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# R-Car V3H, V3M Guidebook

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This Guidebook introduces pick out some features of the R-Car V3H and V3M Renesas Electronics. You can use this reference as investigation before introduction and consideration for design of application.

Proactive Partner  
Hitachi Industry & Control Solution, Ltd.



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Introduction

This R-Car V3H and V3M Guidebook aims to collect and deliver the information that the Sler want to know from a lot of materials and information about R-Car. We will improve our content while listening to the opinions of our customer.

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- Update contents after Autumn of 2021.  
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- Precautions

- This Guidebook is introduction as an application example of R-Car, but the content is not guaranteed. It is necessary to verify the feasibility according to the customer’s application. In addition, application examples may be changed without notice.
- For the specifications of R-Car, please check the hardware manual of R-Car or our “Online Consultation”.
- The contents of this Guidebook may change or delete without notice.

# 1. Features and applications of R-Car V3H and V3M

In R-Car V3H and V3M, characteristic hardware is prepared for Computer Vision, is prepared, and we will introduce examples of using these functions in applications.

Fig. 1 is a block diagram that abstracts the functions of R-Car V3H and V3M. There are ISP,IMR,IMP, and CNN as distinctive functions, and we will introduce the functions and usage of each.

## 1. ISP( Image Signal Processing)

It is a function to process the RAW data output from the CMOS sensor, and you can create your own image processing by combining it with the sensor. If the camera has an ISP, use the camera image without image processing.

Use the R-Car ISP when you need your own image processing for smart cameras, 3D surround views, driver monitors, etc.

## 2. IMR(Image Rendering Unit)

It can be used for camera lens distortion correction and viewpoint conversion. By using this function, it is faster than CPU processing and the CPU load can be reduced.

## 3. IMP(Image Recognition Engine)

Accelerator for fast image recognition, improving the efficiency of hardware and software CPU and image recognition. With this IMP, various processes required for image recognition can be processed at high speed.

## 4. CNN

A module that enables high-speed execution of convolutional neural networks. R-Car CNN Toolchain can be used in combination with various Deep learning opensource libraries.

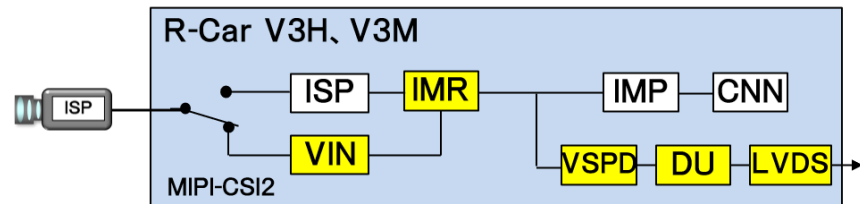


Fig.1 Abstract functional block diagram.

## 2. Other functions of R-Car V3H and V3M

1. VIN(Video Input Module)  
The video input module is a video capture module that provides the functionality of color space conversion. When using ISP with camera, connect with VIN.
2. VSPD(Video Signal Processor)  
Images can be overlaid, rotated, and scaled. With this function, you can process images such as surround view.
3. DU(Display Unit)  
This module inputs image data from VSPD and outputs it to LDVS. Adjust the display size, display position, display format, and superimposition of planes.
4. LVDS(Low Voltage Differential Signal)  
It input RGB signals (display control signal and display data) from DU, converts them to LVDS, and outputs various timing signals for driving the LCD panel.
5. MIPI-CSI2(Mobile industry Processor Interface/Camera Serial Interface2)  
It's Camera Serial Interface 2 receiving module compatible with MIPI CSI-2 V1.1 and D-DHY V1.1.

# 3. Camera connection to MIPI-CSI2

Image input from the camera is required for front cameras, surround view, driver monitors, etc. With R-Car V3H and V3M camera can be connected to MIPI-CSI2(Fig.2 connection example.) Use a Serializer and Deserializer to extend the connection distance between the camera and R-Car. Fig. 3 show a diagram in which the camera and R-Car are connected by a serializer and a Deserializer. A Serializer is an LSI can convert a parallel signal into a serial signal, perform high - speed serial communication with the Deserializer , and output a parallel signal.

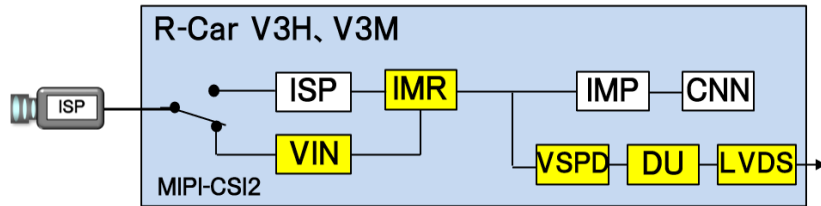


Fig.2 Connecting a camera to MIPI-CSI2.

