Rockchip Developement Guide 3A ISP32

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Preface

Overview

This article aims to describe the role of the RkAiq (Rk Auto Image Quality) module, the overall workflow, and related API interfaces. The main givesEngineers who use the RkAiq module for ISP function development provide assistance.

Product Version

Chip Name	Kernel version
RK1106	Linux 5.10

Reader Object

This document (this guide) is intended for the following engineers:

ISP Module Software Development Engineer

System integration software development engineer

System on Chip Support Status

Chip name	BuildRoot	Debian	Yocto	Android
RK1106	Y	N	N	Y

Revision History

Version number	Author	Date modified	Modification instructions
v0.1.0	Zhu Linjing Chi Xiaofang Hu Kejun	2022-4-27	ISP3A Development Guide First Edition

Directory

4. 2.4 Refer to the code sample

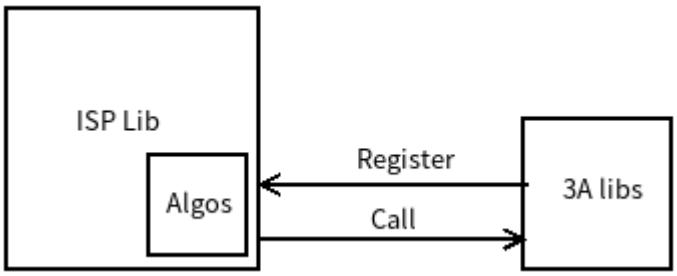
1 Overview

This document mainly introduces the implementation of 3A libraries, aiming to guide users on how to implement customized 3A algorithm libraries.

The 3A algorithm library depends on AIQ, which already contains the 3A algorithm library of RK and is enabled by default. Users can implement customized 3A libraries according to this document as needed.

1. 1.1 Design ideas

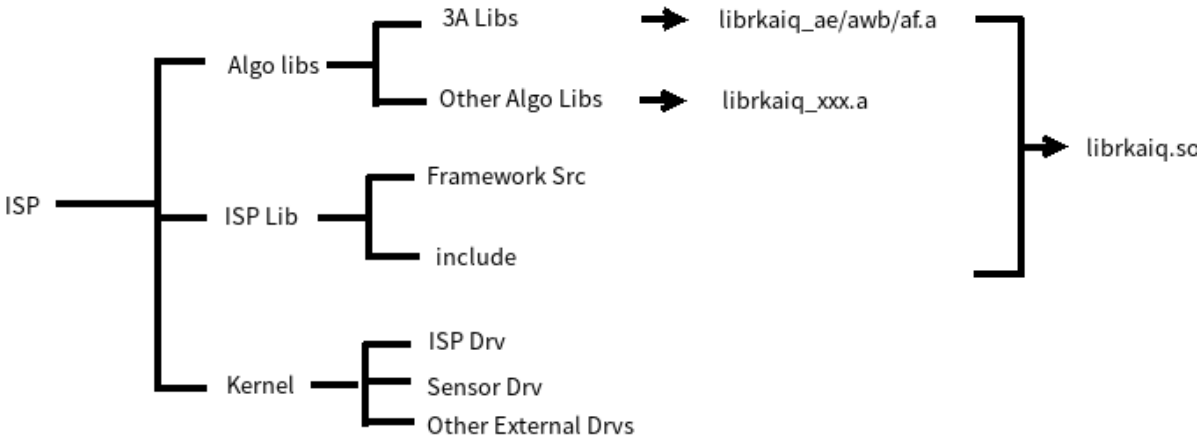
The basic design idea is shown in the following figure:



- The 3A library is registered with the ISP library by registration, note that the 3A library of RK has been implicitly registered, and does not require the user to display the registration
- After the 3A library is registered with the ISP library, after the ISP library gets the 3A statistics from the driver, it calls back to the 3A library interface to get the new 3A parameters, and the ISP library sets the new 3A parameters to the driver

2. 1.2 File organization

The file organization is shown in the following figure:



- ISP Firmware is divided into application layer librkaiq.so and driver layer ISP drivers and peripheral drivers, including Sensor, VCM and Flashlight
- librkaiq.so contains many algorithm libraries, such as 3A algorithm library, HDR algorithm library, etc., the algorithm library exists in the form of static library, and finally links form librkaiq.so. Except for the librkaiq_ae/awb/af.a 3A library, which does not provide source code, the source code of other basic libraries is open.
- The algorithm library of all modules supported by the framework uses the client algorithm, but in general, except for the 3A library that wants to be customized, other basic libraries can use the default library provided by RK.

3. 1.3 Development mode

The following three development modes are supported:

- 3A library uses the RK library. When using this method, RK's 3A library APIs can be used, including: rk_aiq_user_api2_ae.h, rk_aiq_user_api2_af.h, and rk_aiq_user_api2_awb.h.
- 3A library partly uses RK library and part uses user-defined library. For example, the AE library uses a custom library, and the AWB library uses the RK library.
- 3A library custom library and RK library are used at the same time. For example, when the AE library and the RK library run at the same time, the RK AE library will be run first, and then the custom AE library will be run, and the custom library result will overwrite the RK AE library result. This mode is used to simplify the development of custom libraries, which do not need to output all the results required by the AIQ framework, and some of the results can be exported by the RK AE library.

4. 1.4 Software processes

4.1 1.4.1 Basic processes

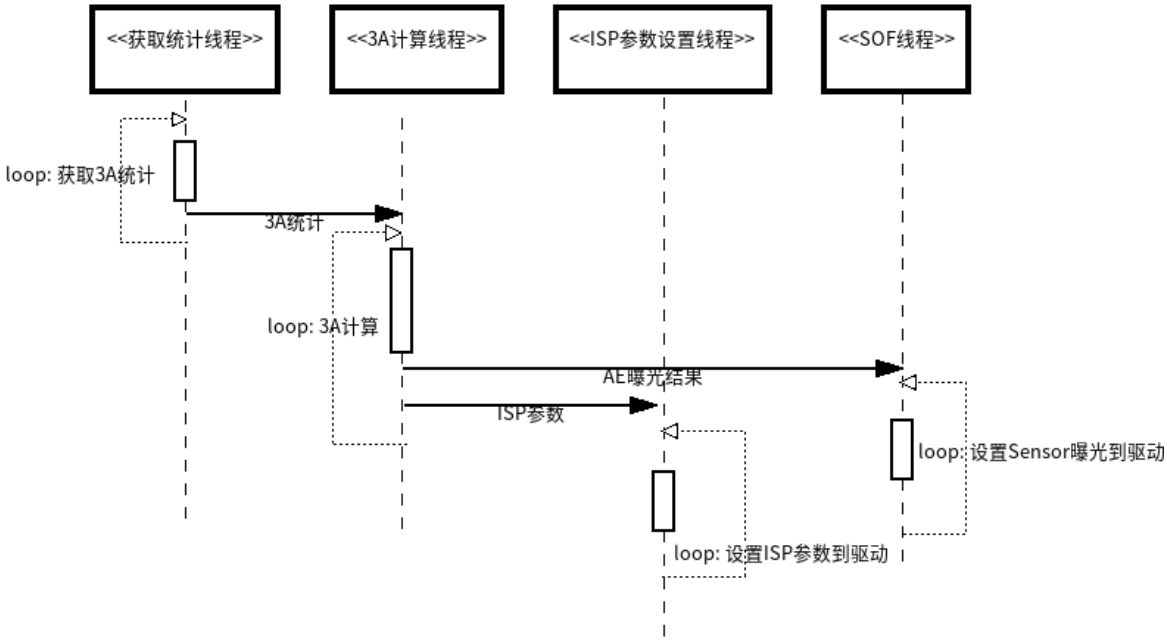
The RK 3A algorithm does not require user display registration, which is implicitly registered within the AIQ framework. Custom 3A algorithm registration, taking custom AE algorithm registration as an example, the example pseudocode is as follows:

```
//  Initialize the usage scenario, not required, defaults to normal, day, which
is used to select scene parameters in the JSON IQ file
if (work_mode == RK_AIQ_WORKING_MODE_NORMAL)
        ret = rk_aiq_uapi2_sysctl_preInit_scene(sns_entity_name, "normal",
"day");
  else
        ret = rk_aiq_uapi2_sysctl_preInit_scene(sns_entity_name, "hdr", "day");

//  Depending on whether the usage pattern is surround view or single camera,
initialize Group Ctx or AIQ ctx
   if (!group_mode)
        ctx->aiq_ctx = rk_aiq_uapi2_sysctl_init(sns_entity_name, ctx->iqpath,
NULL, NULL);
  else {
       rk_aiq_camgroup_instance_cfg_t camgroup_cfg;
       memset(&camgroup_cfg, 0, sizeof(camgroup_cfg));
       camgroup_cfg.sns_num = 1;
       camgroup_cfg.sns_num++;
       camgroup_cfg.sns_ent_nm_array[0] = sns_entity_name;
       camgroup_cfg.sns_ent_nm_array[1] = sns_entity_name2;
       camgroup_cfg.config_file_dir = ctx->iqpath;
       camgroup_cfg.overlap_map_file = "srcOverlapMap.bin";
       ctx->camgroup_ctx = rk_aiq_uapi2_camgroup_create(&camgroup_cfg);
  }

// If you need to register a custom AE algorithm, register a custom AE callback
  rk_aiq_customeAe_cbs_t cbs = {
                           .pfn_ae_init = custom_ae_init,
                           .pfn_ae_run = custom_ae_run,
                           .pfn_ae_ctrl = custom_ae_ctrl,
                           .pfn_ae_exit = custom_ae_exit,
                       };
  rk_aiq_uapi2_customAE_register((const rk_aiq_sys_ctx_t*)(ctx->camgroup_ctx),
&cbs);

// If you need to run a third-party AE algorithm, enable the custom AE algorithm.
Third-party AE library registration interface, single camera and surround view
shared.
//In the current AIQ version, both the default RK algorithm and the third-party
algorithm will run, and if necessary, you can call
rk_aiq_uapi2_sysctl_enableAxlib to force off RK AE.
```

```
  rk_aiq_uapi2_customAE_enable((const rk_aiq_sys_ctx_t*)(ctx->camgroup_ctx),
true);

// Prepare the ISP pipeline and configure initialization parameters such as ISP
and Sensor
// If necessary, you can call the module API before prepare to modify the module
initialization parameters, otherwise the initialization parameters are specified
by the IQ file, or are specified by hard code in AIQ, or the chip reset value
 if (!group_mode) {
      rk_aiq_uapi2_sysctl_prepare(ctx->aiq_ctx, ctx->width, ctx->height,
work_mode);
      rk_aiq_uapi2_sysctl_start(ctx->aiq_ctx );
 } else {
      rk_aiq_uapi2_camgroup_prepare(ctx->camgroup_ctx, work_mode);
      ret = rk_aiq_uapi2_camgroup_start(ctx->camgroup_ctx);
 }

//  Turn on the VI data flow and note that no AIQ library interfaces are called
in this section.
start_capturing(ctx);
......
//  AIQ internal thread loop work: obtain 3A statistics from the driver, call
each algorithm library to calculate new ISP parameters, sensor parameters, etc.,
and issue new parameters to ISP drivers and sensor drivers.
// This procedure calls the API to set parameters for each algorithm module
......

//  Stop the data flow first on exit
stop_capturing(ctx);

// Stop AIQ ctx or Group ctx
 if (!group_mode)
       rk_aiq_uapi2_sysctl_stop(ctx->aiq_ctx, false);
else
       rk_aiq_uapi2_camgroup_stop(ctx->camgroup_ctx);

// Anti-register third-party AEs
 rk_aiq_uapi2_customAE_unRegister(ctx->aiq_ctx);

// Deinitialize AIQ ctx or Group ctx
 if (!group_mode)
        rk_aiq_uapi2_sysctl_deinit(ctx->aiq_ctx);
else
       rk_aiq_uapi2_camgroup_destroy(ctx->camgroup_ctx);
```

