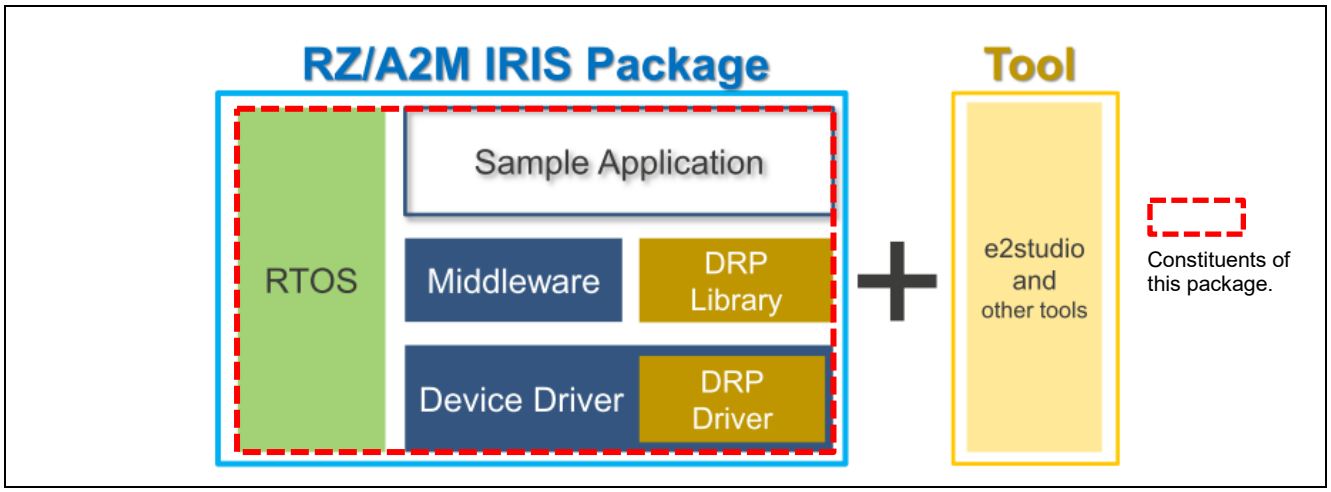
RZ/A2M Group

RZ/A2M IRIS Package V1.11 Release Note

Introduction

This package contains IRIS Detection sample program for RZ/A2M. The IRIS Detection sample program detect the iris portion from the image taken with the camera using DRP (Dynamically Reconfigurable Processor) in RZ/A2M.

This package is one of RZ/A2M Software Package. RZ/A2M Software Package is a software development kit for the RZ/A2M that supports various RZ/A2M functions such as DRP, camera input, LCD output, and image adjustment. The IRIS Detection sample program includes each device driver, middleware, and sample application of RZ / A2M.



RZ/A2M IRIS Package Configuration

For RZ/A2M Software Package details, refer following URL:

https://www.renesas.com/software-tool/rza2m-freertos-software-package

If you want to add software that is not included in the sample program, copy source code from “RZ/A2M Software Core Package (R01AN6055)” (described in session 6). If you want to add software that is not included in the project, please use Smart Configurator. For more detail, please refer RZ/A2M Software Package Quick Start Guide (R01QS0027) bundled in this package.

Target Device / Target Board

Target Device: RZ/A2M

Target Board Kit: RZ/A2M Evaluation Board Kit (RTK7921053S00000BE)

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1. Package Contents

- Software

No	Name	Ver.	Folder
1	IRIS detection Sample program	1.14	iris_sample
2	DRP Driver	0.95	r_drp
3	DRP Library	-	drp_lib

- DRP Library

No	Name	Ver.
1	Affine	1.00
2	ARGB to Grayscale	1.00
3	Bayer to Grayscale	1.00
4	Bayer to RGB	1.00
5	Bayer to RGB Color Correction	1.01
6	Binarization (Adaptive)	1.00
7	Binarization (Adaptive/Bit output version)	1.00
8	Binarization (Fixed)	1.00
9	Canny Calculate	1.00
10	Canny Hysterisis	1.00
11	Circle fitting	1.00
12	Corner Harris	1.00
13	Cropping	1.00
14	Cropping RGB	1.01
15	Dilate	1.00
16	Erode	1.00
17	Find Contours	1.01
18	Gamma correction	1.01
19	Gaussian filter	1.00
20	Histogram	1.00
21	Histogram Normalization	1.01
22	Histogram Normalization RGB	1.01
23	Image merging	1.00
24	Image rotate	1.00
25	Laplacian filter	1.00
26	Median filter	1.00
27	Minutiae delete	1.00
28	Minutiae extract	1.00
29	Prewitt filter	1.00
30	Reed-Solomon	1.00
31	Reed-Solomon (Gf8)	1.00
32	Remap	1.00
33	Resize bilinear	1.00
34	Resize bilinear fixed	1.00
35	Resize bilinear fixed RGB	1.01
36	Resize nearest	1.00
37	Simple ISP	1.02
38	Simple ISP with object detection by color (HSV)	1.00
39	Simple ISP with background subtraction	1.00
40	Simple ISP with object detection using sobel	1.00
41	Simple ISP with distortion correction	1.00
42	Simple ISP with scaling and normalization (32bit)	1.00
43	Simple ISP with color calibration and 3DNR	1.00
44	Sobel filter	1.00
45	Thinning	1.00
46	Unsharp masking	1.00

