Open Source Hardware / Software Collaboration by Renesas & Retronix

COSCUP 2025

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Who we are

Who I am

Engaged in OSS Software Enablement for R-Car SOC at Renesas

- Activities at Renesas (OSS development for R-Car SoC)
  - Write an R-Car driver code → Submit to the community upstream
  - Review code with the maintainer → Add device support into the mainline
  - Work with the community to maintain the code with every kernel version
  - Send team engineers to the community developer conference/meet-up
- External Activity (work with the community and consortium)
  - Leads LF project (AGL, Xen, Zephyr, yocto, CIP, OpenSSF), COVESA
  - Contribute to SOAFEE, Open SDV Initiative, Jaspar, Autosar, and others
  - Create POC using various contributed combining OSS components
  - Work with the community to realize OSS-based Safety (like ISO26262)

Support industry initiatives those aim large-scale OSS software

Who Renesas is

Renesas empowers a safer, smarter and more sustainable future where technology helps make our lives easier.

A leading global provider of microcontrollers, Renesas combines our expertise in embedded processing, analog, power and connectivity to deliver complete semiconductor solutions. These Winning Combinations accelerate time to market for automotive, industrial, infrastructure and IoT applications, enabling billions of connected, intelligent devices that enhance the way people work and live.

* Consolidated, as of December 31, 2024

Headquarters
Tokyo, Japan

Approx. 23,000
employees *

Operating in
30+ countries

1,348.5 billion yen
revenue in 2024

Approx. 20,000
patents & pending applications

Renesas solution offerings

Our mission is to develop a safer, healthier, greener, and smarter world by providing intelligence to our four focus growth segments: Automotive, Industrial, Infrastructure, and IoT that are all vital to our daily lives, meaning our products and solutions are embedded everywhere.

Automotive

Highly reliable vehicle control, safe and secure autonomous driving, Eco-friendly electric vehicles

Industrial

Lean, flexible and smart industry

Infrastructure

Robust infrastructure, enabling safety and efficiency

IoT

Comfortable, safe and healthy lifestyles through IoT

Broad and Scalable Product Portfolio

Microcontrollers & Microprocessors, System-on-Chips (SoCs)

- **RZ** — High-end 32/64-bit MPUs
  High-resolution HMI, Industrial network & real-time control
- **RA** — Advanced 32-bit MCUs
  Arm ecosystem, Advanced security, Intelligent IoT
- **RX** — High Power Efficiently 32-bit MCUs
  Motor control, Capacitive touch, Functional safety, GUI
- **RISC-V products** — General-purpose 64-bit MPUs (RZ/Five Group)
  Application-specific 32-bit MCUs
- **RL78** — Ultra-low Energy 8/16-bit MCUs
  Bluetooth® Low Energy, SubGHz, LoRa®-based Solutions
  Automotive actuators & sensors, Low-end ECUs
- **RH850** — Automotive 32-bit MCUs
  Rich functional safety and embedded security features
- **R-Car** — Automotive SoCs
  Next generation of automotive computing

Analog and Power Devices

- Analog products
- Clocks & Timing
- Interface & Connectivity
- Memory & Logic
- Power & Power management
- Programmable Mixed-signal, ASIC, & IP products
- RF products
- Sensor products
- Space & Harsh environment

- Timing
- Wireless Power
- Battery Management
- Power Devices
- Power Management
- Sensors
- Video & Display

Renesas is committed to healthy growth of Open Source

We are a first-class citizen in the OSS community

- We follow "Upstream First" to fully eliminate in-house tree. Always work with community to add new device support into mainline kernel.
- We continue maintaining merged code for EVERY version of kernel , and that contribute a lot to security patch backport effort.
- We adopt LTS kernel for the production BSP, and migrate them every year.
- Strive to be OPEN not only for the code, but also for document and dev-board access.

Marged Linux kernel patch number count
From Apr.16 **2005** to Jul.24 **2025**
Total 1,265,698 patches from 907 companies