4.2 1.4.2 Internal operational processes

The internal operation of AIQ is shown in the following figure:



- Get statistics thread: This thread continuously fetches 3A statistics from the ISP driver and sends them to the 3A calculation thread.
- 3A calculation thread: After receiving the statistics, the thread starts to call the module algorithm (including third-party algorithm callbacks), calculates new parameters, and then sends the new parameters to the ISP parameter setting thread and the SOF thread.
- ISP parameter setting thread: After receiving a new ISP parameter setting request, the thread sends it to the ISP driver at the appropriate time.
- SOF thread: This thread is the response function of the Sensor frame header event, which receives a new exposure setting request and takes the new exposure parameter setting from the queue to the Sensor driver.

2 Developer Guide

1. 2.1 AE algorithm registration

The AE algorithm registration process involves algorithm registration, algorithm enablement, algorithm deregistration, registration and invocation of rk_aiq_uapi_customAE_register interfaces, enabling rk_aiq_uapi_customAE_enable interfaces, and deregistration of invocation rk_aiq_uapi_customAE_unRegister interfaces

1.1 2.1.1 Algorithm registration API

1.1.1 rk_aiq_uapi2_customAE_register

【Description】
Register the AE algorithm library

【Grammar】

```
XCamReturn
rk_aiq_uapi2_customAE_register(const rk_aiq_sys_ctx_t* ctx,
rk_aiq_customeAe_cbs_t* cbs)
```

【Parameters】

Parameter Name	Description	Input/Output
ctx	AIQ context pointer for single-camera and surround view applications	input
cbs	Callback function pointer	

【Return Value】

Return value	Description
0	Success
Non-0	Failure, see Error Code Table

1.1.2 rk_aiq_uapi2_customAE_enable

【Description】

Register the AE algorithm library

【Grammar】

```
XCamReturn
rk_aiq_uapi2_customAE_enable(const rk_aiq_sys_ctx_t* ctx, bool enable);
```

【Parameters】

Parameter Name	Description	Input/Output
ctx	AIQ context pointer for single-camera and surround view applications	input
enable	AE algorithm enable bit	input

【Return Value】

Return value	Description
0	Success
Non-0	Failure, see Error Code Table

1.1.3 rk_aiq_uapi2_customAE_unRegister

【Description】

Register the AE algorithm library

【Grammar】

```
XCamReturn
rk_aiq_uapi2_customAE_unRegister(const rk_aiq_sys_ctx_t* ctx);
```

【Parameters】

Parameter Name	Description	Input/Output
ctx	AIQ context pointer for single-camera and surround view applications	Input

【Return Value】

Return value	Description
0	Success
Non-0	Failure, see Error Code Table

1.2 2.1.2 Callback functions and data types

Users need to implement the following callback functions in the self-developed custom AE library:

```
rk_aiq_customeAe_cbs_t cbs = {
.pfn_ae_init = custom_ae_init,
.pfn_ae_run = custom_ae_run,
.pfn_ae_ctrl = custom_ae_ctrl,
.pfn_ae_exit = custom_ae_exit,
};
```

Member name	Description
pfn_ae_init	Initialize the callback function pointer of AE
pfn_ae_run	Run AE's callback function pointer
pfn_ae_ctrl	Pointer to the callback function that controls the internal state of AE [This parameter is temporarily invalid]
pfn_ae_exit	Destroys AE's callback function pointer

1.2.1 custom_ae_init

【Description】
Initialize the AE algorithm library

【Grammar】

```
int32_t custom_ae_init(void* ctx);
```

【Parameters】

Parameter Name	Description	Input/Output
ctx	AIQ context pointer for single-camera and surround view applications	Input

【Return Value】

Return value	Description
0	Success
Non-0	Failure, see Error Code Table

1.2.2 custom_ae_run

【Description】

Run the AE algorithm library to calculate the exposure time and gain of the sensor, the digital gain of the ISP, and update the hardware configuration parameters

【Grammar】

```
int32_t custom_ae_run(void* ctx, const rk_aiq_customAe_stats_t* pstAeInfo,
                      rk_aiq_customeAe_results_t* pstAeResult);
```

【Parameters】

Parameter Name	Description	Input/Output
ctx	AIQ context pointer for single-camera and surround view applications	Input
pstAeInfo	Input a data parameter pointer containing AE hardware statistics and their synchronized exposure information Input	
pstAeResult	Output algorithm result pointer containing exposure result parameters of sensor and update hardware configuration parameters	Output

【Return Value】

Return value	Description
0	Success
Non-0	Failure, see Error Code Table

1.2.3 custom_ae_ctrl

【Description】

Change the internal state of the algorithm library and cannot be used temporarily

【Grammar】

```
int32_t custom_ae_ctrl(void* ctx, uint32_t u32Cmd, void *pValue);
```

【Parameters】

Parameter Name	Description	Input/Output
ctx	AIQ context pointer for single-camera and surround view applications	Input

【Return Value】

Return value	Description
0	Success
Non-0	Failure, see Error Code Table

1.2.4 custom_ae_exit

【Description】
Unregister the AE algorithm library

【Grammar】

```
int32_t custom_ae_exit(void* ctx);
```

【Parameters】

Parameter Name	Description	Input/Output
ctx	AIQ context pointer for single-camera and surround view applications	Input

【Return Value】

Return value	Description
0	Success
Non-0	Failure, see Error Code Table

1.2.5 Enter the parameters

【Description】

Third-party AE input data parameters include image luminance statistics and corresponding exposure parameter values, which are compatible with single camera and surround view applications.
【Definition】

```
#define RK_AIQ_MAX_HDR_FRAME (3)
typedef struct rk_aiq_customAe_stats_s
{
    //hw stats
    Aec_Stat_Res_t rawae_stat[RK_AIQ_MAX_HDR_FRAME]; // with awb gain
    Aec_Stat_Res_t extra;      // with awb gain, lsc, TMO

    //exposure
    RkAiqExpParamComb_t linear_exp;
    RkAiqExpParamComb_t hdr_exp[RK_AIQ_MAX_HDR_FRAME];

    struct rk_aiq_customAe_stats_s* next; // for surround view(multiple cams)
} rk_aiq_customAe_stats_t;
```