- Documents

No	Title	Rev.	File
1	RZ/A2M Group RZ/A2M IRIS Package V1.11Release Note	1.11	(English) r01an4584ej0111-rza2m-iris-swpkg-gcc.pdf (This document) (Japanese) r01an4584jj0111-rza2m-iris-swpkg-gcc.pdf
2	RZ/A2M Group IRIS Detection Application Note	1.14	(English) r01an4636ej0114-rza2m-freertos-iris-gcc.pdf (Japanese) r01an4636jj0114-rza2m-freertos-iris-gcc.pdf
3	RZ/A2M Group DRP Driver User's Manual	1.03	(English) r01us0355ej0103-rza2m-drp-driver-gcc.pdf (Japanese) r01us0355jj0103-rza2m-drp-driver-gcc.pdf
4	RZ/A2M Group DRP Library User's Manual	1.09	(English) r01us0367ej0109-rza2m-drp-library.pdf (Japanese) r01us0367jj0109-rza2m-drp-library.pdf
5	RZ/A2M Group RZ/A2M Software Package Quick Start Guide	1.09	(English) r01qs0027ej0109-rza2m-quick-guide-gcc.pdf (Japanese) r01qs0027jj0109-rza2m-quick-guide-gcc.pdf

- Folder structure of IRIS Package

```
an-r01an4584ej0111-rza2-iris-swpkg-gcc
 ├──rza2m_iris_sample_freertos_gcc.zip          : RZ/A2M Group IRIS Detection sample program
 ├──r01an4584ej0111-rza2m-iris-swpkg-gcc.pdf
 ├──r01an4584jj0111-rza2m-iris-swpkg-gcc.pdf
 ├──r01qs0027ej0110-rza2m-quick-guide-gcc.pdf
 └──r01qs0027jj0110-rza2m-quick-guide-gcc.pdf
```

- Folder structure of IRIS Detection sample program

```
rza2m_iris_sample_freertos_gcc.zip                          : Project Top Folder
  ├──.settings                                              : Project Setting Files
  ├──bootloader                                             : QSPI boot loader
  ├──doc    : Document of this sample application
  │    ├──r01an4636ej0113-rza2m-freertos-iris-gcc.pdf       : RZ/A2M Group Iris Detection sample program Application Note (English)
  │    └──r01an4636jj0113-rza2m-freertos-iris-gcc.pdf       : RZ/A2M Group Iris Detection sample program Application Note (Japanese)
  ├──generate                                               : Source files generated / configured by Smart Configurator
  │    ├──compiler                                          : Source files depended on the compiler
  │    ├──configuration                                     : Header files for project configuration
  │    ├──drivers                                           : Basic drivers
  │    │    ├──r_cache                                     : Cache deriver
  │    │    │    ├──doc                                    : Document of Cache driver
  │    │    │    ├──inc                                    : Header files for Cache driver
  │    │    │    └──src                                    : Source files for Cache driver
  │    │    ├──r_cpg                                       : Clock pulse generator driver (same folder structure as Cache driver)
  │    │    ├──r_gpio                                      : GPIO driver (same folder structure as Cache driver)
  │    │    ├──r_intc                                      : INTC driver (same folder structure as Cache driver)
  │    │    ├──r_mmu                                       : MMU driver (same folder structure as Cache driver)
  │    │    └──r_stb                                       : STB driver (same folder structure as Cache driver)
  │    ├──os_abstraction                                    : OS abstraction layer (same folder structure as Cache driver)
  │    │    ├──doc                                         : Document of OS abstraction layer
  │    │    ├──inc                                         : Header files for OS abstraction layer
  │    │    └──src                                         : Source files for OS abstraction layer
  │    ├──sc_drivers                                        : General drivers
  │    │    ├──r_cbuffer                                   : Ring buffer (same folder structure as DRP driver)
  │    │    ├──r_ceu                                       : CEU driver (same folder structure as DRP driver)
  │    │    ├──r_drp                                       : DRP driver (same folder structure as DRP driver)
  │    │    │    ├──doc                                    : Documents of DRP driver
  │    │    │    │    ├──r01us0355ej0103-rza2m-drp-driver-gcc.pdf : RZ/A2M Group DRP Driver User's Manual (R01US0355) (English)
  │    │    │    │    ├──r01us0355jj0103-rza2m-drp-driver-gcc.pdf : RZ/A2M Group DRP Driver User's Manual (R01US0355) (Japanese)
  │    │    │    │    ├──r01us0367ej0109-rza2m-drp-library.pdf    : RZ/A2M Group DRP Library User's Manual (R01US0367) (English)
  │    │    │    │    └──r01us0367jj0109-rza2m-drp-library.pdf    : RZ/A2M Group DRP Library User's Manual (R01US0367) (Japanese)
  │    │    │    ├──drp_lib                               : Source files for DRP library
  │    │    │    ├──inc                                    : Header files for DRP driver
  │    │    │    └──src                                    : Source files for DRP driver
  │    │    ├──r_hyperbus                                  : HyperBus driver (same folder structure as DRP driver)
  │    │    ├──r_mipi                                      : MIPI driver (same folder structure as DRP driver)
  │    │    ├──r_ostm                                      : OS timer driver (same folder structure as DRP driver)
  │    │    ├──r_riic                                      : I2C driver (same folder structure as DRP driver)
  │    │    ├──r_rvapi                                     : Video utility (same folder structure as DRP driver)
  │    │    ├──r_scifa                                     : SCIFA driver (same folder structure as DRP driver)
  │    │    └──r_vdc                                       : VDC driver (same folder structure as DRP driver)
  │    └──system                                            : System files for example, IO registers
  └──src                                                    : Source files for application
       ├──config_files                                      : Configurations
       ├──FreeRTOS                                          : FreeRTOS™
       │    ├──include                                      : FreeRTOS™ header files
       │    └──portable                                     : FreeRTOS™ RZ/A2M dependent files
       ├──renesas                                           : Software developed by Renesas
       │    ├──application                                  : application source files developed by Renesas
       │    │    ├──common                                 : Common processing
       │    │    │    ├──camera                            : Storage folder for Raspberry Pi Camera V2 control processing
       │    │    │    ├──perform                           : Storage folder for elapsed time measurement processing
       │    │    │    ├──port_setting                      : Storage folder for port setting processing
       │    │    │    └──render                           : Storage folder for character and dot rendering processing
       │    │    └──inc                                    : Storage folder for header files
       │    └──hwsetup                                     : Storage folder for peripheral function initialization processing
       │         └──hyperbus_setup                         : Storage folder for HyperBus initialization processing
       ├──user_prog                                         : main.c
       └──LICENSE
```

