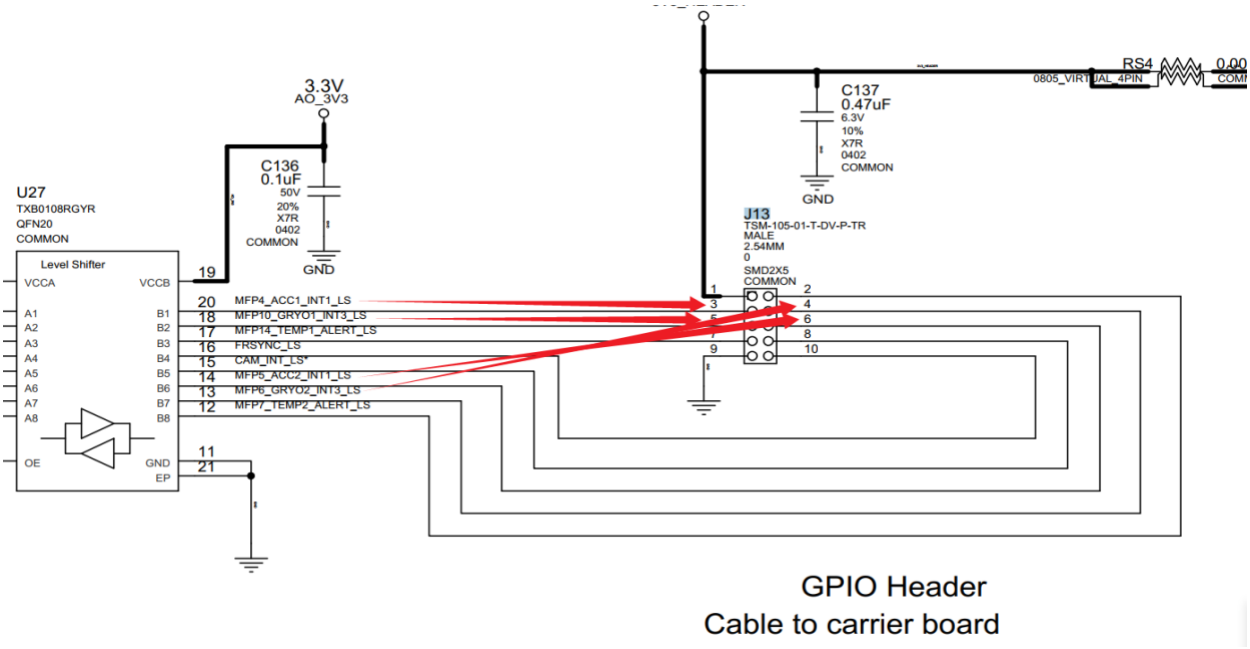


Figure 2: IMU used pins in E3653-A03 adapter board's J13 header is shown in this picture.