【Members】

Member Name	Description
rawae_stat[RK_AIQ_MAX_HDR_FRAME]	Based on the pre-hardware statistics of RAW images, up to 3 frames of RAW graphics statistics are supported. In linear exposure mode, only rawae_stat [0] is effective; In HDR exposure mode, rawae_stat [0-2] represents hardware statistics for short, medium, and long frames. The 1106 platform supports HDR 2TO1 mode at most, so only 0-1 elements are valid rawae_stat
extra	Post-hardware statistics based on RAW graphs
linear_exp	Exposure parameters in linear mode, synchronized with hardware statistics
hdr_exp[RK_AIQ_MAX_HDR_FRAME]	Exposure parameters in HDR mode, synchronized with hardware statistics. The 1106 platform is only valid 0~1, indicating the exposure parameters of short and long frames respectively
next	It is only valid under the surround view multi-camera application, the pointer points to the input data parameter of the next camera, and the input parameter member content corresponding to each camera is the same; For non-surround view multicamera applications, the pointer is empty. 1106 platform does not support

【Description】

- Input data parameters are divided into two types of parameters, namely the hardware statistics of the image and the exposure parameters corresponding to the image
- The input data parameters can be compatible with single camera and surround view multi-camera applications, and the input data parameters of multiple cameras can be obtained through the next pointer
- The hardware statistics data type of the image is Aec_Stat_Res_t, the exposure information data type is RkAiqExpParamComb_t, and the data type description is detailed in the "Rockchip_Development_Guide_ISP32" document

- RK_AIQ_MAX_HDR_FRAME indicates that the RK platform supports up to 3 HDR frames and only 2 HDR frames for the 1106 platform

1.2.6 The result of the operation

【Description】

Third-party AE output parameters include exposure parameters, hardware parameters, etc., and are compatible with single camera and surround view applications

【Definition】

```
#define RK_AIQ_MAX_HDR_FRAME (3)
typedef struct rk_aiq_i2c_data_s {
    bool            bValid;
    unsigned int    nNumRegs;
    unsigned int*   pRegAddr;
    unsigned int*   pAddrByteNum;
    unsigned int*   pRegValue;
    unsigned int*   pValueByteNum;
    unsigned int*   pDelayFrames;
} rk_aiq_i2c_data_t;

typedef struct rk_aiq_customeAe_results_singel_s
{
    //exposure result (including:reg value & real value)
    RkAiqExpParamComb_t linear_exp;
    RkAiqExpParamComb_t hdr_exp[RK_AIQ_MAX_HDR_FRAME];
    rk_aiq_i2c_data_t   exp_i2c_params;

    //hw result
    struct window meas_win;
    unsigned char meas_weight[15 * 15];

    struct rk_aiq_customeAe_results_singel_s* next; // for surround view(multiple
cams)
} rk_aiq_customeAe_results_single_t;

typedef struct rk_aiq_customeAe_results_s
{
    //exposure result (including:reg value & real value)
    RkAiqExpParamComb_t linear_exp;
    RkAiqExpParamComb_t hdr_exp[RK_AIQ_MAX_HDR_FRAME];
    rk_aiq_i2c_data_t   exp_i2c_params;

    //hw result
    struct window meas_win;
    unsigned char meas_weight[15 * 15];

    RkAiqIrisParamComb_t Iris;
    uint32_t frame_length_lines;
    bool     is_longfrm_mode;
```

```
    struct rk_aiq_customeAe_results_singel_s* next; // for surround view(multiple
cams)
} rk_aiq_customeAe_results_t;
```

【Members】

Member Name	Child members	Description
linear_exp	exp_real_params exp_sensor_params	Exposure parameters in linear mode, containing the actual exposure value (exp_real_params) and the registered value in RK format (exp_sensor_params)
hdr_exp[RK_AIQ_MAX_HDR_FRAME]	exp_real_params exp_sensor_params	The exposure parameters in HDR mode include the actual value of exposure (exp_real_params) and the register value of RK format (exp_sensor_params), where 0~2 represents the exposure parameters of short, medium and long frames, respectively, for HDR2 frame compositing, 0 and 1 elements are valid, for HDR3 frame compositing, 0-2 are valid
exp_i2c_params	bValid nNumRegs pRegAddr pAddrByteNum pRegValue pValueByteNum pDelayFrames	i2c register value parameter When bValid is true, register value settings are made using exp_i2c_params parameters; When bValid is false, register settings are made using the RK format register value parameter in the above linear_exp or hdr_exp
frame_length_lines		The VTS value of the sensor, which is related to the frame rate setting
is_longfrm_mode		Long frame mode enable bit true: enable long frame mode; false: Turn off long frame mode , this parameter is only valid in HDR mode
Iris	PIris DCIris	Aperture setting parameters, including P aperture and DC aperture setting parameters
meas_win	h_offs v_offs h_size v_size	The hardware statistics window area parameter h/v_offs indicates the horizontal and vertical offset of the upper-left vertex of the window relative to the upper-left vertex of the photosensitive area. h/v_size indicates the dimensions of the window in the horizontal and vertical directions, respectively

Member Name	Child members	Description
meas_weight		Hardware statistical weight parameters, including 15X15 weight parameters, the value range is 0~32
next		For non-surround view applications, the pointer needs to be empty; Looking around the application, if multiple cameras need to set the same algorithm result, the pointer needs to be empty, only the members in the rk_aiq_customeAe_results_t need to be set, and then all cameras use the algorithm result in the rk_aiq_customeAe_results_t as their final result; If multiple cameras need to set different algorithm results, the user needs to apply for the next pointer memory and add the algorithm result of the next camera

【Precautions】

- Output algorithm results, compatible with single-camera applications and surround view multi-camera applications. In surround-view multi-camera applications, it can be compatible with single algorithm results and multiple algorithm results.
- meas_win the window area parameters for AE hardware statistics, hardware statistics (tile brightness, histogram) will expand based on the window area. For HDR multi-frame exposure applications, the hardware statistics window is the same by default for all frames.
- meas_weight is the weight parameter required for weighted histogram statistics, generally consistent with the weight (software weight) used for the weighted mean of tile-weighted luminance
- When setting the exposure, you need to configure the actual exposure value and the corresponding register value. The actual exposure value includes: exposure time (unit: seconds), exposure gain (unit: multiple), DCG state (0:LCG, 1:HCG), for other algorithm modules; The exposure register value is the register value that interfaces with the sensor and supports RK format and third-party formats.
- When setting the exposure register value, RK format and third-party format are supported. The register value of RK format does not need to be set by the customer, and it is internally converted according to the actual value of exposure, and the bValid value in the exp_i2c_params is required to be false; Third-party formats require the user to set the required register value and corresponding address, and require the bValid value in the exp_i2c_params to be true.
- For surround view applications, if all cameras in surround view need to set the same exposure and hardware values, only set the parameters in the rk_aiq_customeAe_results_t, the next pointer is empty; If each camera in the surround view needs to set different exposures and hardware, you need to set the result values in order, allocate memory for the next pointer to point to the next camera algorithm result. It should be noted that there are differences between rk_aiq_customeAe_results_t and the parameters in the rk_aiq_customeAe_results_single_t, the former has more individual result parameters than the two, which is a public parameter and all cameras are set to the same value by default.

- The hardware statistics data type of the image is Aec_Stat_Res_t, the RK exposure information data type is RkAiqExpParamComb_t, and the RK aperture parameter data type is RkAiqIrisParamComb_t, the above data types are described in the statistics module in the "Rockchip_Development_Guide_ISP32" document

2. 2.2 AWB algorithm registration

The RK AWB algorithm implements a rk_aiq_uapi_customAWB_register registration function, and the user calls the registration function to register the Custom AWB algorithm with the ISP, the example is similar to the AE algorithm library registration, and the Custom AWB algorithm is enabled through the rk_aiq_uapi_customAWB_enable.

Note: For a smooth transplant, it is recommended to review:

(1) The following content of the "Rockchip_Color_Optimization_Guide" document,

(a) "2 AWB/2.1 Function Description" section content and AWB flowchart content

(b) AWB white spot detection flowchart in the section "2 AWB/2.2 White Spot Detection Process for Key Parameters/Hardware"

(2) "Statistics / Data Types / rk_aiq_isp_awb_stats2_v3x_t" section of Rockchip_Development_Guide_ISP32

2.1 2.2.1 Algorithm registration API

2.1.1 rk_aiq_uapi_customAWB_register

【Description】

Custom AWB algorithm registration.

【Grammar】

```
XCamReturn
rk_aiq_uapi_customAWB_register(const rk_aiq_sys_ctx_t* ctx,
rk_aiq_customeAwb_cbs_t* cbs);
```

【Parameters】

Parameter Name	Description	Input/Output
ctx	AIQ context pointer	Input
cbs	For the callback function registered by the Custom AWB algorithm with the ISP library, refer to the rk_aiq_customeAwb_cbs_t structure description below Input	

【Return Value】

Return value	Description
0	Success
Non-0	Failure, see Error Code Table

【Note】

- You must first call rk_aiq_uapi_sysctl_init to initialize the AIQ context pointer ctx.