No.1	Unknown	239,127	18.89%
No.2	Intel	132,016	10.43%
No.3	Red Hat	97,489	7.70%
No.4	Hobbyists	79,729	6.30%
No.5	Novell	48,974	3.87%
No.6	Linaro	46,423	3.67%
No.7	IBM	40,870	3.23%
No.8	AMD	40,483	3.20%
No.9	Google	37,618	2.97%
No.10	Huawei	26,651	2.11%
No.11	**Renesas Electronics**	**24,606**	**1.94%**
No.12	Oracle	22,952	1.81%
No.13	Texas Instruments	18,634	1.47%
No.14	Samsung	18,585	1.47%
No.15	NVIDIA	15,597	1.23%
No.16	ARM	12,713	1.00%
No.17	NXP	12,399	0.98%
No.19	Mellanox Technologies	11,521	0.91%
No.21	QUALCOMM	10,027	0.79%
No.23	Broadcom	9,654	0.76%
No.27	Linux Foundation	7,718	0.61%
No.28	Code Aurora Forum	7,079	0.56%
No.29	Analog Devices	6,742	0.53%
No.31	MediaTek	5,647	0.45%
No.33	Marvell	5,275	0.42%
No.35	Freescale	4,699	0.37%
No.38	STMicroelectronics	4,269	0.34%
No.39	Facebook	4,266	0.34%

https://www.remword.com/kps_result/all_whole.html

Who Retronix is

ABOUT Retronix

Founded in 2006, Retronix Technologies is a leading Taiwanese provider of embedded IoT solutions and smart automotive electronics. As the first to launch Renesas R-Car-based platforms in Taiwan, it delivers CMS, digital clusters, and custom ECUs with deep software-hardware integration.

Retronix has become a Renesas Preferred Partner as well as an R-Car Consortium Proactive Partner.

Work Scope & Core Capabilities

- Embedded platform bring-up: R-Car V4H, V3H2, H3/M3
- OS support: Linux, QNX, Android Automotive (from IPL to application)
- Hardware design: architecture, layout, BOM optimization
- Sensor & SerDes integration: Sony, OVT, ONSEMI, Maxim
- System platform: BSP, drivers, MCU firmware, R46 pre-test
- Software stack: middleware, ISP tuning, CNN/DOF/GPU, AI Vision SDK
- In-house lab tuning, optical testing, and full ECU system development

Raptor R-Car V4H High-Performance AI SOM

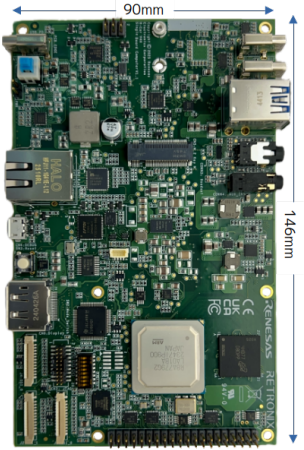
”SparrowHawk”
yet another embedded AI hacker board

HW / SW concept

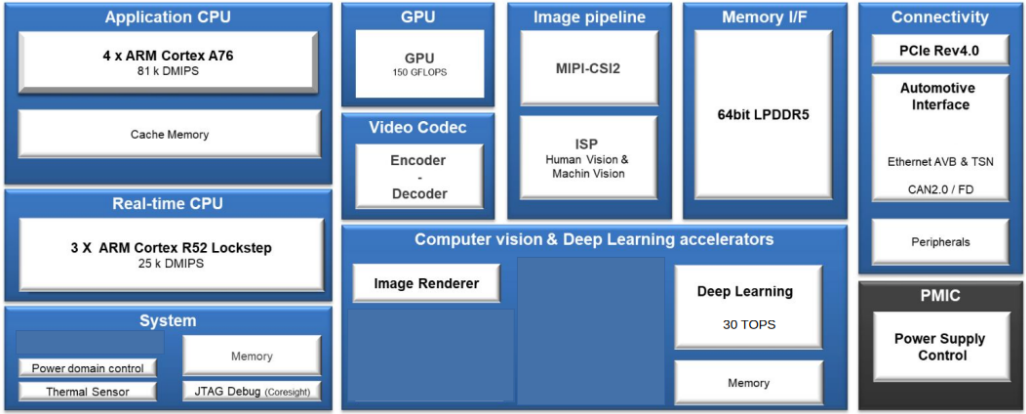
SparrowHawk: Accelerated Edge AI capable hacker board

Single Board Computer using Renesas R-CarV4H

- CPU = 4x CA76 (81k DMIPS), 3x CR52
- GPU = IMG AXM-8-256 (150GFLOPS)
- NPU = Renesas CNNIP engine (30TOPS)
- RAM/ROM = 8GB/16GB LPDDR5, 64MB QSPI Flash
- Camera = 2x 4-Lane MIPI Camera RPi Style
- Ethernet= 1x 1Gbps (AVB support)
- PCIe = 1x M.2 Key-M、USB = 4x USB 3.0 Port
- Audio = 1x Headphone, 1x Audio Input
- I/O = RPi HAT style 40-Pin header