2. System Requirements

The system requirements for this sample program are listed below.

Item	Description
CPU	RZ/A2M (R7S921051VCBG, R7S921052VCBG, R7S921053VCBG)
Board	RZ/A2M CPU board (RTK7921053C00000BE) RZ/A2M SUB board (RTK79210XXB00000BE) RZ/A2M Display Output Board (RTK79210XXB00010BE)
Compiler	GNU Arm Embedded Toolchain 9-2020-q2-update
Integrated development environment	e2 studio 2022-07 Windows 64-bit product version
Emulator	SEGGER J-Link Base
Camera	Raspberry Pi Camera V2
Monitor	Monitor compatible with Full-WXGA(1366*768) resolution

3. Operation Confirmation Conditions

(1) Boot mode

Boot mode 3

(Boot from serial flash memory 3.3V)

* The program cannot be operated if the boot mode except the above is specified.

(2) Operating frequency

The RZ/A2M clock pulse oscillator is set to see that the RZ/A2M clocks on the CPU board have the following frequencies.

(The frequencies indicate the values in the state that the clock with 24MHz is input to the EXTAL pin in RZ/A2M clock mode 1.)

- CPU clock (I clock) : 528MHz
- Image processing clock (G clock) : 264MHz
- Internal bus clock (B clock) : 132MHz
- Peripheral clock1 (P1 clock) : 66MHz
- Peripheral clock0 (P0 clock) : 33MHz
- QSPI0_SPCLK : 66MHz
- CKIO : 132MHz

(3) Serial flash memory used

Manufacturer : Macronix Inc.

Product No. : MX25L51245G

(4) Setting for cache

Refer to the "RZ/A2M group Example of Initialization" application note(R01AN4321) about "Setting for MMU" included in "RZ/A2M Simple Applications Package (R01AN4494)" for the valid/invalid area of L1 and L2 caches.

4. Operation procedure

4.1 Hardware preparation

Connect the hardware described in “2 System Requirements” as follows.

