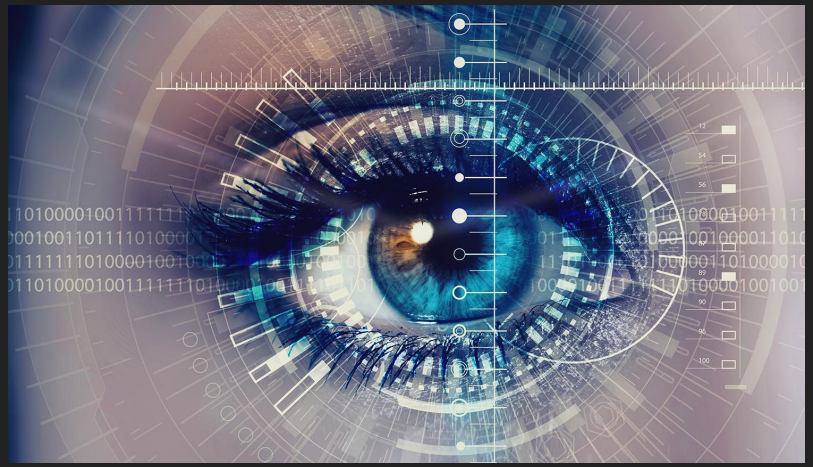
# Camera interface Trade Study

# Big picture of the system



# Processor board: Ultra 96

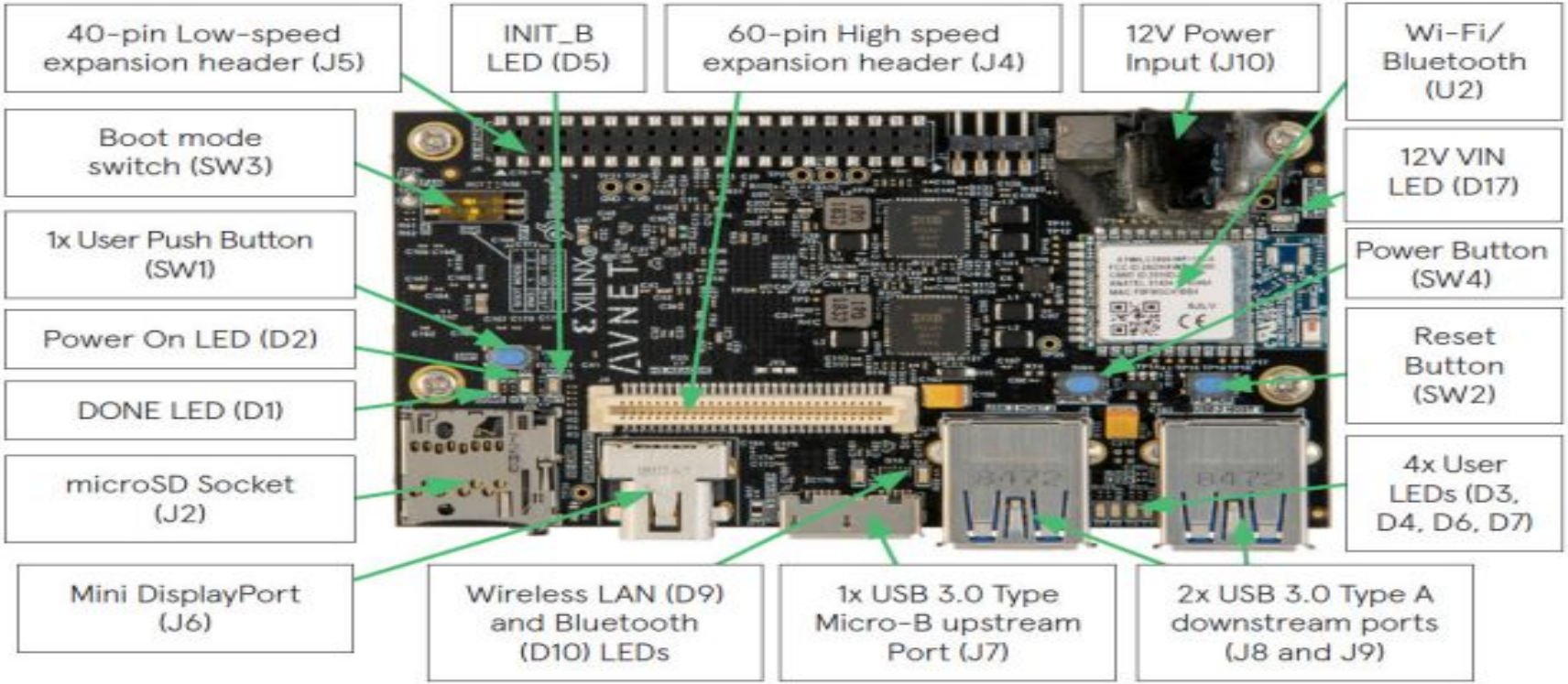



**Figure 3 – Ultra96-V2 Topology**

# MIPI: Mobile Industry Processor Interface

LVDS: Low Voltage Differential Signaling

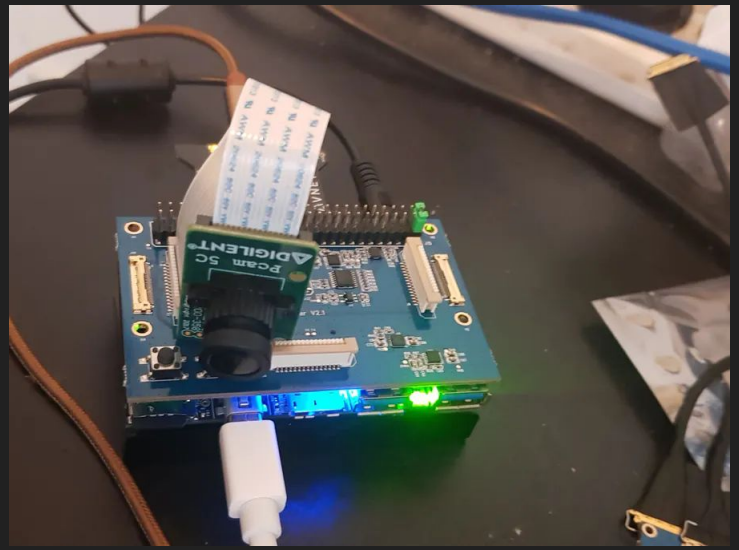
MIPI csi-2: is a sensor interface commonly used in embedded systems to connect an image sensor to an embedded circuit board that controls it and processes image data

Product:

96 Boards DUAL MIPI Adapter Mezzanine

OV5640

PCam5



Building a MIPI CSI-2 Video Pipeline in Programmable Logic

Doing image processing in Ultra 96 (OpenCV)

Advantage: stable, fast, compatibility

Predictable issue: technical ( port collection - complex interface - requires effort )

### 5.1.3.2 High Speed Expansion Connector

Ultra96 provides a 96Boards compatible High Speed Expansion Connector. An Amphenol FCI 61082-061409LF (or compatible) 60 pin low profile 0.8mm receptacle is specified.