R-Car V4H: Renesas 4th generation Vision Processing SoC

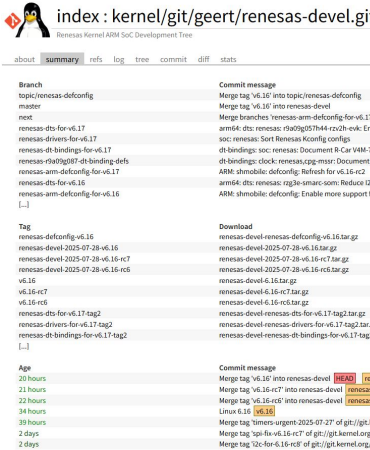


https://www.renesas.com/en/products/r-car-v4h#overview

SparrowHawk: Open SDK

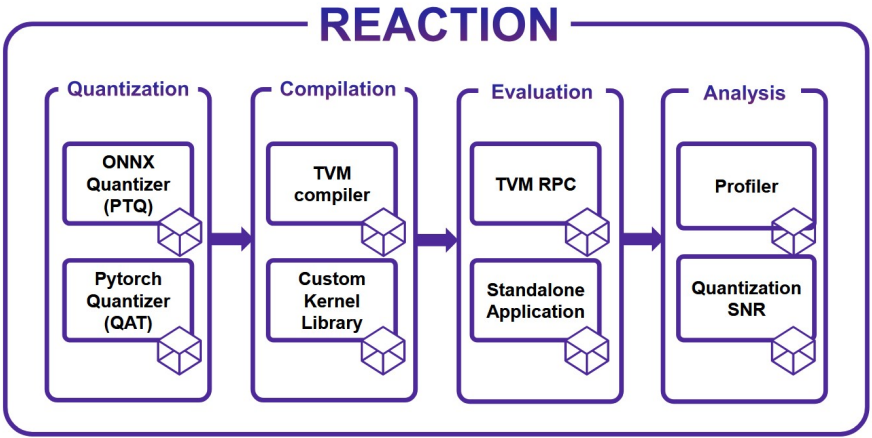
An OSS stack to enable edge-AI applications

- Eliminate time-consuming paper NDA requirement
- Easy-to-Access (board, SW, Document,..)
  - Camera: MIPI-camera (RPI camera)
  - Power: USB PD (65W - 100W)
- Collection of cutting-edge OSS components
  - uboot (2025.07)
  - Linux (6.12 = latest LTS kernel)
  - Ruby Installer to select userland
  - Userland: yocto (Scarthgap 5.0) / Debian (bookworm 12) / And more
  - OSS AI tool support (ONNX, PyTorch, TVM,...)



Accelerated Edge-AI support

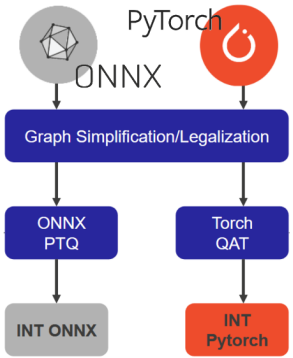
Renesas Edge AI Compilation Tool Into Optimized Networks



REACTION: AI-assisted low-code and user-friendly tools

Optimal way to utilize AI acceleration with your model

- Granular control of each step of model conversion
- Support ONNX, PyTorch format inputs
- Supports BYOM, BYOD and BYOC
- Optimization (Quantization) for edge-AI execution
  - Post Training Quantization (PTQ)
  - Quantization Aware Training (QAT)
- Unify multiple steps in single toolchain
- Custom node implementation