【Requirements】

- Header file: rk_aiq_user_api_custom_awb.h
- Library file: librkaiq.so

2.1.2 rk_aiq_uapi_customAWB_enable

【Description】

Custom AWB algorithm enabled.

【Grammar】

```
XCamReturn
rk_aiq_uapi_customAWB_enable(const rk_aiq_sys_ctx_t* ctx, bool enable);
```

【Parameters】

Parameter Name	Description	Input/Output
ctx	AIQ context pointer	Input
enable	Custom AWB enable switch value: true / false default: false	Input

【Return Value】

Return value	Description
0	Success
Non-0	Failure, see Error Code Table

【Note】

- Called after rk_aiq_uapi_customAWB_register has completed the Custom AWB algorithm registration.

【Requirements】

- Header file: rk_aiq_user_api_custom_awb.h
- Library file: librkaiq.so

2.1.3 rk_aiq_uapi_customAWB_unRegister

【Description】

Custom AWB algorithm logout.

【Grammar】

```
XCamReturn
rk_aiq_uapi_customAWB_unRegister(const rk_aiq_sys_ctx_t* ctx);
```

【Parameters】

Parameter Name	Description	Input/Output
ctx	AIQ context pointer	Input

【Return Value】

Return value	Description
0	Success
Non-0	Failure, see Error Code Table

【Note】

- Called after rk_aiq_uapi_customAWB_register has completed the Custom AWB algorithm registration.

【Requirements】

- Header file: rk_aiq_user_api_custom_awb.h
- Library file: librkaiq.so

2.2 2.2.2 Callback functions and data types

2.2.1 A callback function registered with the ISP library

2.2.1.1 rk_aiq_customeAwb_cbs_t

【Description】

Defines the callback function that the Custom AWB algorithm registers with the ISP library.

【Definition】

```
typedef struct rk_aiq_customeAwb_cbs_s
{
    int32_t (*pfn_awb_init)(void* ctx);
    int32_t (*pfn_awb_run)(void* ctx, const void* pstAwbInfo, void*
pstAwbResult);
    int32_t (*pfn_awb_run)(void* ctx, uint32_t u32Cmd, void *pValue);
    int32_t (*pfn_awb_exit)(void* ctx);
} rk_aiq_customeAwb_cbs_t;
```

【Member】

Member name	Description
pfn_awb_init	After initialization , the first initialization is called by the AwbDemoPrepare function
pfn_awb_ctrl	Callback function pointers that control the internal state of Custom AWB are not currently supported.
pfn_awb_run	The callback function pointer that runs Custom AWB is rk_aiq_customAwb_stats_t and the actual type of pstAwbResult is rk_aiq_customeAwb_results_t, both of which are called by AwbDemoProcessing with reference to the following instructions If pstAwbResult==nullptr is represented as the time of initialization, it is used to configure the pstAwbResult at initialization, otherwise it is necessary to implement the function of calculating pstAwbResult based on the statistics pstAwbInfo
pfn_awb_exit	The freed requested memory, etc . is called by AwbDemoDestroyCtx

【Note】

- Users need to implement the above callback functions in the custom AWB library.
- pfn_awb_run implement pseudocode in custom_awb_run functions that can be referred to third_party_awb_algo_v32.cpp

2.2.2 Statistics

2.2.2.1 rk_aiq_customAwb_stats_t

【Description】

Defines white balance hardware statistics obtained by the Custom AWB algorithm.

【Definition】

```
typedef struct rk_aiq_customAwb_stats_s
{
    rk_aiq_awb_stat_wp_res_light_v201_t
light[RK_AIQ_AWB_MAX_WHITEREGIONS_NUM_V32];
    int WpNo2[RK_AIQ_AWB_MAX_WHITEREGIONS_NUM_V32];
    rk_aiq_awb_stat_blk_res_v201_t   blockResult[RK_AIQ_AWB_GRID_NUM_TOTAL];
    rk_aiq_awb_stat_wp_res_v201_t
excWpRangeResult[RK_AIQ_AWB_STAT_WP_RANGE_NUM_V201];
    unsigned int WpNoHist[RK_AIQ_AWB_WP_HIST_BIN_NUM];
    struct rk_aiq_customAwb_stats_s* next;
} rk_aiq_customAwb_stats_t;
```

【Member】

Member name	Description
light	White point statistics under different light sources in the main window, up to RK_AIQ_AWB_MAX_WHITEREGIONS_NUM_V32 light sources.
WpNo2	The number of white points at the intersection of the XY domain and the UV domain under different light sources in the main window, without decimal places.
blockResult	The RGB accumulation image for each block is evenly tiled in a total of 15x15 (RK_AIQ_AWB_GRID_NUM_TOTAL) blocks.
excWpRangeResult	Statistics of points that fall in the excludeWpRange region (only the first four regions of excludeWpRange are recorded), up to 4 regions.
WpNoHist	The number of white dots per bin in the white point histogram, no decimal places; Whether the white point of the XY box or the box in XY is counted is determined by the register xyRangeTypeForWpHist.
next	Useless

【Note】

- For details of each member, see the "Statistics/Data Types" section of Rockchip_Development_Guide_ISP32 rk_aiq_isp_awb_stats2_v32_t Definition of Structure Members.

2.2.3 The result of the operation

2.2.3.1 rk_aiq_customeAwb_results_t

【Description】

Define the configuration parameters and calculation results of the Custom AWB algorithm.

【Definition】

```
typedef struct rk_aiq_customeAwb_results_s
{
    bool  IsConverged; true: converged; false: not converged
    rk_aiq_wb_gain_t awb_gain_algo;
    float awb_smooth_factor;
    rk_aiq_customAwb_hw_cfg_t  awbHwConfig;
    rk_aiq_customeAwb_single_results_t *next;//defalut vaue is nullptr,which
means all cameras with the same cfg;
} rk_aiq_customeAwb_results_t;
```

【Member】

Member name	Description
IsConverged	characterize whether the current AWBgain converges; true converged, false unconverged; Default value: false; Must be configured.
awb_gain_algo	The gain of the R, GR, GB, B color channels derived by the Custom AWB algorithm; Default value: {1.0, 1.0, 1.0, 1.0}, no white balance correction; Must be configured.
awb_smooth_factor	The inter-frame smoothing factor provided to CCM and LSC, with larger values and smaller weights for the current frame; value range: [0,1]; Default value: 0.5; can be left unconfigured.
awbHwConfig	Hardware configuration parameters for the Custom AWB algorithm; Most parameters and module-related parameters need to be configured correctly, and other parameters have been configured with default values, which can not be updated; See the rk_aiq_customAwb_hw_cfg_t structure description below for details.
next	Useless

2.2.3.2 rk_aiq_customeAwb_single_results_t (useless)

【Description】

Define the configuration parameters and calculation results of each camera in the surround view mode of the Custom AWB algorithm, and non-surround view do not need to care

【Definition】

```
typedef struct rk_aiq_customeAwb_single_results_s
{
    rk_aiq_wb_gain_t awb_gain_algo;//for each camera
    rk_aiq_customAwb_single_hw_cfg_t  awbHwConfig;//for each camera
    struct rk_aiq_customeAwb_single_results_s *next;
} rk_aiq_customeAwb_single_results_t;
```

【Member】

Member name	Description
awb_gain_algo	Meaning of awb_gain_algo member in the same rk_aiq_customeAwb_results_s
awbHwConfig	This struct member has the same meaning as the member with the same name in the awbHwConfig struct in the rk_aiq_customeAwb_results_s
next	Useless, meaning of anext member in the same rk_aiq_customeAwb_results_s

2.2.3.3 rk_aiq_wb_gain_t

- See Rockchip_Development_Guide_ISP32 "AWB/Function-Level API/Data Type" section rk_aiq_wb_gain_t Struct definition.

2.2.3.4 rk_aiq_customAwb_hw_cfg_t

【Description】

Define hardware configuration parameters for the Custom AWB algorithm, main window multi-window configuration, statistical frame selection, etc.