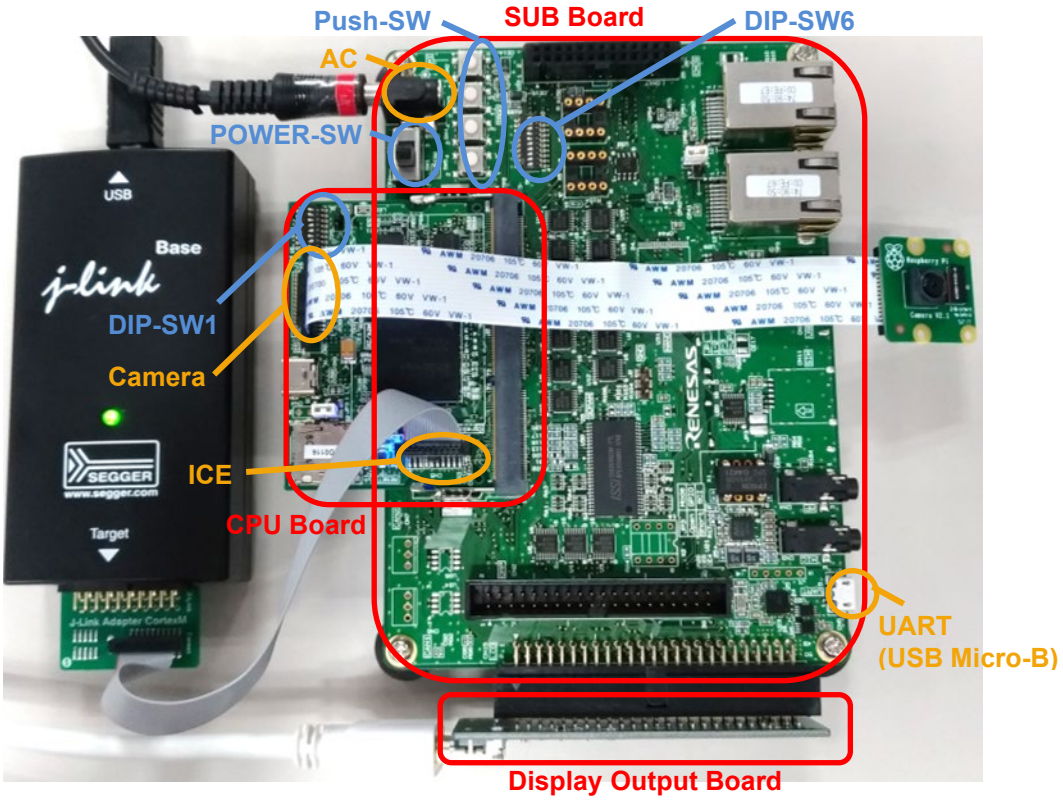
(1) Connect the CPU board and the SUB board.

(2) Connect the SUB board and Display Output Board.

(3) Connect the MIPI camera to the CPU board.

(4) Connect the J-Link Base to the CPU board.

(5) Connect the SUB board and the AC Adapter.



To operate this package, set the DIP-SW and jumpers as follows.

Refer to the CPU board and the SUB board user's manual (R20UT4239, R20UT4240) for more details about setting for the DIP switches and jumpers.

Set the DIP switches and jumpers of the CPU board as follows.

DIP-SW1							
1	2	3	4	5	6	7	8
ON	OFF	ON	OFF	OFF	ON	ON	ON

JP	Configuration	Function
JP1	1-2	Setting to supply 3.3V power for PVcc_SPI of RZ/A2M and U2
JP2	2-3	Setting to supply 1.8V power for PVcc_HO of RZ/A2M and U3
JP3	Open	Use USB ch 0 in the function mode (Not supply VBUS0 power)

Set the DIP switches and jumpers of the SUB board as follows.

DIP-SW2									
1	2	3	4	5	6	7	8	9	10
OFF	OFF	OFF	ON	ON	ON	ON	OFF	OFF	OFF

JP	Configuration	Function
JP1	2-JP2	Setting to use PJ_1 as interrupt terminal for IRQ0 switch (SW3)

4.2 How to build source code

Refer to the RZ/A2M Group RZ/A2M Software Package Quick Start Guide (R01QS0027) included in this package for the procedure of building, downloading and executing the sample program.

5. Memory footprint

This sample program uses about 4.1 Mbytes for On-chip RAM, about 1 Mbytes for HyperRAM™, and about 1 Mbyte for ROM. The main uses and rough size of each are shown below.

5.1 On-chip RAM usage

Use	Rough size (Mbyte)
Camera capture buffer	0.9
Display buffer	1.2
Work memory of DRP Library*	0.3
MMU Page Table	0.1
Stack area	0.1
Heap area	0.3
Heap area used by FreeRTOS	0.5
DRP configuration data	0.7

Note: The output image of simple ISP is placed in HyperRAM™.

5.2 HyperRAM™ usage

Use	Rough size (Mbyte)
Work memory of Simple ISP of DRP Library	0.9

5.3 ROM usage

Use	Rough size (Mbyte)
Sample program	0.8

6. Reference Application Notes

Following is the list of application notes related to this software package.

RZ/A2M Group RZ/A2M Software Core Package (R01AN6629).
Drivers and middleware for RZ/A2M that can be added to the project bundled in this package.

7. Restrictions

The Restrictions of this package are shown as follow.