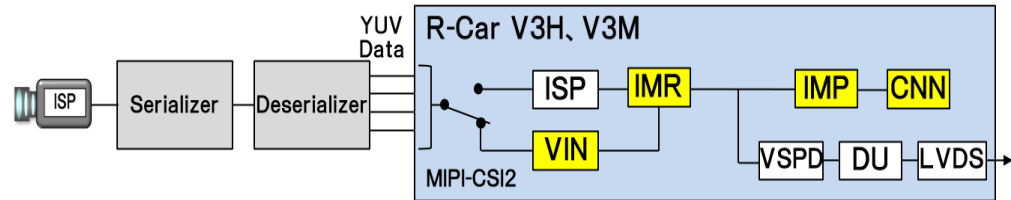


Fig.3 Camera connection by Serializer and Deserializer .

MIPI-CSI2 has 4-lanes connection, and the specifications differ between R-Car V3H and V3M.

- R-Car V3H: Ut to 6Gbps data speed is available with one camera, or 4-lanes of input with data speed up to 1.5Gbps per lane.
- R-Car V3M: Ut to 4Gbps data speed is available with one camera, or 4-lanes of input with data speed up to 1Gbps per lane

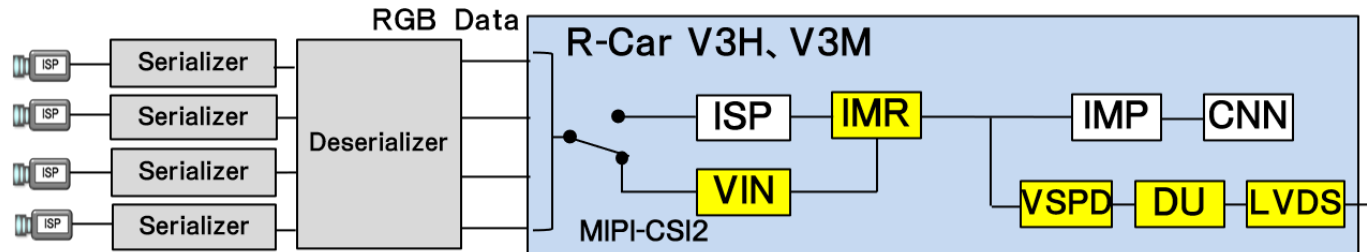


Fig.4 Connect four cameras with Serializer and Deserializer .

# 4. Camara and ISP

Fig. 5 shows the internal blocks of the camera with ISP and the camera without ISP. The image sensor used in the cameras shown in Fig. 5 and Fig. 6 converts light into an electrical signal and outputs RAW data. RAW data is unprocessed sensor data, which is different from the image format, so image processing is required with ISP (Image Signal Processor) to view it as an image or recognize it. ISP-equipped cameras provide prepared image processing, but they are difficult to customize and the price of the camera itself is high. Camera costs can be reduced by using R-Car V3H and V3M ISPs. Image recognition requires image processing such as a monochrome camera and customization, and custom processing is available with R-Car v3H and V3M.

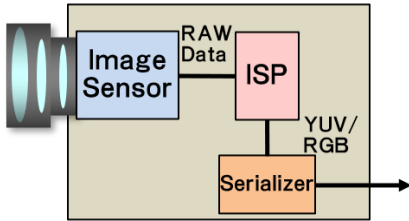


Fig.5 Camera with ISP.

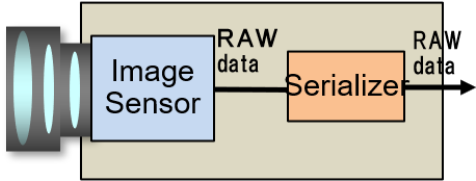


Fig.6 Camera without ISP.

The connection method with MIPI-CSI2 is the same for cameras with and without ISP. Fig. 7 Shows how to connect one camera. Fig. 8 Show how to connect 4 cameras.

