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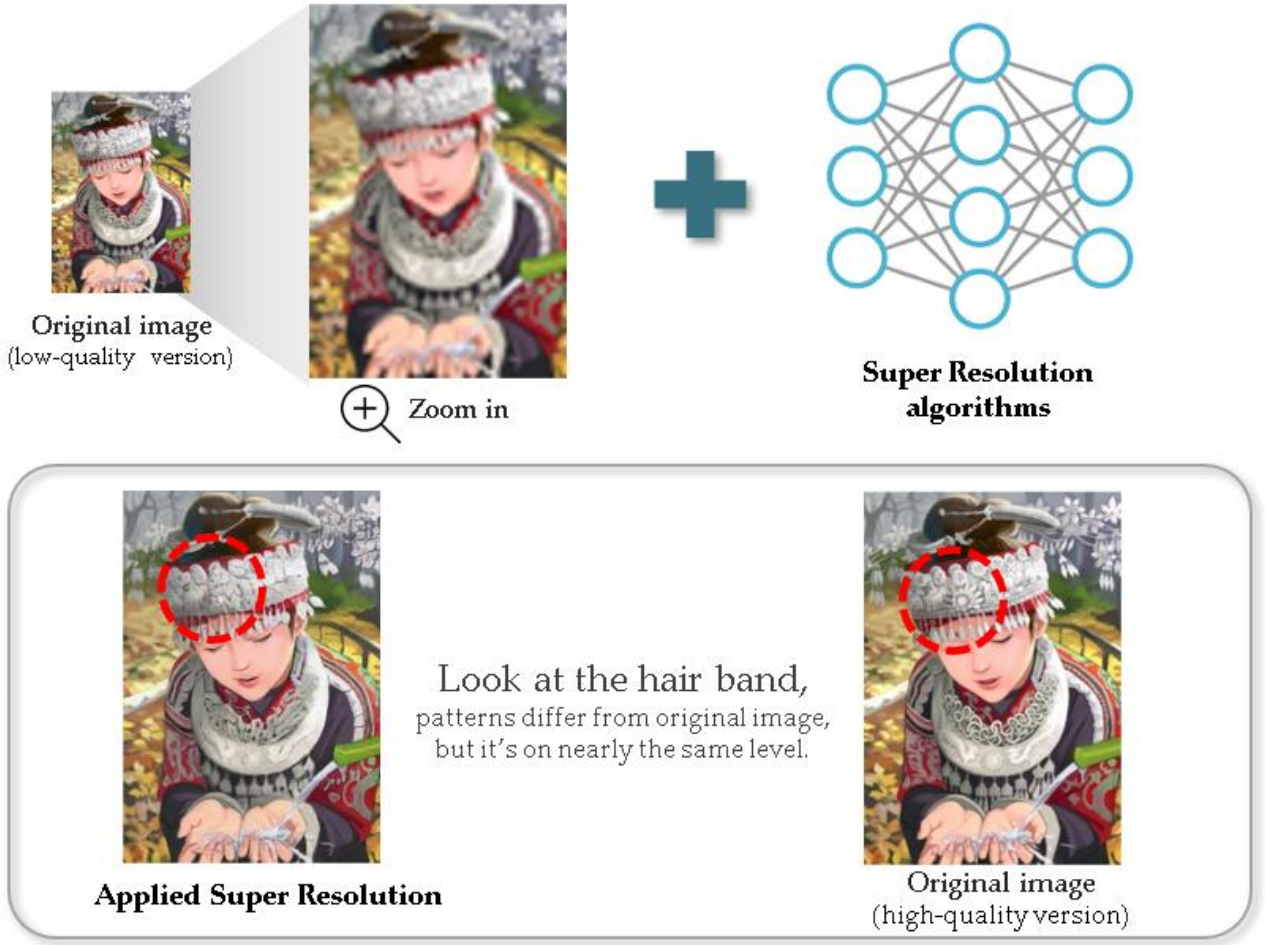
Super Resolution

IP LINE-UP: CV (Super Resolution)