【Definition】

```
typedef struct rk_aiq_customAwb_hw_cfg_s {
    bool awbEnable;
    rk_aiq_customAwb_Raw_Select_Mode_e frameChoose;
    unsigned short windowSet[4];
    unsigned char lightNum;
    unsigned short maxR;
    unsigned short minR;
    unsigned short maxG;
    unsigned short minG;
    unsigned short maxB;
    unsigned short minB;
    unsigned short maxY;
    unsigned short minY;
    bool multiwindow_en;
    unsigned short multiwindow[RK_AIQ_AWB_MULTIWINDOW_NUM_V201][4];
} rk_aiq_customAwb_hw_cfg_t;
```

【Member】

Member name	Description
awbEnable	AWB statistics enable switch; true enabled, false not enabled; Default value: true.
frameChoose	Input frame selection for AWB hardware statistics; values CUSTOM_AWB_INPUT_RAW_SHORT, CUSTOM_AWB_INPUT_RAW_LONG, CUSTOM_AWB_INPUT_BAYERNR, and CUSTOM_AWB_INPUT_DRC. CUSTOM_AWB_INPUT_RAW_SHORT Select short frame RAW; CUSTOM_AWB_INPUT_RAW_LONG Select long frame RAW (HDR mode is only effective); CUSTOM_AWB_INPUT_BAYERNR Select the output of the bayer2dnr module; CUSTOM_AWB_INPUT_DRC Select the output of the DRC module; default value: CUSTOM_AWB_INPUT_BAYERNR.
windowSet	AWB statistics main window configuration; windowSet=[h_offset,v_offset,h_size,v_size],h: horizontal, v: vertical; Value range: [0x0, 0xfff]; h_size* v_size must be less than 5120*2880; default value: {0, 0, RawWidth, RawHeight}, full window, if you do not change the window, no configuration is required.
lightNum	the number of light sources that are useless to participate in the statistics; value range: [0, 7]; default value: 7. It needs to be configured according to the number of light sources used during calibration, and the calibration tool will output.
maxR	When the RGB domain counts white point information, the upper limit of the R channel detected by white point detection; value range: [0x0, 0xff]; default value: 230.
minR	When the RGB domain counts the white point information, the lower limit of the R channel for white point detection; value range: [0x0, 0xff]; Default value: 3.
maxG	When the RGB domain counts the white point information, the upper limit of the G channel detected by the white point; value range: [0x0, 0xff]; default value: 230.
minG	When the RGB domain counts the white point information, the lower limit of the G channel of white point detection; value range: [0x0, 0xff]; Default value: 3.

Member name	Description
maxB	When the RGB domain counts the white point information, the upper limit of the B channel of white point detection; value range: [0x0, 0xff]; default value: 230.
minB	When the RGB domain counts the white point information, the lower limit of the B channel of white point detection; value range: [0x0, 0xff]; Default value: 3.
maxY	When the RGB domain counts the white point information, the upper limit of the Y channel detected by the white point; value range: [0x0, 0xff]; default value: 230.
minY	When the RGB domain counts the white point information, the lower limit of the Y channel of white point detection; value range: [0x0, 0xff]; Default value: 3.
multiwindow_en	AWB multi-window statistics enable switch; true enabled, false not enabled; default value: false.
multiwindow	AWB multi-window configuration, support up to 4 windows, multiwindow[i]= [h_offset,v_offset,h_size,v_size], h: horizontal, v: vertical; Value range: [0x0, 0xfff].

【Note】

- For a more in-depth understanding of these parameters, please refer to the following in the Rockchip_Color_Optimization_Guide document,

(a) "2 AWB/2.1 Function Description" section content and AWB flowchart content

(b) AWB white spot detection flowchart in the section "2 AWB/2.2 White Spot Detection Process for Key Parameters/Hardware"

2.2.3.5 rk_aiq_customAwb_single_hw_cfg_t (useless)

【Description】

Define the differentiated hardware configuration of each CAMEA in surround view mode, and non-surround view does not need to be concerned

【Definition】

```
typedef struct rk_aiq_customAwb_single_hw_cfg_t {
    unsigned short windowSet[4];
    bool multiwindow_en;
    unsigned short multiwindow[RK_AIQ_AWB_MULTIWINDOW_NUM_V201][4];
} rk_aiq_customAwb_single_hw_cfg_t;
```

【Member】

Member name	Description
windowSet	The meaning of windowSet in the same rk_aiq_customAwb_hw_cfg_t
multiwindow_en	multiwindow_en meaning in the same rk_aiq_customAwb_hw_cfg_t
multiwindow	The meaning of multiwindow in the same rk_aiq_customAwb_hw_cfg_t

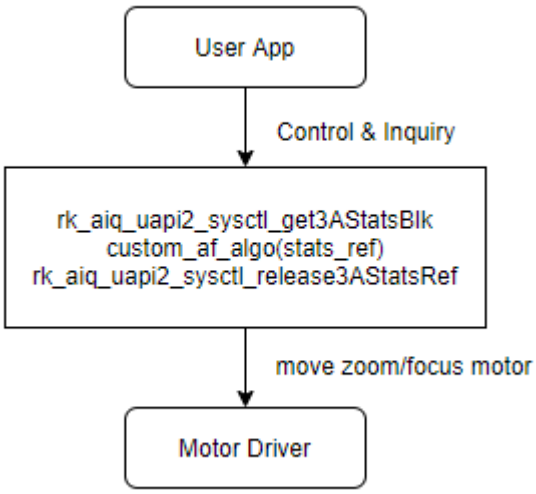
3. 2.3 Develop user AF algorithms

When the user does not use the RK AF algorithm library, the AF algorithm can be developed based on the 3A statistical value to realize functions such as zoom focusing.

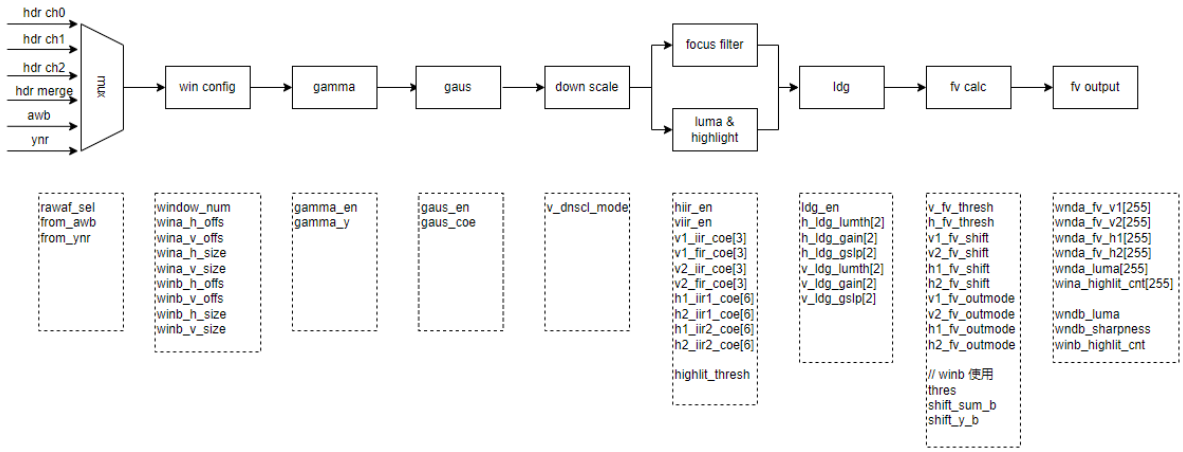
When the user implements the AF algorithm,

1. First, call rk_aiq_user_api2_af_SetAttrib to configure AF statistics;
2. Secondly, use the rk_aiq_uapi2_sysctl_get3AStatsBlk to obtain 3A statistical values, which is a blocking API, and when a new 3A statistical value is generated, it will be returned immediately;
3. Then the user AF algorithm can perform relevant calculations according to the 3A statistical value, and drive the zoom motor and focus motor to move;
4. Finally, you need to call rk_aiq_uapi2_sysctl_release3AStatsRef release the obtained 3A statistical value;

The overall flow of the algorithm is shown in the following figure.



3.1 2.3.1 AF statistics module



If the sensor inputs an HDR image, the AF module can select the output image of HDR short/medium/long exposure or a data of the HDR composite image as the input data of AF statistics.

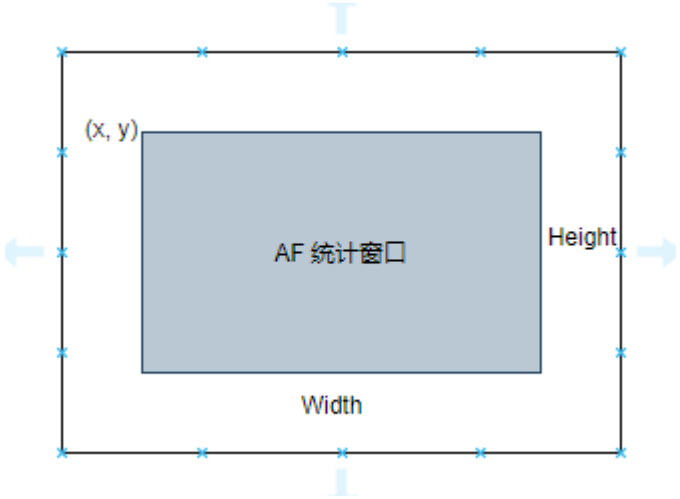
If the sensor inputs a Normal image, the AF module can select the input image of the sensor or the debayer image as the input data for AF statistics.

AF3.1 supports main window A, which contains 15*15 sub-windows, which can configure V1/V2/H1/H2 four filters, and output V1/V2/H1/H2 four FV values, brightness values and highlight statistics

Value. Stand-alone window B is in a discarded state and is not recommended.