Table 7-1 Restrictions

No.	Type	Description
1	DRP Driver*	The following API Functions are not supported. - R_DK2_Uninitialize - R_DK2_Inactivate If these functions are called, these functions occur an error and return "R_DK2_ERR_INTERNAL".
2	DRP Driver *	The function that load the configuration data in background is not supported. This function validates when argument "pload" of R_DK2_Load Function is set to anything other than NULL. In the version in this package this function occurs an error and return "R_DK2_ERR_INTERNAL".
3	DRP Driver *	R_DK2_Load Function notifies the return value "R_DK2_ERR_DEVICE", when detects a transfer error of the configuration data. In the version in this package this function is not supported.
4	DRP Driver *	Processing Completion Callback Function notifies the argument "result" is "R_DK2_ERR_DEVICE", when detects a transfer error in DRP. In the version in this package this function is not supported.
5	DRP Driver *	Processing Completion Callback Function notifies the argument "result" is "R_DK2_ERR_STOPPED", when detects a transfer stopped by calling R_DK2_Unload Function of R_DK2_Inactivate Function. In the version in this package this function is not supported.

Note 1 Please refer to "RZ/A2M Group DRP Driver User's Manual(R01US0355)" for details of DRP Driver's function.

8. Precautions

The Precautions of this package are shown as follow.

Table 8-1 Precautions

No.	Type	Description
1	Ethernet	It is not possible to add the TCP/IP protocol stack to a project by using Smart Configurator. In the case you use the TCP/IP protocol stack, please use “Ethernet sample program” bundled in "RZ/A2M Simple Applications Package"(R01AN4494).
2	Environment	If it is happened a build error while building the project of this package as it is, the setting of environment may be incorrect. Check following items: · Follow section 3 of “RZ/A2M Software Package Quick Start Guide”(R01QS0027) · Install e2 studio v7.3 or later again.
3	Environment	To avoid build error, expand the project to the folder with short full-path.
4	Environment	To avoid build error, expand the project to the folder without multi-byte character.
5	Environment	This package includes elf-formatted boot loader. Therefore, the project to generate the boot loader is not bundled. Following application note includes the boot loader project. To get it, please download from Renesas site: RZ/A1LU Group Example of Booting from Serial Flash Memory (R01AN4333)
6	All	The folder location of following drivers has moved to “generate\sc_drivers”(V1.01) from “src\renesas\drivers”(V1.00). r_ceu, r_drp, r_mipi, r_riic, r_rvapi and r_vdc Therefore, they are incompatible with the project between V1.01 and V1.00.
7	All	Since V1.02, the folder structure of the project using FreeRTOS has been changed to follow Amazon FreeRTOS. Therefore, they are incompatible with the project between V1.02 and V1.01.
8	DRP Driver	Supported the problem that the processing completion callback function may be called multiple times in Ver.0.94 (problem before Ver.0.93).

9. Used open source software and licenses

Open source software used in this package and license of them are shown as following:

- newlib is used under the license described in following site:
  https://www.sourceware.org/newlib/COPYING.NEWLIB
- FreeRTOS™ is a trade mark of Amazon Web Services, Inc.
- FreeRTOS is used under MIT license described in following site:
  https://www.freertos.org/a00114.html
  https://github.com/aws/amazon-freertos/blob/master/LICENSE
  https://aws.amazon.com/freertos/faqs/
- mbedTLS is used under the Apache License, Version 2.0 described in following site:
  http://www.apache.org/licenses/LICENSE-2.0
- FatFs is used under the license described in following site:
  http://elm-chan.org/fsw/ff/doc/appnote.html#license

SD Host/Ancillary Product License Agreement (SD HALA) is required to develop SD host-related products.
Refer https://www.sdcard.org/developers/licensing/ for detail:

Appendix

- Function overview of DRP Library

Function		Processing content
Image processing	Simple ISP	ISP (Image Signal Processor) which is optimal for image recognition. Perform color component integration, color component correction, demosaicing, noise elimination, sharpening, and gamma correction for RAW data (Bayer array) from CMOS.
	Simple ISP with object detection by color (HSV)	Simple ISP that implements object detection using color components of the target object. Outputs a binarized image extracting the target color components and a grayscale image of the captured data.
	Simple ISP with background subtraction	Simple ISP that extracts a moving object by using the background subtraction. Outputs a binary images of moving objects extracted and a grayscale image of the captured data.
	Simple ISP with object detection using sobel	Simple ISP that extracts an object having complex contours from multiple objects. Outputs a binary image that emphasizes the contours of objects with complex contours.
	Simple ISP with distortion correction	Simple ISP that performs barrel distortion correction. Add a barrel distortion correction function to the standard Simple ISP and output a grayscale image.
	Simple ISP with scaling and normalization(32bit)	Simple ISP that implements pre-processing (floating-point conversion, normalization, and resizing) for AI inference. Outputs ARGB(32BPP) image for display and RGB(96BPP) image after normalization.
	Simple ISP with color calibration and 3DNR	Simple ISP that specializes in the output of images having high color-reproducibility through color-matrix correction and 3D noise reduction.
Image transformation	Bayer to Grayscale	Converts from RAW data (Bayer array) acquired from CMOS to grayscale.
	Bayer to RGB	Converts from RAW data (Bayer array) acquired from CMOS to RGB.
	Bayer to RGB with color correction	Converts from RAW data acquired from CMOS to RGB and color correction.
	ARGB to Grayscale	Converts from ARGB to grayscale.
	Binarization(Fixed)	Converts the image to a binary image with a fixed threshold.
	Binarization(Adaptive)	Converts the image to a binary image with a dynamic threshold matching the surrounding image.
	Gamma correction	Corrects the image with gamma value.
	Cropping	Crops a part of the image.
	Resize bilinear fixed	Image resizing (bilinear method, fixed magnification)
	Resize bilinear	Image resizing (bilinear method)
	Resize nearest	Image resizing (nearest neighbor method)
	Image rotate	Rotates the image.
	Affine	Performs parallel translation and linear transformation of the image.
	Remap	Performs the image conversion using the X- and Y-coordinate map data.
Image filter	Median filter	Reduces the noise contained in the image.
	Gaussian filter	The image smoothing.
	Unsharp masking	The image sharpening.
	Sobel filter	Creates the edge of the image using Sobel filter.
	Prewitt filter	Creates the edge of the image using Prewitt filter.
	Laplacian filter	Creates the edge of the image using Laplacian filter.
	Dilate	Dilation of white part in the image.
	Erode	Erosion of white part in the image.
	Opening *1	Dilation after erosion. Noise in the black part in reduced.
	Closing *1	Erosion after dilation. Noise in the white part in reduced.