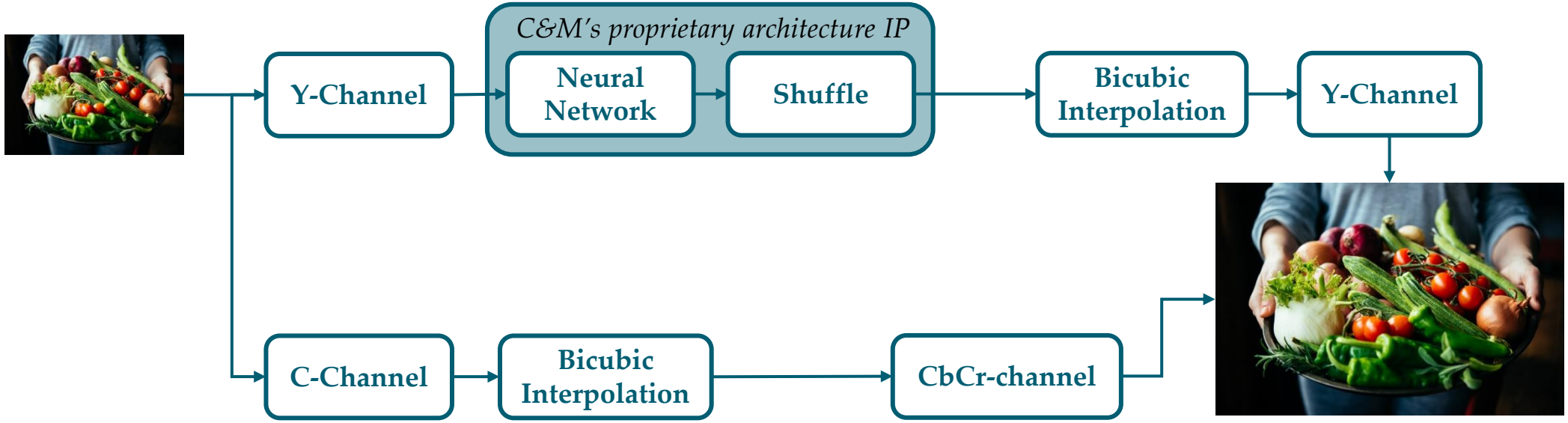
Upscaling and improving details within the video based on a **deep learning-based neural network super resolution HW IP, c.WAVE120**



<Steps of applying deep learning-based Super Resolution>

1) Basis of the massive set of training datasets
2) Extracts the feature points of an image or video
3) Splits them pixel by pixel
4) Applies the appropriate colors to fill in the missing parts of the data
5) Stitches them
6) Reproduces in sharper high-resolution image or video.

IP LINE-UP: CV (Super Resolution)



Super Resolution IP (as Upscaling) : c.WAVE120

- 8K60fps @550MHz
- Supported scaling ratio
  - X2.0 ~ x8.0 with x0.1 step
- Support On-the-fly and mem-to-mem mode
- # of parameters: 4K in Scale 2, 12K in Scale 4
- Normalized quantization for Weight/Feature map

- Convolutional Neural Network for Y-Channel
  - Features Extraction
  - Constructing HR Image
- No bandwidth required in On-the-fly mode
- Cost-effective high-quality IP

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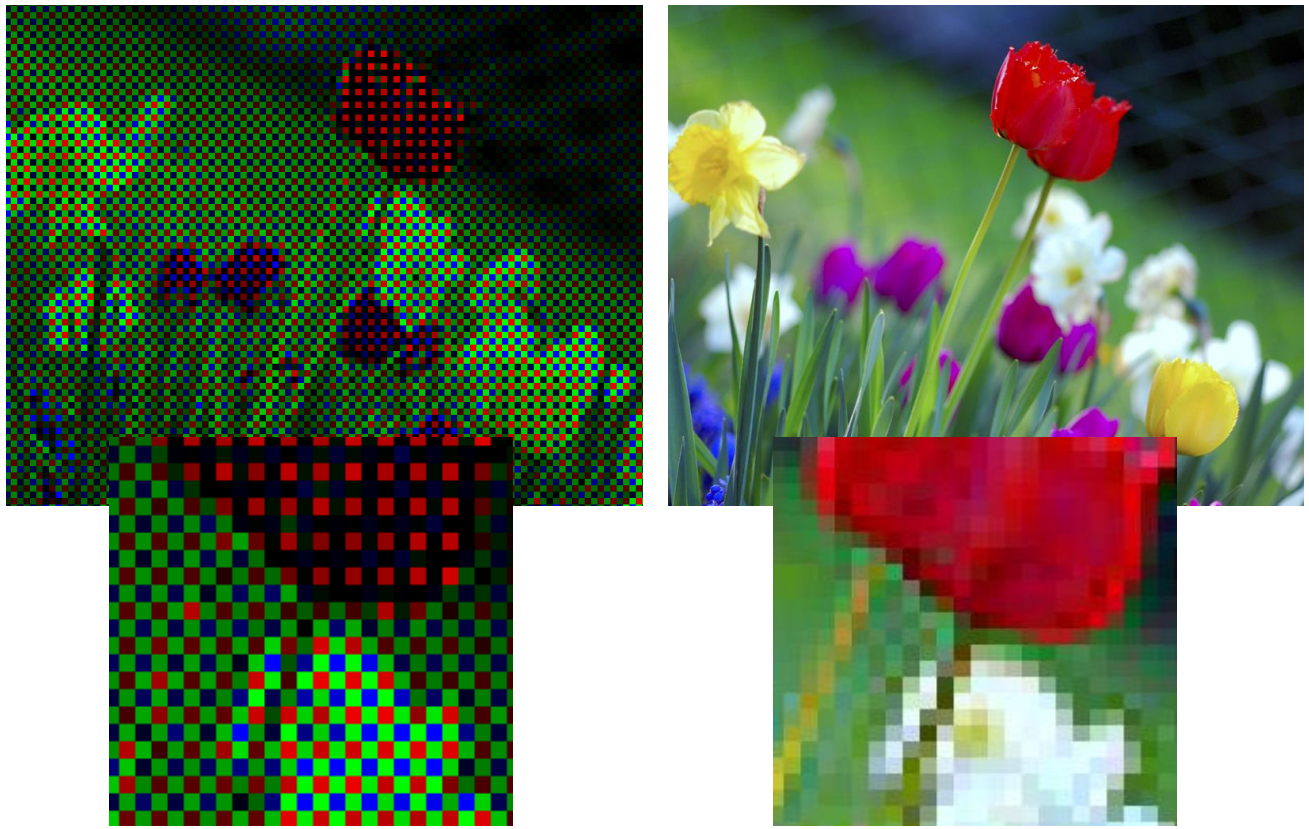
Image Signal Processing