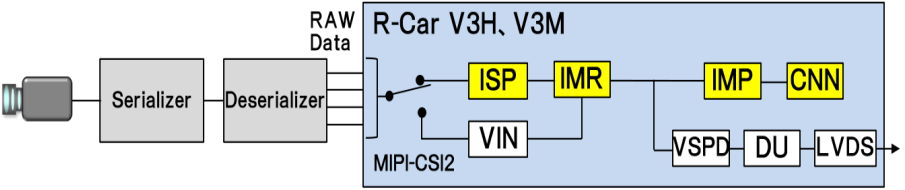


Fig.7 Connect a camera without an ISP to MIPI-CSI2

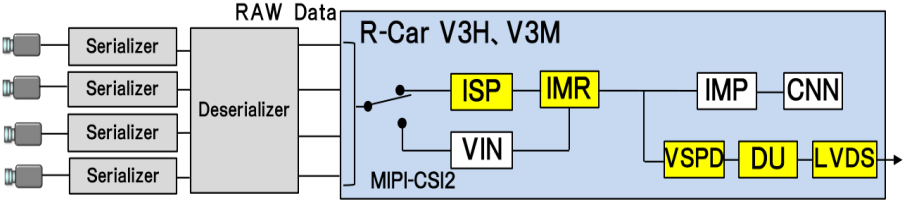


Fig.8 Connect 4 cameras without ISP to MIPI-CSI2

# 5.Use R-Car ISP

Dedicated software is required to use R-Car’s ISP. Fig.9 shows ISP software when using a camera without ISP function. The part surrounded by the red frame in Fig.9 shows ISP software, and it is necessary for the customer to develop it independently or to customize it be based on ISP software provided by R-Car consortium partner.

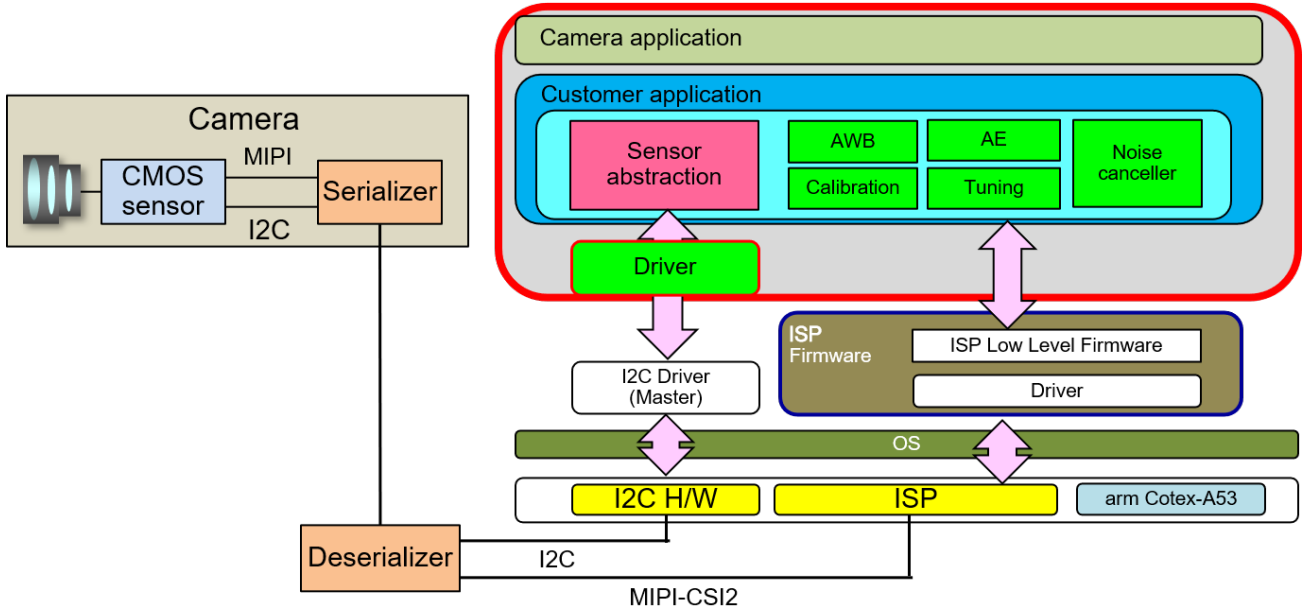


Fig.9 Camera connection without ISP function and ISP software.

-For customers using R-Car V3H and V3M ISP.  
If you need R-Car ISP usage or software, please use consulting.

# 6.IMR distortion correction unit

## Functions and usage of IMR

Dedicated hardware developed to correct image distortion. Development is required because software is not prepared.

-Distortion correction( 3D surround view) of Fisheye lens.

A fisheye lens can distort the subject and see a wide range, but since it is difficult to distinguish the subject from the captured image, so use the distortion correction function to correct the distortion.

-Distortion correction of Camera lens.