Note 1 This function can be executed by a combination of Dilate and Erode.

Function		Processing content
Feature detection	Canny edge detection	Detects the edge of the image using the Canny method.
	Harris corner detection	Detects the corner contained in the image using the method devised by Chris Harris.
	Minutiae extraction	Process of extraction feature points of fingerprint ridges used in fingerprint authentication.
	Circle fitting	Detects the circle.
	Find contours	Detect a contour and output its circumscribed rectangle.
Histograms	Histogram	Generates a histogram that is luminance distribution of the image.
	Histogram normalization	Normalizes the histogram of the image.
Other	Reed-Solomon	Error correction using Reed-Solomon on code.
	Thinning	Performs thinning of the image.
	Image merging	Merges two grayscale-images separately captured over different ranges.

Please refer to "RZ/A2M Group DRP Library User's Manual(R01US0367)" for details of DRP Library's function.

- Performance list of DRP Library

Category	Function	Tiles	Processing performance [ms]			Note
			DRP	CPU	vs CPU	
Image processing	Simple ISP(Bayer to Color)	6	11.88	-	-	
		3	21.61	-	-	
	Simple ISP (Bayer to Color planar format)	6	12.90	-	-	
		3	19.00	-	-	
	Simple ISP(Bayer to Grayscale)	6	6.46	-	-	
		3	12.61	-	-	
	Simple ISP(Grayscale to Grayscale)	6	6.74	-	-	
		3	13.45	-	-	
	Simple ISP (Bayer to RGB)	6	12.30	-	-	
	Simple ISP with object detection by color (HSV)	6	7.60	-	-	
	Simple ISP with background subtraction	6	12.70	-	-	
	Simple ISP with object detection using sobel	6	8.40	-	-	
		4	13.30	-	-	
	Simple ISP with distortion correction	6	18.80	-	-	
	Simple ISP with scaling and normalization(32bit)	6	17.50	-	-	
	Simple ISP with color calibration and 3DNR	6	24.40	-	-	
Image transformation	Bayer to Grayscale	1	0.90	15.3	x 17.0	6 Parallel Processing
	Bayer to RGB	2	2.88	8.9	x 3.0	3 Parallel Processing
	Bayer to RGB with color correction	6	9.70	-	-	
	ARGB to Grayscale	1	0.65	5.9	x 9.0	6 Parallel Processing
	Binarization(Fixed)	1	0.12	2.3	x 19.1	6 Parallel Processing
	Binarization(Adaptive)	3	1.69	10.1	x 5.9	
	Gamma correction	1	0.21	3.8	x 18.0	6 Parallel Processing
	Cropping	1	0.04	0.2	x 5.0	6 Parallel Processing
	Cropping RGB	1	0.08	0.4	x 5.0	6 Parallel Processing
	Resize Bilinear Fixed	4	1.96	2.7	x 1.3	
	Resize Bilinear Fixed RGB	6	2.54	6.7	x 2.6	
	Resize Bilinear	6	1.31	3.1	x 2.3	
	Resize Nearest	6	0.31	0.6	x 1.9	
	Image Rotate	1	0.35	3.0	x 8.5	6 Parallel Processing
	Affine	6	25.95	41.6	x 1.6	
	Remap	6	12.30	100.8	x 8.1	
Image filter	Median filter	1	0.89	76.1	x 85.5	6 Parallel Processing
	Gaussian filter	1	0.89	14.4	x 16.1	6 Parallel Processing
	Unsharp masking	2	1.71	34.1	x 19.9	3 Parallel Processing
	Sobel filter	1	0.88	30.7	x 34.4	6 Parallel Processing
	Prewitt filter	1	0.89	30.7	x 34.4	6 Parallel Processing
	Laplacian filter	1	0.89	29.1	x 32.6	6 Parallel Processing
	Dilate	1	0.89	18.0	x 20.2	6 Parallel Processing
	Erode	1	0.89	18.0	x 20.2	6 Parallel Processing