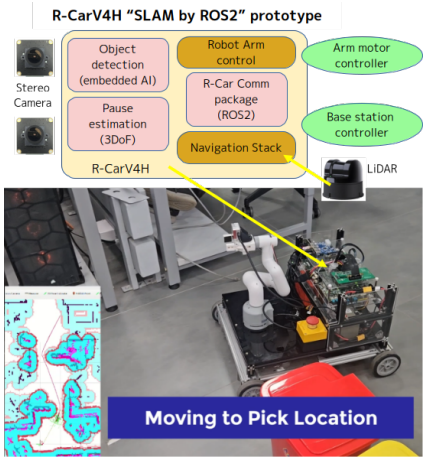


Renesas plan to provide CNNIP-optimized model at our Model Zoo

SparrowHawk AI application example: Autonomous SLAM Robot

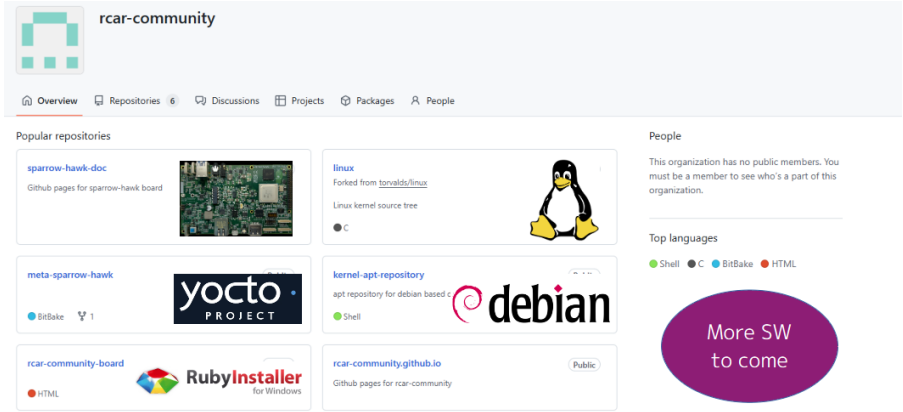
Our Autonomous Robotics prototype

- Stereo image processing
  - Visual SLAM (depth detection)
  - Accelerated object detection (YOLOv8)
  - 3-DoF Pose estimation
- Autonomous Robot-base navigation
  - URDF (Unified Robot Description Format) for accurate robot modeling
  - SLAM (Simultaneous Localization and Mapping) for map building and localization in dynamic environments
  - Nav2 for path planning and autonomous navigation



Stress-free resource Access

Code access (maintained in github named rcar-community)



https://github.com/rcar-community

Document access (we edit contents progressively)

Sparrow Hawk Contents

1. Introduction
2. Hardware
    1. Sparrow Hawk Information
    2. Sparrow Hawk Picture
    3. Switches Assignment
        1. Boot mode
        2. Other switch
    4. Debug Serial
    5. Caution
3. Software Version List
4. Quick Start How To
    1. How to build
    2. How to flash
        1. Flashing loader
        2. Flashing OS image into SD card
    3. How to boot
    4. How to run applications
        1. Software support list
        2. CAN
        3. Audio
        4. GPIO
        5. I2C
        6. USB3.0
        7. UART
        8. Thermal
        9. M.2
        10. Pi Camera
        11. Pi Display
        12. Pi Active Cooler
5. Tips
6. Known Issues & Restrictions

Introduction

This is the page for Sparrow Hawk board with R-Car V4H provided Retronix Technology Inc.

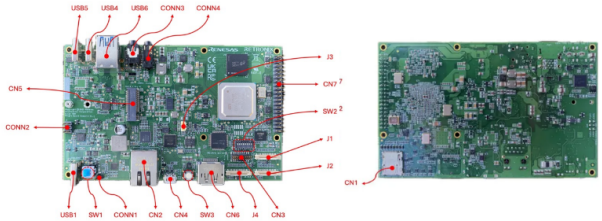
Hardware

Sparrow Hawk Information

R-Car V4H SoC Version	Board Information	Where to buy
v3.0	Click here	Click here

Sparrow Hawk Picture

left: top view, right: bottom view



https://rcar-community.github.io/Sparrow-Hawk/index.html

Where you can find (purchase) SparrowHawk?

You can buy SparrowHawk from online web store

- We are hoping that SparrowHawk (=SH) penetrate to broader industry, researcher, startups, and academia.
- Initially, SH is a product of Retronix (not Renesas). And they plan to sell SH through various online web channel.
- So far, SHIMAFUJI which is Japanese embedded board reseller, start treating SH.
- http://www.shimafuji.co.jp/en/products/2207

Our challenges & Summary

Hacker board challenges - and How We Raise the Bar

- Challenges in modern Hacker Boards
  - Hardware is getting powerful, but software complexity increases.
  - Open source tools often lack integration and documentation.
  - Access to hardware resources is limited due to NDA, license, or ecosystem lock-in.
  - Balancing performance, openness, and developer usability is difficult.
- Our Commitment with SparrowHawk
  - Keep SDK maintained with upstream-first OSS components.
  - Simplify access - NDA-free, well-documented, and freely available code & tools.
  - Engage with developer feedback - shape the future of embedded AI together.
  - Collaborate with global OSS communities and share real use cases.

Summary

- We developed SparrowHawk hacker board using Renesas R-CarV4H SoC.
- R-CarV4H is high-performance SoC including, 30TOPS embedded-AI, 81kDMIPS Quad-Arm Cortex, 150GFLOPS GPU, and more.
- As R-CarV4H can support multiple camera input, you can develop advanced image processing embedded-AI application, like autonomous robot.
- We deliver advanced embedded-AI development environment "REACTION" to encourage you to run your own model using embedded-NPU capability. We believe this enables the development of attractive embedded-AI applications.
- We prepare paper NDA less, stress-free, SW development resources utilizing cutting-edge OSS resources.