IP LINE-UP: ISP (Image Signal Processing)

Image Signal Processing (ISP), a signal processing, is equipped with an end-to-end full-featured ISP IP that converts the sensor's signal into a more visible and processable format, enabling the more clear vision of the image.



Converts the data received from the camera sensor as if it were seen by the human's eye:

- Color Enhancement
- Noise Reduction
- Sharpness, etc.

IP LINE-UP: CP (Computational Photography)

Computational Photography (CP) improves the captured image by applying computational imaging techniques, enabling the more clear vision of the image.

<WITHOUT HDR>

<WITH HDR>

<WITHOUT 3DNR>

<WITH 3DNR >

Enhances the quality of images taken in a strong or poor lighting environments

- HDR (High Dynamic Range)
- 3DNR (3D Noise Reduction)

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IP LINE-UP: CP (Computational Photography)

KERBEROS – Lens Distortion Correction (with a wide angle) Example

<Original Image>

<Corrected Image>

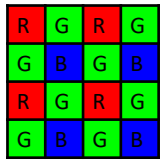
IP LINE-UP: CP & ISP

Expanded Product Map based on Data Flow

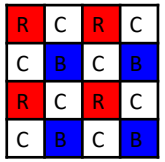
R : RTL Ready
C : C-model Ready
D : Demonstration Board Ready

Channel Support

RGGB

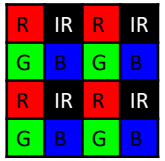


RCCB



<Under dev.>

RGB-IR



<Under dev.>

Inputs

Single Sensor

Multi Sensor(s)

	IP Name	Description	Exposure	MP	FPS	Base	Status *(R: RTL ready, C: C-model Ready, D: Demonstration Board Ready)*
Pre-Processing	NIX	Multi-Exposure HDR (WDR)	2	N/A	N/A		RCD
	STYX		3	N/A	N/A		C
ISP Processing	CARPO	Image Signal Processing	N/A	<2MP	30fps		RCD
	LEDA		N/A	<8MP	30fps		RCD
	METIS		N/A	<13MP	60fps		RCD
Post Processing	HYDRA	3D Noise Reduction	N/A	<8MP	30fps	MA *(Motion Adaptive)*	RCD
	CHARON	3D Noise Reduction	N/A	<8MP	30fps	ME *(Motion Estimation)*	RCD
	KERBEROS	Lens Distortion Correction	N/A	<5MP	30fps	FOV 180 degree	RCD

* Based on the selected foundry, the fps and MP's output may differ based on the foundry's process.