Category	Function	Tiles	Processing performance [ms]			Note
			DRP	CPU	vs CPU	
Feature detection	Canny edge detection	1+2+6	8.17	110.6	x 13.5	Parallel Processing & Dynamic Loading
	Harris corner detection	1+6	11.82	235.3	x 19.9	Parallel Processing & Dynamic Loading
	Minutiae Extract	3	0.85	-	-	2 Parallel Processing
	Minutiae Delete	2	0.36	-	-	
	Circle Fitting	2	58.16	1135.0	x 19.5	
	Find Contours	2	3.52	5.4	x 1.5	
Histograms	Histogram	2	1.57	3.5	x 2.2	
	Histogram normalization *	1	2.85	-	-	6 Parallel Processing
	Histogram normalization RGB *	1	6.14	-	-	6 Parallel Processing
Other	Reed-Solomon	1	0.33	5.0	x 15.1	6 Parallel Processing
	Thinning	3	0.49	-	-	2 Parallel Processing
	Image merging	6	8.70	-	-	

Note. The sum of processing time of MODE1 and 2.

Image size	640 x 480 VGA	
Image color	Grayscale 8BPP	
	YUV422:	Simple ISP (Bayer to Color)
	RGB888:	Bayer to RGB, Bayer to RGB with color correction, Cropping RGB, Histogram normalization RGB, Resize Bilinear Fixed RGB
CPU	RZ/A2M Cortex®-A9@528MHz	
RAM	RZ/A2M internal RAM	
ROM	QSPI Flash-ROM	

Revision History

Rev.	Date	Description	
		Page	Summary
1.00	Dec. 28, 2018	-	First Edition issued
1.01	Apr. 15, 2019	3, 4	Updated the IRIS Detection sample program to Ver.1.01. Added the following to DRP Library. (1) Affine (2) Bayer2Rgb (3) ImageRotate (4) Laplacian (5) MinutiaeDelete (6) MinutiaeExtract (7) ReedSolomonGf8 (8) Thinning Version up the following to DRP Library. (1) SimpleIsp
		4	Updated the RZ/A2M Group DRP Library User's Manual.
		11	Updated function overview of DRP Library.
		12	Updated Performance list of DRP Library.
1.02	Jun 07, 2019	3, 4	Updated the IRIS Detection sample program to Ver.1.10. Added the following to DRP Library. (1) Bayer to RGB Color Correction (2) Cropping RGB (3) Find Contours (4) Histogram Normalization (5) Histogram Normalization RGB (6) Resize bilinear fixed RGB
		4	Updated the RZ/A2M Group DRP Library User's Manual.
		4, 5, 11	The folder structure of the project using FreeRTOS was changed to follow Amazon FreeRTOS.
		12	Updated function overview of DRP Library.
1.03	Sep 30, 2019	3	Updated the IRIS detection Sample program to Ver.1.11. Updated DRP Driver to Ver.0.93. Updated the following to DRP Library. (1) Bayer to RGB Color Correction (2) Cropping RGB (3) Find Contours (4) Histogram Normalization (5) Histogram Normalization RGB (6) Resize bilinear fixed RGB
		4,5	Updated the RZ/A2M Group IRIS Detection Application Note. Updated the RZ/A2M Group DRP Driver User's Manual. Updated the RZ/A2M Group DRP Library User's Manual. Updated the RZ/A2M Group RZ/A2M Software Package Quick Start Guide.
		6	Integrated development environment version updated.
		10	Updated 6 Restrictions.
		12	Added 8 Used open source software and licenses.
		14	Updated Performance list of DRP Library.