3.2 2.3.2 AF Statistics Window Configuration

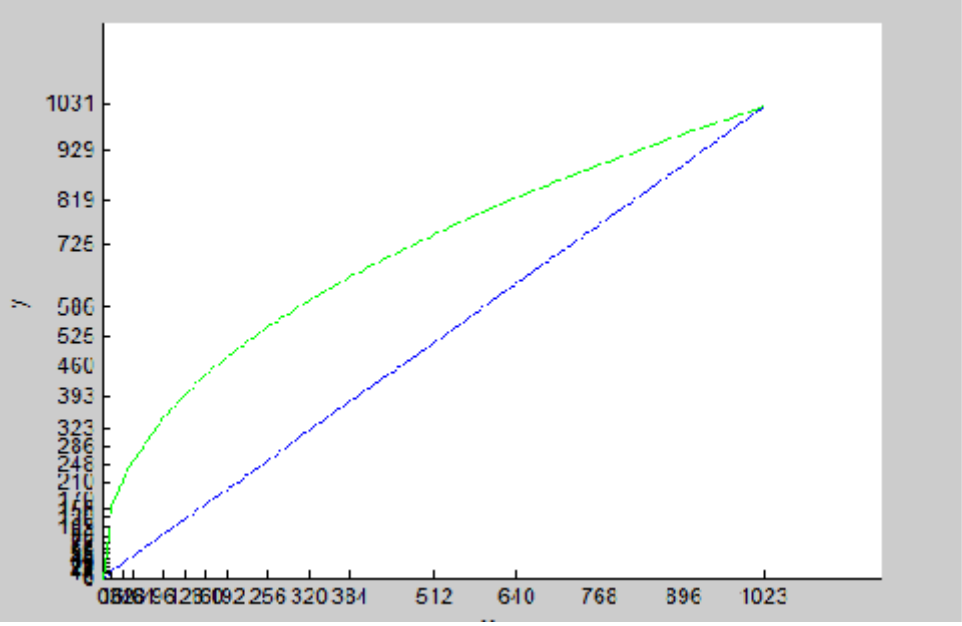
Main window A supports rectangular window configuration. You can configure the upper-left coordinates of rectangular windows and the width and height of the window.



3.3 2.3.3 Gamma

Gamma converts the sensor input RAW image into the degree to which the human eye perceives natural brightness, which is used to improve dark area contrast.
The x-coordinate segment is 0 to 1023:
16 16 16 16 32 32 32 32 64 64 64 128 128 128 128 128

The value range of the y coordinate is 0 to 1023.



3.4 2.3.4 Gaus

Pre-denoising treatment can be carried out, generally no treatment is required, and the following configuration can be performed.0 64 0

0 64 0

0 0 0

3.5 2.3.5 DownScale

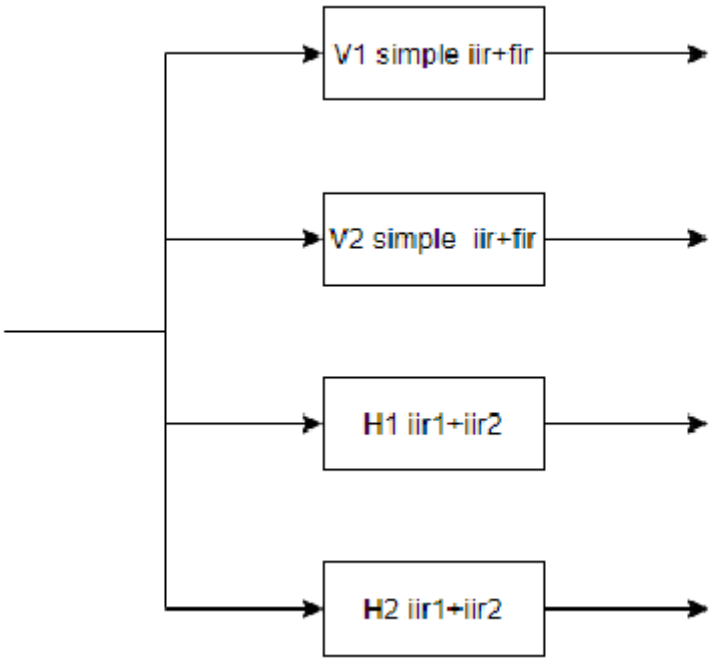
DownScale downsamples the incoming AF statistical signal to help support lower frequency filter bands.

3.6 2.3.6 Focus Filter

The main window A provides four filters V1/V2/H1/H2 for setting.

The frequency bands of the V1/V2/H1/H2 filters can be adjusted, and filter register values are generated using filter design tools.

Common typical band configurations can use [0.04n ~ 0.1n], and n is the scaling ratio, such as [0.01 ~ 0.025], [0.02 ~ 0.05], [0.04 ~ 0.1], [0.08 ~ 0.2], etc.



3.7 2.3.7 Luma/Highlight

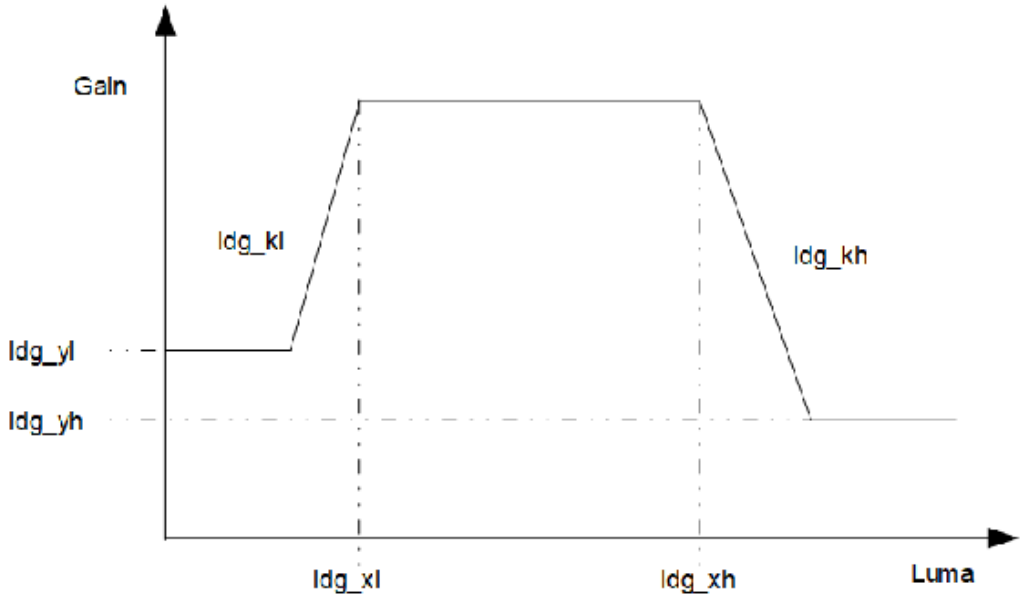
The main window A provides luminance statistics and highlight count statistics.

The FV value is easily affected by the light source, and when the focus is blurred, the low-frequency component in the image increases due to the diffusion of the halo, and the image blur will appear and the FV value will become larger.

The general solution is to use a highlight counter, when the focus is blurred, because the halo expands, the number of high highlights will increase, and when it is clear, the number of high highlights will be the smallest.

3.8 2.3.8 Luma Depend Gain

The effect of the light source can also be removed by the LDG function, which attenuates the FV value according to the brightness of the pixel and reduces the FV value at bright spots and too dark points.



When the brightness value is between [ldg_xl, ldg_xh], the Gain value output is 1, and the FV value is not attenuated;

When the brightness value is between [0, ldg_xl], the Gain value is attenuated according to the slope ldg_kl, and the Gain value is at least ldg_yl;

gain = 256 - ldg_kl*(ldg_xl - x)/256;
gain = max(gain, ldg_yl);

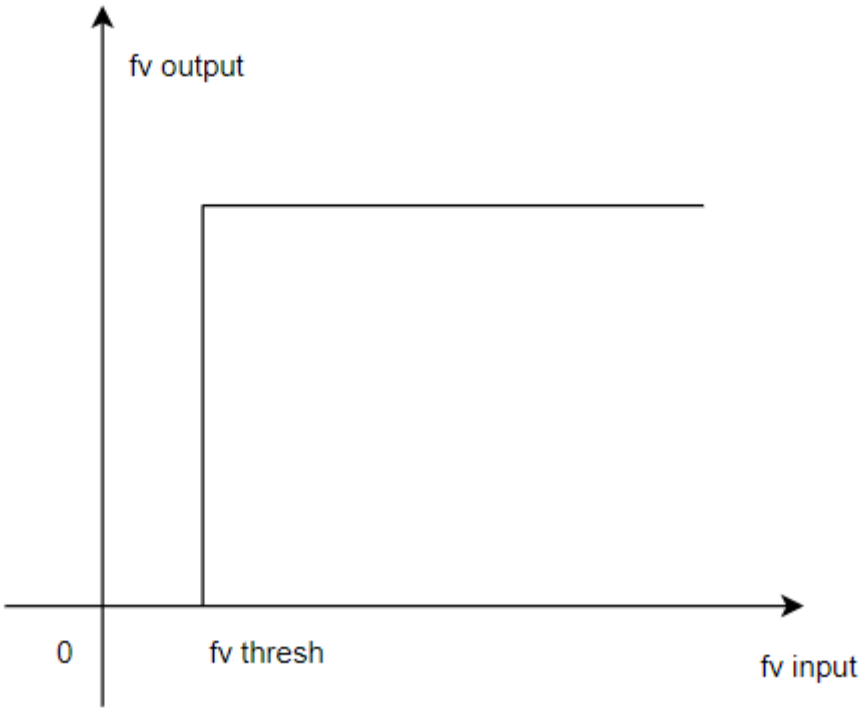
When the brightness value is between [ldg_xh, 255], the Gain value is attenuated according to the slope ldg_kh, and the Gain value is at least ldg_yh.

gain = 256 - ldg_kh*(x-ldg_xh)/256;
gain = max(gain, ldg_yh);

Horizontal H1/H2 share an LDG curve, vertical V1/V2 share an LDG curve.