Use the distortion correction function of IMR to flatten and correct the distortion of the lens image of the camera.

By it is dedicated hardware accelerator, the load of the CPU can be reduced.

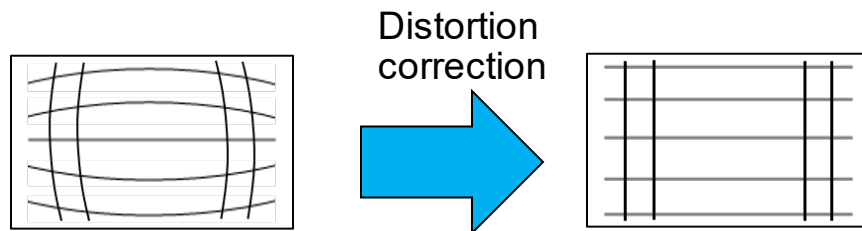


Fig.10 Camera lens distortion correction.

-For customer who use IMR  
If you need R-Car IMR usage or software, Please use consulting.

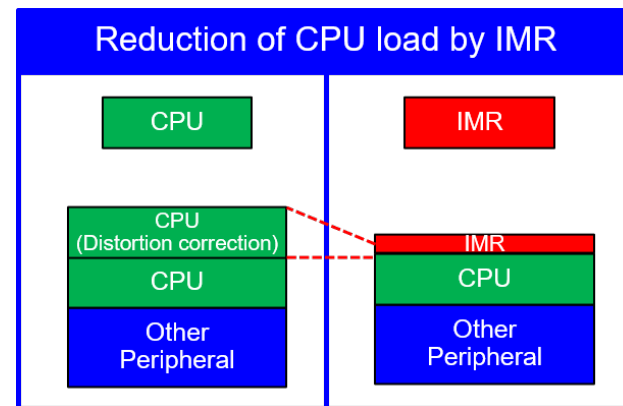


Fig.11 Reduction of CPU load by IMR.



# 7. IMP image recognition engine

In R-Car V3H and V3M, there is an accelerator optimized for image recognition. This accelerator requires software that uses dedicated instructions. Software provided by **Renesas Electronics**. This accelerator is different from OpenCV's highly abstracted API, so you can't use the image recognition program created with OpenCV. API need to be changed.

Fig.12 Show the difference between the library for using the IMP accelerator and API of OpenCV.