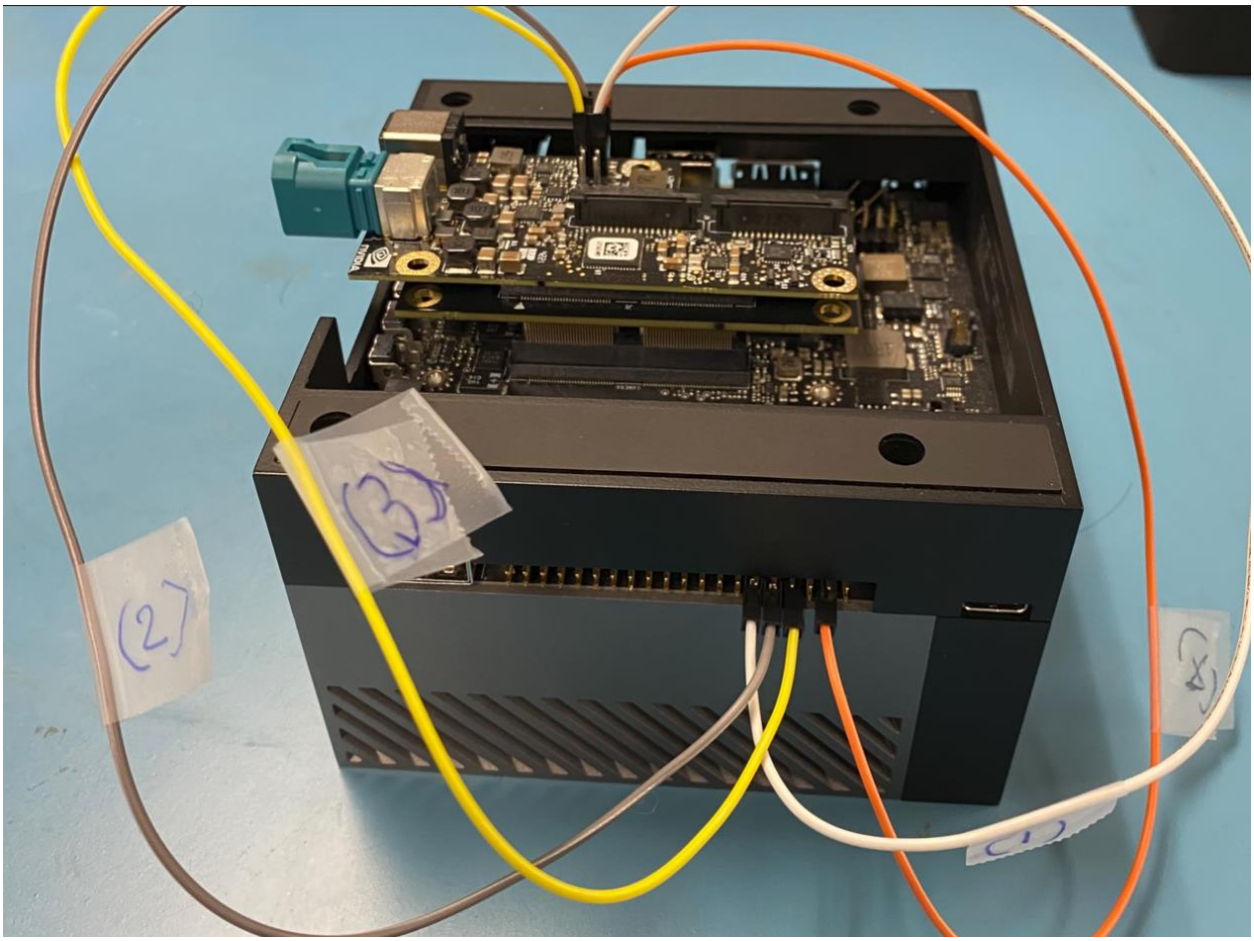


Figure 3: This picture shows the physical IMU test wire connections on the Jetson AGX Orin system with E3653-A03 adapter board.

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

```
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_GRYO2_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_GRYO1_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_GRYO1_INT3_LS
      Pin 4 of E3653-A3 is MFP6_GRYO2_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 lef 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 COMPONETS” 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_samples.sh ~/Downloads/
```

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 “File” -> “Open” 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.