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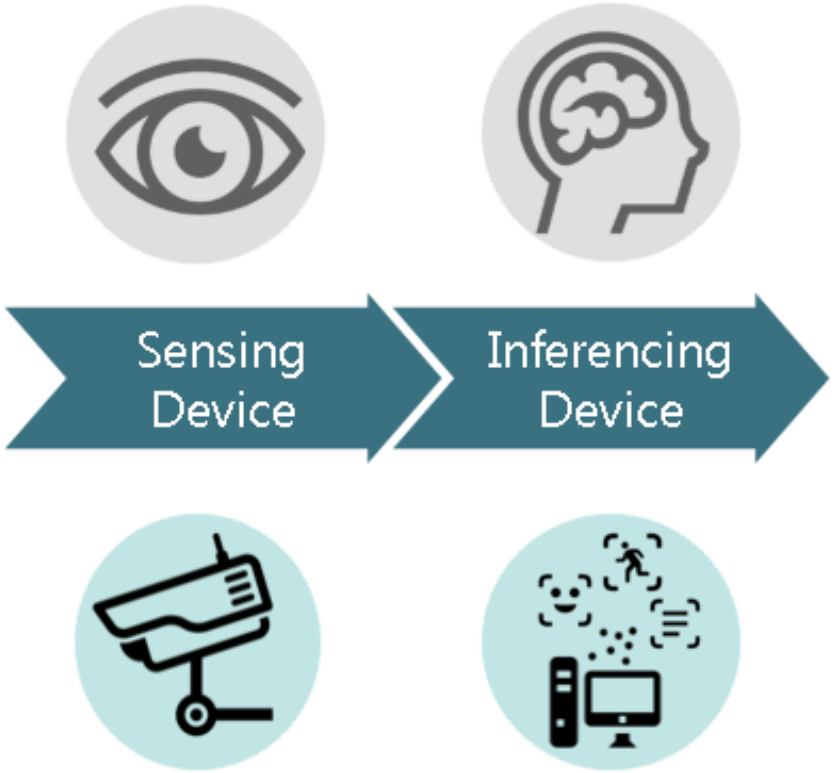
Object Detection

IP LINE-UP: CV (Object Detection)

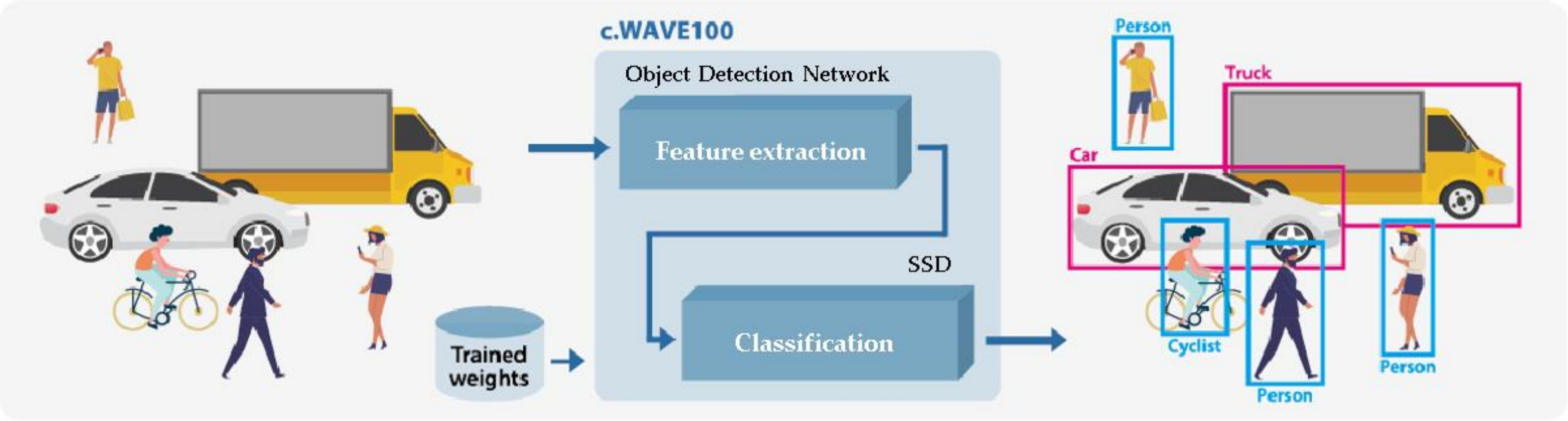
Based on neural network **deep learning-based object detection HW IP**; which detects objects by **up to 20 classifiers** from live or recorded data.

<Image or Video>



<Detection>

IP LINE-UP: CV (Object Detection)



Fully Hardwired Object Detection IP, c.WAVE100

- up to 20 classifier
- 2K inputs, 30 FPS

- **Application-Specific Neural Networks**
- **Quantization**
- 8-bit activation, 8-bit bias with dynamic fixed point
- **Per layer**
- Log-quantized weights

Network Dedicated Hardware IP

- **1,168 MACs in FLX (Full Layer Accelerators)**
- Optimized Area
- Multiply-less MAC operation, save 30% logic gates (compared to the typical MAC)

Fusing Layers

- Reduces bandwidth and less power consumption used
- Saves external memory bandwidth

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Thank You

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