Table 4 shows the pinout of the High Speed Expansion Header (Ultra96 column) and the differences from the 96Boards specification (96Boards column). With the exception of SD, I2C2 and I2C3, all dedicated interfaces specified by 96Boards are replaced with GPIO. All HP_GPIO are routed as differential pairs.

Table 4 – High Speed Expansion Connector

| Xilinx | 96Boards | Pin # |
|---|---|---|
| PS_SPI0_MOSI | SD_DAT0/SPI1_DOUT | 1 |
| n/c | SD_DAT1 | 3 |
| n/c | SD_DAT2 | 5 |
| PS_SPI0_CS | SD_DAT3/SPI1_CS | 7 |
| PS_SPI0_SCLK | SD_SCLK/SPI1_SCLK | 9 |
| PS_SPI0_MISO | SD_CMD/SPI1_DIN | 11 |
| GND | GND | 13 |
| HD_GPIO_CC | CLK0/CSI0_MCLK | 15 |
| HD_GPIO_CC | CLK1/CSI1_MCLK | 17 |
| GND | GND | 19 |
| HP_GPIO_CC+ | DSI_CLK+ | 21 |
| HP_GPIO_CC- | DSI_CLK- | 23 |
| GND | GND | 25 |
| HP_GPIO+ | DSI_D0+ | 27 |
| HP_GPIO- | DSI_D0- | 29 |
| GND | GND | 31 |
| HP_GPIO+ | DSI_D1+ | 33 |
| HP_GPIO- | DSI_D1- | 35 |
| GND | GND | 37 |
| HP_GPIO+ | DSI_D2+ | 39 |
| HP_GPIO- | DSI_D2- | 41 |
| GND | GND | 43 |
| HP_GPIO+ | DSI_D3+ | 45 |
| HP_GPIO- | DSI_D3- | 47 |
| GND | GND | 49 |
| USB_D+ | USB_D+ | 51 |
| USB_D- | USB_D- | 53 |
| GND | GND | 55 |
| HP_GPIO | HSIC_STR | 57 |
| HP_GPIO | HSIC_DATA | 59 |