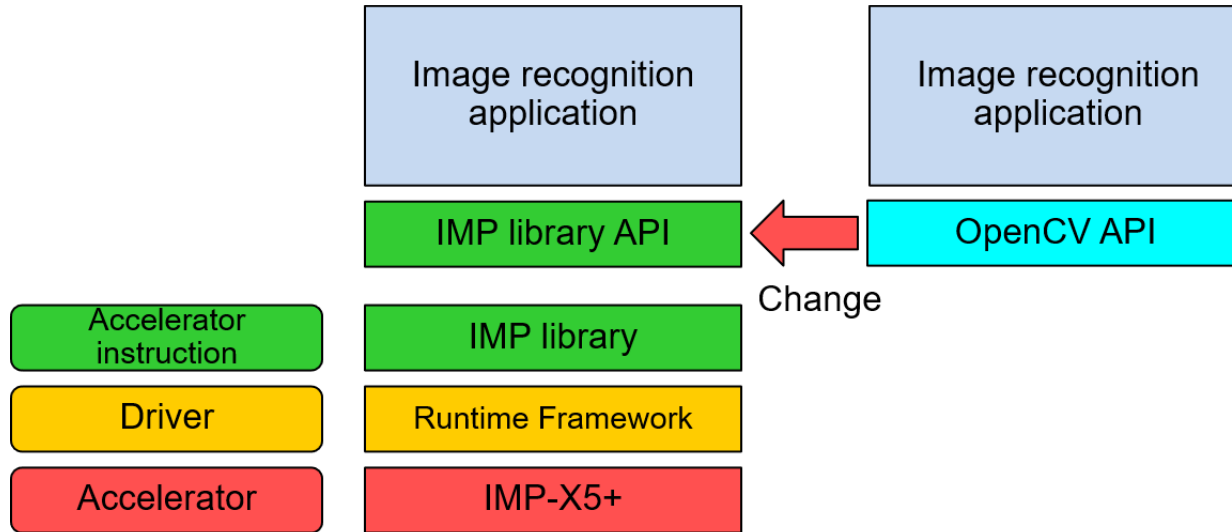


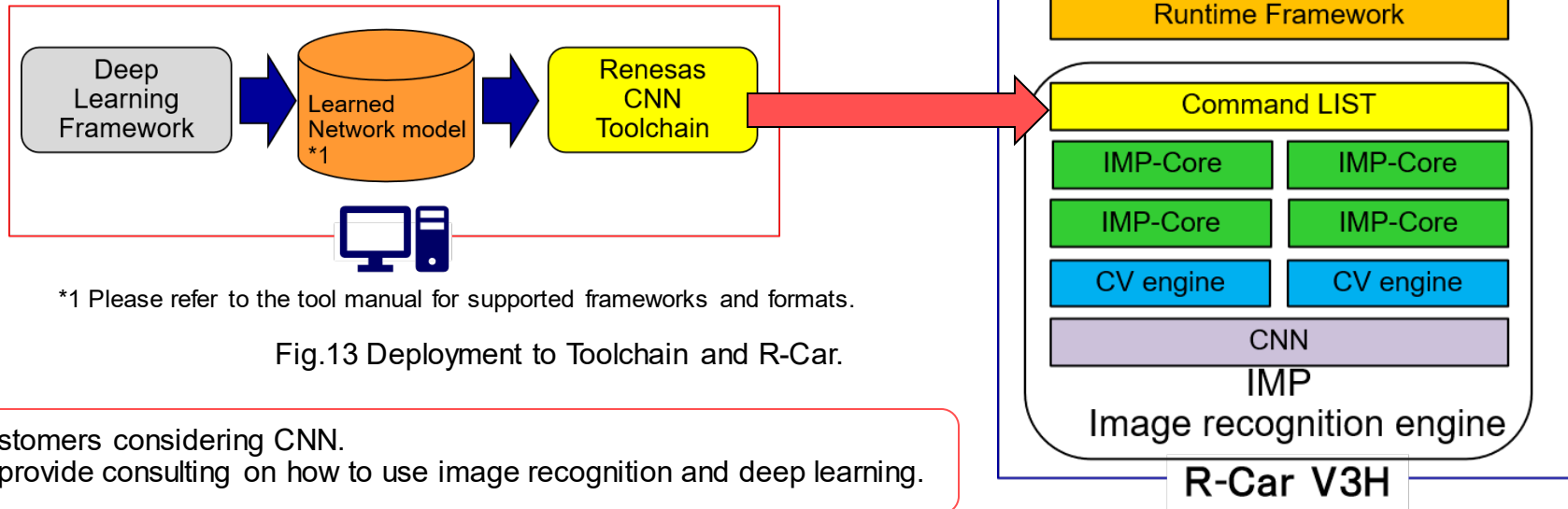
Fig.12 Difference between IMP library and OpenCV API.

-For customers who use the IMP library  
When using the IMP library, please use consulting if you need to change the API.

# 8.CNN and Toolchain

Deep learning is used for object detection and object recognition. Deep learning improves the image recognition rate by the learning model in which layers that perform various operations are networked in addition to convolution operations. CNN Toolchain is a conversion tool for executing pre-learned deep learning network models on R-Car V3H and V3M. CNN Toolchain selects the most suitable accelerator form CNN and IMP according to the type of layer that composes the model, and converts it into a format that can be executed on the device. Can be downloaded from the Renesas Electronics website.

<https://www.renesas.com/document/swr/renesas-r-car-cnn-toolchain>



\*1 Please refer to the tool manual for supported frameworks and formats.

Fig.13 Deployment to Toolchain and R-Car.

-For customers considering CNN.  
We provide consulting on how to use image recognition and deep learning.

# 9. At the end

## Production Hitachi Industry & Control Solutions, Ltd.

As an R-Car Sier, a company that sells R-Car sublicense, develops custom BSP, and provides various OS platforms.

- Automotive SoC Consulting Service. [https://info.hitachi-ics.co.jp/product/in-vehicle\\_sol/](https://info.hitachi-ics.co.jp/product/in-vehicle_sol/)
- R-Car Online Consulting [https://info.hitachi-ics.co.jp/product/in-vehicle\\_sol/contact\\_en/](https://info.hitachi-ics.co.jp/product/in-vehicle_sol/contact_en/)
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- Tsutomu Nakajima Hitachi Industry & Control Solutions, Ltd.

Engaged in camera connection with R-Car V3H and V3M, ISP software development, and in charge of customer guidance, consulting, and mass production design.

## Supervision / cooperation

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Marketing for R-Car V3H and V3M.

- Yasuhiro Yamakoshi Renesas Electronics Corporation.

Marketing and business development centered on R-Car for ADAS.