3.9 2.3.9 Fv threshold

When calculating the Fv value, when the Fv value is less than the Fv threshold information, the final output is not counted, which can reduce the influence of noise.



The Fv threshold is the threshold for the LDG output value after the filtered result.

3.10 2.3.10 Fv Calc

The Fv value supports absolute value mode and squared mode, and the square mode squares the Fv value, which can increase the proportion of FV value in a clear position.

The hardware filter has an output bit width of 10 bits per pixel and a cumulative register bit width of 31 bits.

In order to avoid overflow during window statistical accumulation, it is necessary to configure the appropriate shift shift register according to the statistical mode and window size, shift the pixel FV value to the right and then perform window accumulation.

At present, the register used for shift is only 3 bits, and the maximum support is sum_shift=7, and the maximum window supported in absolute mode is 2^(31+7-10)=2^28, and the FV value in squared mode does not exceed it

20bit, the maximum supported window is 2^(31+7-20)=2^18 (in fact, most of the FV values obtained in a typical bandpass configuration do not meet the above thresholds, and larger windows can be supported).

3.11 2.3.11 Fv Output

The output of main window A contains v1/v2/h1/h2 Fv information for 15*15 and luma/highlight information for 15*15.

The distribution of the output of the main window A on the image is shown below

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv
2	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv
3	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv
4	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv
5	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv
6	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv
7	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv
8	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv
9	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv
10	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv
11	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv
12	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv
13	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv
14	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv
15	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv	Fv

3.12 2.3.12 Calculation of the final FV value

H1 and V1 can be configured in the low-pass band for coarse search and H2 and V2 in the high-pass band for fine search.

The horizontal filter output H and the vertical filter output V can be weighted with certain weights.

FV = FvH * weight + FvV * (1-weight)

The FV values obtained from each block can also be weighted according to a certain weight as needed.

3.13 Configuration of 2.3.13 AF statistics

Use rk_aiq_user_api2_af_SetAttrib for configuration

```
XCamReturn
rk_aiq_user_api2_af_SetAttrib(const rk_aiq_sys_ctx_t* sys_ctx, rk_aiq_af_attrib_t
attr);
```

Parameter Name	Description	Input/Output
sys_ctx	AIQ context pointer	Input
attr	Parameter properties of focus	Input

The rk_aiq_af_algo_meas_v31_t in the parameter rk_aiq_af_attrib_t are described as follows:

```
typedef struct {
    unsigned char af_en;
    unsigned char rawaf_sel;
    unsigned char gamma_en;
    unsigned char gaus_en;
    unsigned char v1_fir_sel;
    unsigned char hiir_en;
    unsigned char viir_en;
```

```
    unsigned char v1_fv_outmode;    // 0 square, 1 absolute
    unsigned char v2_fv_outmode;    // 0 square, 1 absolute
    unsigned char h1_fv_outmode;    // 0 square, 1 absolute
    unsigned char h2_fv_outmode;    // 0 square, 1 absolute
    unsigned char ldg_en;
    unsigned char accu_8bit_mode;
    unsigned char ae_mode;
    unsigned char y_mode;
    unsigned char vldg_sel;
    unsigned char sobel_sel;
    unsigned char v_dnscl_mode;
    unsigned char from_awb;
    unsigned char from_ynr;
    unsigned char ae_config_use;
    unsigned char line_en[RKAIQ_RAWAF_LINE_NUM];
    unsigned char line_num[RKAIQ_RAWAF_LINE_NUM];

    unsigned char window_num;
    unsigned short wina_h_offs;
    unsigned short wina_v_offs;
    unsigned short wina_h_size;
    unsigned short wina_v_size;
    unsigned short winb_h_offs;
    unsigned short winb_v_offs;
    unsigned short winb_h_size;
    unsigned short winb_v_size;

    unsigned short gamma_y[RKAIQ_RAWAF_GAMMA_NUM];

    // [old version param]
    unsigned short thres;
    unsigned char shift_sum_a;
    unsigned char shift_sum_b;
    unsigned char shift_y_a;
    unsigned char shift_y_b;

    char gaus_coe[9];

    /**********[Vertical IIR (v1 & v2)]************/
    short v1_iir_coe[3];
    short v1_fir_coe[3];
    short v2_iir_coe[3];
    short v2_fir_coe[3];

    /**********[Horizontal IIR (h1 & h2)]************/
    short h1_iir1_coe[6];
    short h2_iir1_coe[6];
    short h1_iir2_coe[6];
    short h2_iir2_coe[6];

    /**********[Focus value statistic param]**********/
    // level depended gain
    // input8 lumi, output8bit gain
    unsigned char h_ldg_lumth[2];    //luminance thresh
    unsigned char h_ldg_gain[2];     //gain for [minLum,maxLum]
    unsigned short h_ldg_gslp[2];    //[slope_low,-slope_high]
```

```
    unsigned char v_ldg_lumth[2];
    unsigned char v_ldg_gain[2];
    unsigned short v_ldg_gslp[2];

    // coring
    unsigned short v_fv_thresh;
    unsigned short h_fv_thresh;

    // left shift, more needed if outmode=square
    unsigned char v1_fv_shift; //only for sel1
    unsigned char v2_fv_shift;
    unsigned char h1_fv_shift;
    unsigned char h2_fv_shift;

    /**********[High light]**********/
    unsigned short highlit_thresh;
} rk_aiq_af_algo_meas_v31_t;
```

Member Name	Description
af_en	Whether AF is enabled Information statistics, 0 is off and 1 is on
rawaf_sel	Select the channel of AF information statistics, the value range is 0-3, the long/medium/short/synthetic frame channel selection corresponding to HDR mode, the general AF selection medium frame channel, the non-HDR mode is set to 0, and the HDR mode is set to 1
gamma_en	The gamma module enables the switch, 0 is off and 1 is on
gaus_en	The setting needs to be fixed to 1
v1_fir_sel	The setting needs to be fixed to 1
hiir_en	H1/H2 channel enable switch, 0 is off and 1 is on
viir_en	V1/V2 channel enable switch, 0 is off and 1 is on. Note that when the gamma_en is open, the viir_en must be set to 1
v1_fv_outmode	V1 channel FV output mode selection, 0 for squared mode, 1 for absolute value mode
v2_fv_outmode	V2 channel FV output mode selection, 0 for squared mode, 1 for absolute mode
h1_fv_outmode	H1 channel FV output mode selection, 0 for squared mode, 1 for absolute mode
h2_fv_outmode	H2 channel FV output mode selection, 0 for squared mode, 1 for absolute mode
ldg_en	The LDG function enables the switch, 0 is off and 1 is on
accu_8bit_mode	The setting needs to be fixed to 1
ae_mode	When the ae_mode is set to 1, RAWAF enables 15x15 luminance averaging statistics, multiplexing the logic of the RAWAE_BIG module
y_mode	The setting needs to be fixed to 0
vldg_sel	The setting needs to be fixed to 0
sobel_sel	The setting needs to be fixed to 0
v_dnscl_mode	Wide and narrow band mode selection, set to the output of the AF filter coefficient generation tool
from_awb	The AF statistical input is obtained from AWB
from_ynr	The AF statistics input is obtained from the YNR
ae_config_use	Fixed configuration is 0
line_en	It is not yet in effect
line_num	It is not yet in effect
window_num	The number of windows in effect, when the window_num is 1, WinA (main window) takes effect; When the window_num is 2, WinA (main window) and WinB (independent window) take effect

Member Name	Description
wina_h_offs	The horizontal coordinate of the first pixel in the upper-left corner of Wina (main window), which must be greater than or equal to 2
wina_v_offs	The vertical coordinate of the first pixel in the upper-left corner of WinA (main window), which must be greater than or equal to 1
wina_h_size	the window width of Wina (main window), which must be less than the image width -2-wina_h_offs; At the same time, the value must be a multiple of 15;
wina_v_size	the window width of Wina (main window), which must be less than the image width -2-wina_v_offs; At the same time, the value must be a multiple of 15;
winb_h_offs	The horizontal coordinate of the first pixel in the upper-left corner of Winb (Standalone Window), which must be greater than or equal to 2
winb_v_offs	The vertical coordinate of the first pixel in the upper-left corner of Winb (Standalone Window), which must be greater than or equal to 1
winb_h_size	The window width of winb (independent window), which must be less than the image width -2-wina_h_offs
winb_v_size	The window height of WinB (Independent Window), which must be less than the image height -2-wina_v_offs
gamma_y	The y value of the gamma table, the value range is 0-1023; The x-coordinate segment is 0 to 1023: 16 16 16 16 32 32 32 32 64 64 64 128 128 128 128 128
thres	When the calculated fv value is less than this value, the fv value is changed to 0 to reduce the influence of noise, and the value range is 0-0xFFFF
shift_sum_a	It is currently unavailable and can be fixed to 0
shift_sum_b	The shit bit value of the fv value of win b (independent window) will shift the fv value to the right according to this value to avoid the overflow of the obtained fv value, and the value range is 0-7
shift_y_a	It is currently unavailable and can be fixed to 0
shift_y_b	The shit bit value of the luma value of win b (independent window) will shift the luma value to the right according to this value to avoid the overflow of the luma value, and the value range is 0-7
gaus_coe	3*3 pre-filtering
v1_iir_coe[3]	The 1X3 IIR factor for the V1 channel is set according to the output of the AF filter coefficient generation tool
v1_fir_coe[3]	The 1x3 FIR factor for the V1 channel is set to the output of the AF filter coefficient generation tool
v2_iir_coe[3]	The 1x3 IIR factor for the V2 channel is set according to the output of the AF filter coefficient generation tool