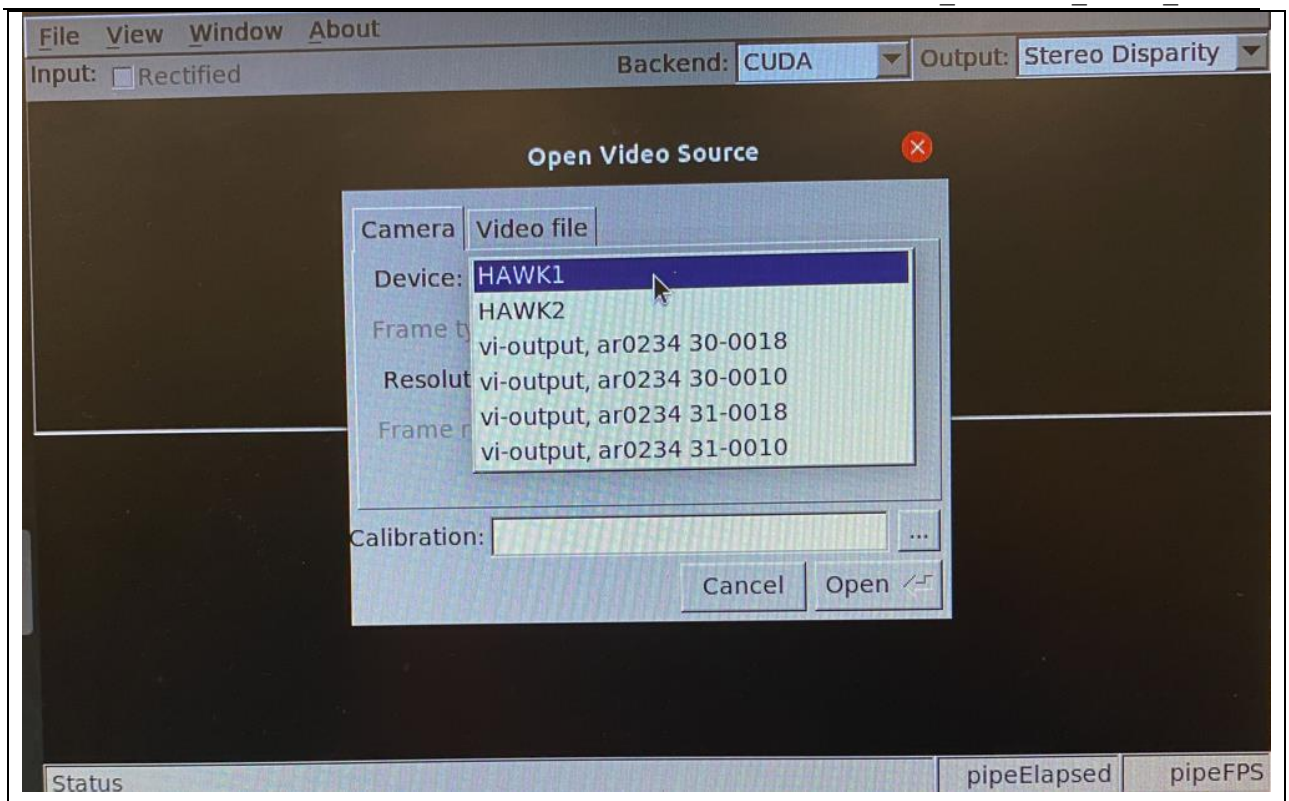


Figure 5: The "vpi_demo_stereo" application window's selections for using two HAWK1 and HAWK2 cameras to stream 3D depth images from two LI-AR0234CS-STEREO-GMSL2-30 cameras.

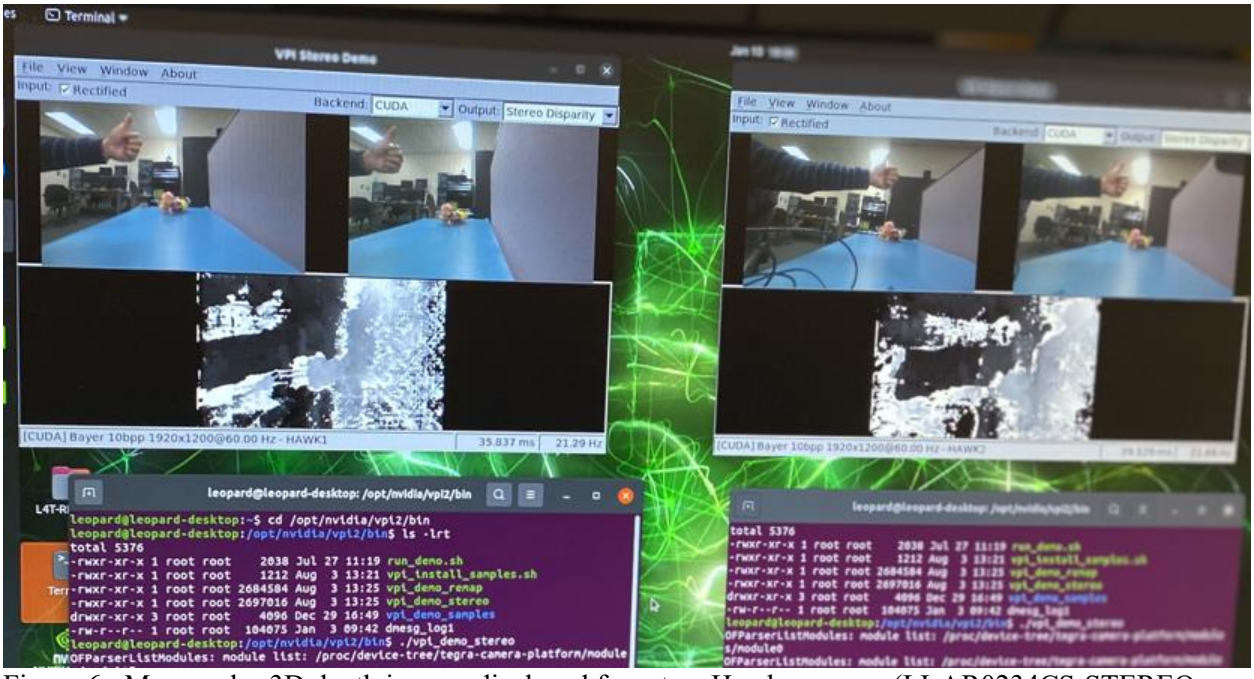


Figure 6: Mono color 3D depth images displayed from two Hawk cameras (LI-AR0234CS-STEREO-GMSL2-30) using the "vpi_demo_stereo" application.