1.04	Dec 17, 2019	3	1. Package Contents Update IRIS detection Sample program to 1.12. Update each document name to latest version Update Folder structure to latest version
		6	2. System Requirements Update the version of e2 studio.
		10	Added 5 Memory footprint.
1.05	Mar 31, 2020	3,4,5	1. Package Contents Update DRP Library (Simple ISP) to 1.01. Update each document name to latest version Update Folder structure to latest version
		6	2. System Requirements Update the version of e2 studio.
		11	7. Restrictions No.5 Corrected description of return value of processing completion callback function.
		15	Performance list of DRP Library Update performance of Simple ISP.
1.06	Jun 30, 2020	3,4,5	1. Package Contents (1) Update DRP Driver to 0.94. (Modified that the processing completion callback function is not executed multiple times.) (2) Update DRP Library. (3) Update each document name to latest version (4) Update Folder structure to latest version
		6	2. System Requirements Update the version of e2 studio.
		13	8. Precautions No.10 Added notes for DRP Driver.
		15,16	Updated function overview of DRP Library.
		17,18	Updated Performance list of DRP Library.
1.07	Sep 30, 2020	3	1. Package Contents Update IRIS detection Sample program to 1.13.
		5,6	Updated the RZ/A2M Group IRIS Detection Application Note. Updated the RZ/A2M Group DRP Library User's Manual.
1.08	Apr 20, 2021	3	1. Package Contents (1) Update DRP Driver to 0.95. (Changed the DRP interrupt priority level from 8 to 26.)
		5,6	Updated the RZ/A2M Group DRP Driver User's Manual. Updated the RZ/A2M Group DRP Library User's Manual.
		11	5.1 On-chip RAM usage Corrected a typo.
1.09	Jan 20, 2022	7	2. System Requirements Update the version of complier. Update the version of e2 studio. Update the FreeRTOS version to V10.4.3-LTS-Patch-1.
1.10	Jul 20, 2022	-	Change library related build options

1.11	Feb 28, 2023	7	Modified Critical Section related functions in OS abstraction to support IRQ handler. Modified SCIFA files to change the return value when transferring 0 bytes. Modified GPIO macro value. Update some smart configurator component files. Added quick start guide link.

General Precautions in the Handling of Microprocessing Unit and Microcontroller Unit Products

The following usage notes are applicable to all Microprocessing unit and Microcontroller unit products from Renesas. For detailed usage notes on the products covered by this document, refer to the relevant sections of the document as well as any technical updates that have been issued for the products.

1. Precaution against Electrostatic Discharge (ESD)

   A strong electrical field, when exposed to a CMOS device, can cause destruction of the gate oxide and ultimately degrade the device operation. Steps must be taken to stop the generation of static electricity as much as possible, and quickly dissipate it when it occurs. Environmental control must be adequate. When it is dry, a humidifier should be used. This is recommended to avoid using insulators that can easily build up static electricity. Semiconductor devices must be stored and transported in an anti-static container, static shielding bag or conductive material. All test and measurement tools including work benches and floors must be grounded. The operator must also be grounded using a wrist strap. Semiconductor devices must not be touched with bare hands. Similar precautions must be taken for printed circuit boards with mounted semiconductor devices.
2. Processing at power-on

   The state of the product is undefined at the time when power is supplied. The states of internal circuits in the LSI are indeterminate and the states of register settings and pins are undefined at the time when power is supplied. In a finished product where the reset signal is applied to the external reset pin, the states of pins are not guaranteed from the time when power is supplied until the reset process is completed. In a similar way, the states of pins in a product that is reset by an on-chip power-on reset function are not guaranteed from the time when power is supplied until the power reaches the level at which resetting is specified.
3. Input of signal during power-off state

   Do not input signals or an I/O pull-up power supply while the device is powered off. The current injection that results from input of such a signal or I/O pull-up power supply may cause malfunction and the abnormal current that passes in the device at this time may cause degradation of internal elements. Follow the guideline for input signal during power-off state as described in your product documentation.
4. Handling of unused pins

   Handle unused pins in accordance with the directions given under handling of unused pins in the manual. The input pins of CMOS products are generally in the high-impedance state. In operation with an unused pin in the open-circuit state, extra electromagnetic noise is induced in the vicinity of the LSI, an associated shoot-through current flows internally, and malfunctions occur due to the false recognition of the pin state as an input signal become possible.
5. Clock signals

   After applying a reset, only release the reset line after the operating clock signal becomes stable. When switching the clock signal during program execution, wait until the target clock signal is stabilized. When the clock signal is generated with an external resonator or from an external oscillator during a reset, ensure that the reset line is only released after full stabilization of the clock signal. Additionally, when switching to a clock signal produced with an external resonator or by an external oscillator while program execution is in progress, wait until the target clock signal is stable.
6. Voltage application waveform at input pin

   Waveform distortion due to input noise or a reflected wave may cause malfunction. If the input of the CMOS device stays in the area between V_{IL} (Max.) and V_{IH} (Min.) due to noise, for example, the device may malfunction. Take care to prevent chattering noise from entering the device when the input level is fixed, and also in the transition period when the input level passes through the area between V_{IL} (Max.) and V_{IH} (Min.).
7. Prohibition of access to reserved addresses

   Access to reserved addresses is prohibited. The reserved addresses are provided for possible future expansion of functions. Do not access these addresses as the correct operation of the LSI is not guaranteed.
8. Differences between products

   Before changing from one product to another, for example to a product with a different part number, confirm that the change will not lead to problems. The characteristics of a microprocessing unit or microcontroller unit products in the same group but having a different part number might differ in terms of internal memory capacity, layout pattern, and other factors, which can affect the ranges of electrical characteristics, such as characteristic values, operating margins, immunity to noise, and amount of radiated noise. When changing to a product with a different part number, implement a system-evaluation test for the given product.

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