Member Name	Description
v2_fir_coe[3]	The 1x3 FIR factor for the V2 channel is set according to the output of the AF filter coefficient generation tool
h1_iir1_coe[6]	The 1X6 IIR1 coefficient for the H1 channel is set according to the output of the AF Filter Factor Generation tool
h2_iir1_coe[6]	The 1X6 IIR1 coefficient for the H2 channel is set according to the output of the AF filter coefficient generation tool
h1_iir2_coe[6]	The 1X6 IIR2 coefficient for the H1 channel is set according to the output of the AF filter coefficient generation tool
h2_iir2_coe[6]	The 1X6 IIR2 coefficient for the H2 channel is set according to the output of the AF filter coefficient generation tool
h_ldg_lumth[2]	The brightness threshold coefficient of the ldg module used for H1/H2 channels, 0 is set for the left dark area, 1 is the right highlight area, and the value range is 0~255
h_ldg_gain[2]	The minimum gain value of the ldg module used for H1/H2 channels, 0 is the left dark area setting, 1 is the right highlight area setting, the value range is 0~255
h_ldg_gslp[2]	The slope coefficient of the ldg module used for H1/H2 channels, 0 is set for the left dark area, 1 is set for the right highlight area, and the value range is 0~65535
v_ldg_lumth[2]	The brightness threshold coefficient of the ldg module used for V1/V2 channels, 0 is set for the left dark area, 1 is the right highlight area, and the value range is 0~255
v_ldg_gain[2]	The minimum gain value of the ldg module used for V1/V2 channels, 0 is the left dark area setting, 1 is the right highlight area setting, the value range is 0~255
v_ldg_gslp[2]	The minimum gain value of the ldg module used for V1/V2 channels, 0 is the left dark area setting, 1 is the right highlight area setting, the value range is 0~255
v_fv_thresh	For the AF statistical threshold used for V1/V2 channels, when the calculated fv value is less than this value, the fv value is changed to 0, which can reduce the influence of noise, and the value range is 0-0x0FFF
h_fv_thresh	For the AF statistical threshold used for H1/H2 channels, when the calculated fv value is less than this value, the fv value is changed to 0, which can reduce the influence of noise, and the value range is 0-0x0FFF
v1_fv_shift	The shit bit value of the fv value used for the V1 channel will shift the fv value to the right according to this value to avoid the overflow of the obtained fv value, and the value range is 0-7
v2_fv_shift	The shit bit value of the fv value used for the V2 channel will shift the fv value to the right according to this value to avoid the overflow of the obtained fv value, and the value range is 0-7
h1_fv_shift	The shit bit value of the fv value used for the H1 channel will shift the fv value to the right according to this value to avoid the overflow of the obtained fv value, and the value range is 0-7

Member Name	Description
h2_fv_shift	The shit bit value of the fv value used for the H2 channel will shift the fv value to the right according to this value to avoid the overflow of the obtained fv value, and the value range is 0-7
highlit_thresh	Indicates the threshold of the highlight statistics, when higher than this value, it is considered to be high highlights, included in the statistics, only the number of high highlights in each area is accumulated, and the value range is 0-0x0FFF

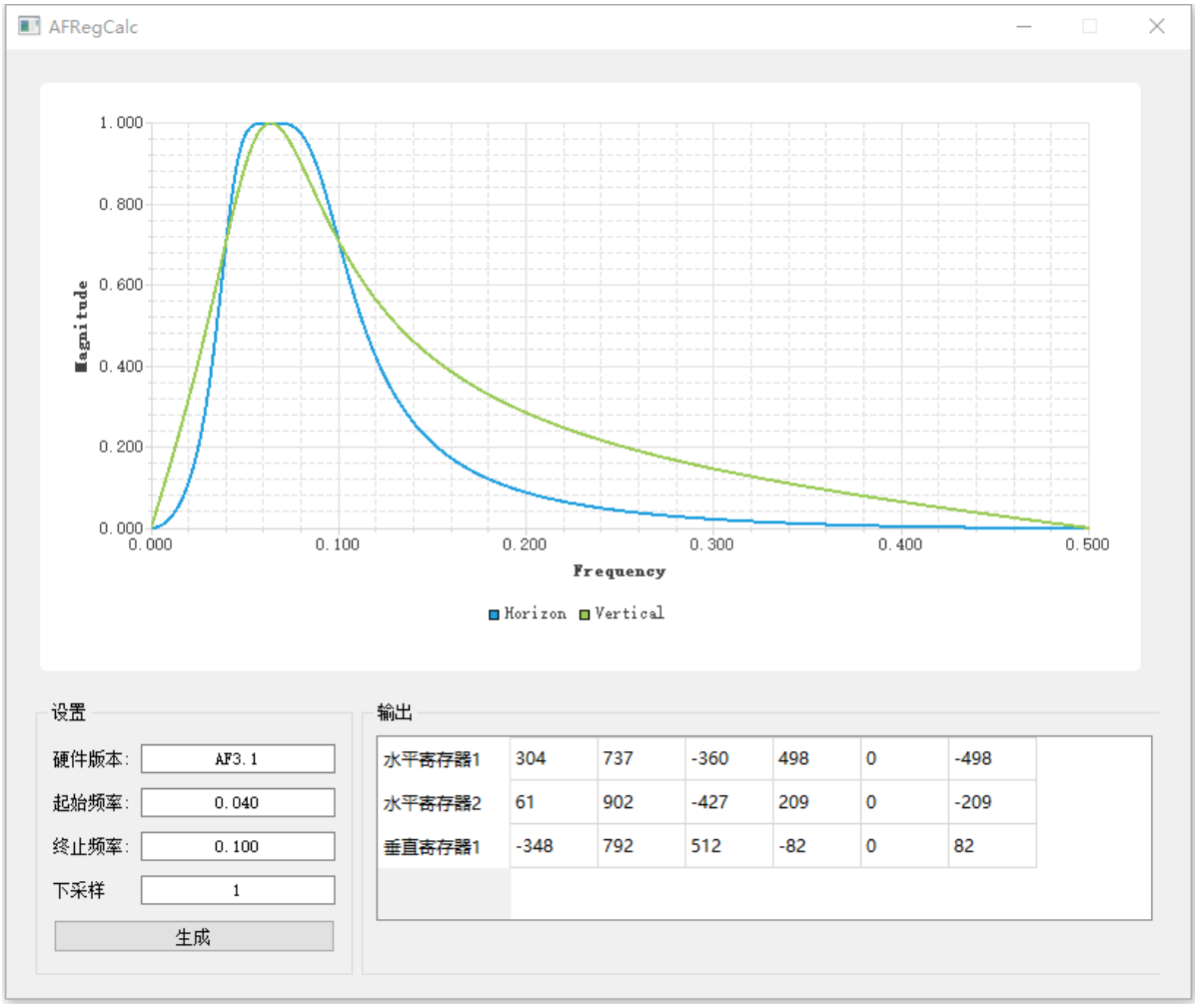
3.14 2.3.14 Acquisition of AF statistical values

See the "Statistics" section of Rockchip_Development_Guide_ISP32 for details

rk_aiq_uapi2_sysctl_get3AStatsBlk () / rk_aiq_uapi2_sysctl_release3AStatsRef()

The relevant structure for AF statistical results is rk_aiq_isp_af_stats_v3x_t

3.15 2.3.15 Use of filter design tools



The hardware version on ISP32 platforms should enter AF3.1.

The input range of the start frequency and end frequency is 0.005 ~ 0.490, but due to actual hardware limitations, the input range is smaller than the theoretical input range, refer to the output of the tool.

Downsampling helps support lower frequency filter bands, with inputs of 1 or 2, which the tool may modify depending on the input of the start and end frequencies.

When the generate button is clicked, the output box displays the filter register value and the corresponding filter response curve at the top.

4. 2.4 Refer to the code sample

For customer 3A algorithm implementation reference code examples, you can refer to:

Directory: AIQ root/rkisp_demo/demo/

|-------ae_algo_demo // AE algorithm reference code

|-------awb_algo_demo // AWB algorithm reference code

|-------af_algo_demo // AF algorithm reference code