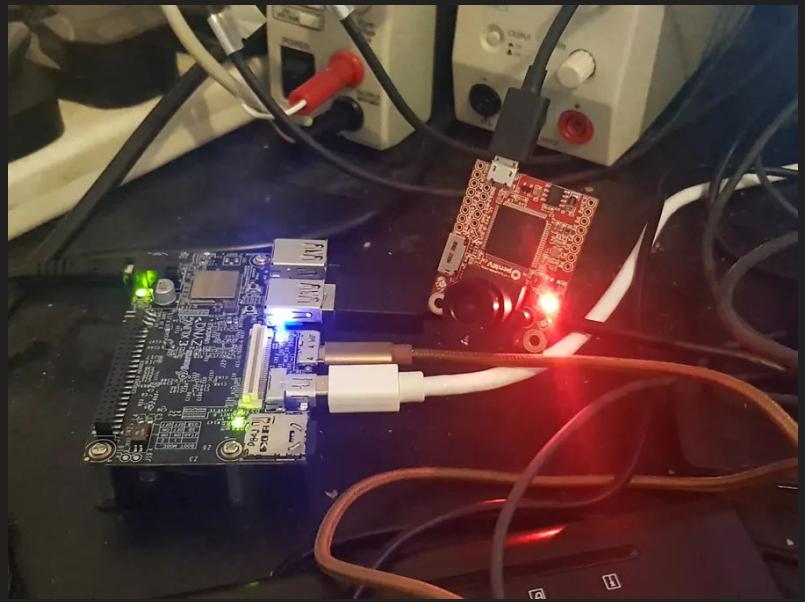
| Pin # | 96Boards | Xilinx |
|---|---|---|
| 2 | CSI0_C+ | HP_GPIO+ |
| 4 | CSI0_C- | HP_GPIO- |
| 6 | GND | GND |
| 8 | CSI0_D0+ | HP_GPIO+ |
| 10 | CSI0+D0- | HP_GPIO- |
| 12 | GND | GND |
| 14 | CSI0_D1+ | HP_GPIO+ |
| 16 | CSI0_D1- | HP_GPIO- |
| 18 | GND | GND |
| 20 | CSI0_D2+ | HP_GPIO+ |
| 22 | CSI0_D2- | HP_GPIO- |
| 24 | GND | GND |
| 26 | CSI0_D3+ | HP_GPIO+ |
| 28 | CSI0_D3- | HP_GPIO- |
| 30 | GND | GND |
| 32 | I2C2_SCL | PS_I2C0_SCL |
| 34 | I2C2_SDA | PS_I2C0_SDA |
| 36 | I2C3_SCL | PS_I2C1_SCL |
| 38 | I2C3_SDA | PS_I2C1_SDA |
| 40 | GND | GND |
| 42 | CSI1_D0+ | HP_GPIO+ |
| 44 | CSI1_D0- | HP_GPIO- |
| 46 | GND | GND |
| 48 | CSI1_D1+ | HP_GPIO+ |
| 50 | CSI1_D1- | HP_GPIO- |
| 52 | GND | GND |
| 54 | CSI1_C+ | HP_GPIO+ |
| 56 | CSI1_C- | HP_GPIO- |
| 58 | GND | GND |
| 60 | Reserved | Reserved |

# USB: Universal Serial Bus

Its characteristic is the communication line is simple, as long as a pair of transmission lines can achieve two-way communication, thus greatly reducing the cost, especially suitable for long-distance communication, but the transmission speed is slower.

Product:

OpenMV



OpenMV Camera can offload some of the image processing to the camera. Meaning the image frames received by our Ultra96 already have faces identified, eyes tracked or Sobel filtering, it all depends on how we set up the OpenMV Camera.

Advantage: Easy to connect with Ultra96, flexibility

Disadvantage: slow,

MIPI CSI-2 offer more bandwidth than USB 3.0 (5 Gbit/s)

# Requirements Table

| | weights | USB camera | MIPI camera | Score USB | Score MIPI |
|---|---|---|---|---|---|
| Latency | 3 | 3 | 5 | 9 | 15 |
| Accuracy | 9 | 5 | 5 | 45 | 45 |
| Memory | 5 | 5 | 1 | 25 | 5 |
| Cost Impact | 1 | 5 | 5 | 5 | 5 |
| Schedule impact | 7 | 6 | 2 | 42 | 14 |
| Technical opportunity | 5 | 5 | 3 | 25 | 15 |
| Technical Risk | 9 | 5 | 2 | 45 | 19 |
| Total | | | | 196 | 118 |

# Reference

MIPI:

https://www.hackster.io/bluetiger9/stereo-vision-and-lidar-powered-donkey-car-575769#toc-8--mipi-adapter-for-ultra96-10

https://www.hackster.io/adam-taylor/mipi-procesing-with-ultra96-777721

USB:

https://www.hackster.io/adam-taylor/accelerating-image-processing-with-pynq-openmv-cam-50ba7a

Difference (Chinese version): https://www.weibo.com/ttarticle/p/show?id=2309404401905123066001