HISILICON

GDC Debugging Guide

Issue   01

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About This Document

Related Versions

The following table lists the product versions related to this document.

Product Name	Version
Hi3559A	V100ES
Hi3559A	V100
Hi3559C	V100
Hi3519A	V100
Hi3556A	V100
Hi3516C	V500
Hi3516D	V300
Hi3516A	V300
Hi3559	V200
Hi3556	V200

📖 NOTE

- Unless otherwise stated, Hi3559C V100 and Hi3559A V100 contents are consistent.
- Unless otherwise stated, Hi3556A V100 and Hi3519A V100 contents are consistent.
- Unless otherwise stated, Hi3516D V300 and Hi3516C V500 contents are consistent.
- Unless otherwise stated, Hi3559 V200, Hi3556 V200, Hi3516A V300, and Hi3516D V300 contents are consistent.

Intended Audience

This document is intended for:

- Technical support engineers
- Software development engineers

Symbol Conventions

The symbols that may be found in this document are defined as follows.

Symbol	Description
DANGER	Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.
WARNING	Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.
CAUTION	Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.
NOTICE	Indicates a potentially hazardous situation which, if not avoided, could result in equipment damage, data loss, performance deterioration, or unanticipated results. NOTICE is used to address practices not related to personal injury.
NOTE	Calls attention to important information, best practices and tips. NOTE is used to address information not related to personal injury, equipment damage, and environment deterioration.

Change History

Changes between document issues are cumulative. The latest document issue contains all changes made in previous issues.

Issue 01 (2019-06-25)

This issue is the first official release, which incorporates the following changes:

The descriptions about functions unsupported by Hi3556 V200 are added.

Issue 00B08 (2019-03-12)

This issue is the eighth draft release, which incorporates the following changes:

In section 1.1, Table 1-1 is modified.

In section 2.2.1, Table 2-4, Table 2-5, Table 2-6, and Table 2-9 are modified, and Table 2-10 is added.

Section 2.1.3 is added.

Issue 00B07 (2019-01-15)

This issue is the seventh draft release, which incorporates the following changes:

In section 1.1, Table 1-1 is modified.

Issue 00B06 (2018-10-15)

This issue is the sixth draft release, which incorporates the following changes:

Section 2.2.4, Table 2-14 and Table 2-15 are modified.

Issue 00B05 (2018-09-06)

This issue is the fifth draft release, which incorporates the following changes:

The description of Hi3516C V500/Hi3516D V300 is added.

Issue 00B04 (2018-07-10)

This issue is the fourth draft release, which incorporates the following changes:

In section 2.2.4, Table 2-14 is modified.

Issue 00B03 (2018-05-18)

This issue is the third draft release, which incorporates the following changes:

Sections 2.1.2 and 2.2.4 are added.

Issue 00B02 (2018-01-30)

This issue is the second draft release, which incorporates the following changes:

Section 2.2.1 is modified.

Issue 00B01 (2017-11-15)

This issue is the first draft release.

Contents

Figures

Tables

1 GDC Functions and Specifications

The geometric distortion correction (GDC) subsystem implements fisheye correction (including 360° panoramic, 180° panoramic, and normal correction modes), lens distortion correction (LDC), and broadening functions on image frames.

NOTICE

For details about LDC description, see chapter 2 "System Control" in *HiMPP V4.0 Media Processing Software Development Reference*.

1.1 Algorithm Specifications of Each Chip

Table 1-1 Algorithm specifications

Specifications		Hi3516C V500	Hi3519A V100	Hi3559A V100	Hi3559A V100ES
Fisheye Correction	General Configuration	Pan, Tilt, Zoom	Pan, Tilt, Zoom	Pan, Tilt, Zoom	Pan, Tilt, Zoom
		Offset configurable	Offset configurable	Offset configurable	Offset configurable
		OutRadius	OutRadius LMF	OutRadius LMF	OutRadius LMF
	Ceiling/Desktop View	N.A.	InRadius	InRadius	InRadius
	360 Panorama				
	Ceiling/Desktop View	IsUseROIXY ROICenterX	IsUseROIXY ROICenterX	sUseROIXY ROICenterX	N.A.
	Rectilinear	ROICenterY	ROICenterY	ROICenterY	
	Wall	N.A.	Fan Correction	Fan Correction	Fan Correction

Specifications		Hi3516C V500	Hi3519A V100	Hi3559A V100	Hi3559A V100ES
	180 Panorama	N.A.	Trapezoid Correction	Trapezoid Correction	Trapezoid Correction
	Wall	Trapezoid Correction	Trapezoid Correction	Trapezoid Correction	Trapezoid Correction
	Rectilinear	IsUseROIXY ROICenterX ROICenterY	IsUseROIXY ROICenterX ROICenterY	IsUseROIXY ROICenterX ROICenterY	
LDC		Offset configurable Ratio configurable FOV configurable (XRatio, YRatio, XYRatio)	Offset configurable Ratio configurable FOV configurable (XRatio, YRatio, XYRatio)	Offset configurable Ratio configurable FOV configurable (XRatio, YRatio, XYRatio)	Offset configurable Ratio configurable FOV configurable (XRatio, YRatio, XYRatio)
Image Spread		Spread Strength configurable	Spread Strength configurable	Spread Strength configurable	Spread Strength configurable
Free Angle Rotation		Rotation Angle: [0,360]	Rotation Angle: [0,360]	Rotation Angle: [0,360]	Rotation Angle: [0,360]
		Crop mode: CropIn, CropOut, Typical	Crop mode: CropIn, CropOut, Typical	Crop mode: CropIn, CropOut, Typical	Crop mode: CropIn, CropOut, Typical
Perspective Mapping Function		Supported	Supported	Supported	N.A.
Function Combination		LDC + Fix Angle Rotation	LDC + Fix Angle Rotation	LDC + Fix Angle Rotation	LDC + Fix Angle Rotation
		LDC + PMF (for DIS) LDC + Spread	LDC + PMF (for DIS) LDC + Spread	LDC + PMF (for DIS) LDC + Spread	LDC + PMF (for DIS) LDC + Spread

2 GDC Debugging Guide

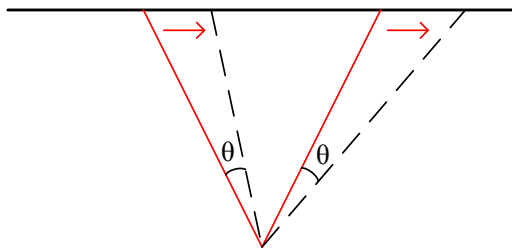## 2.1 Basic Concepts

2.1.1 Field Angle

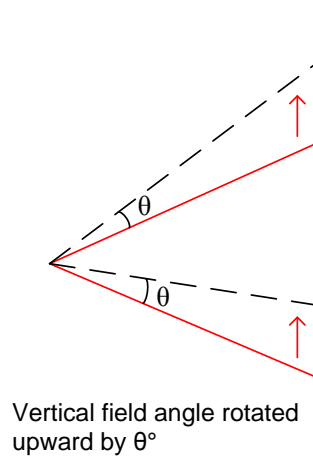**Figure 2-1** Diagram of the horizontal and vertical field angles

Horizontal field angle: α
Vertical field angle: β
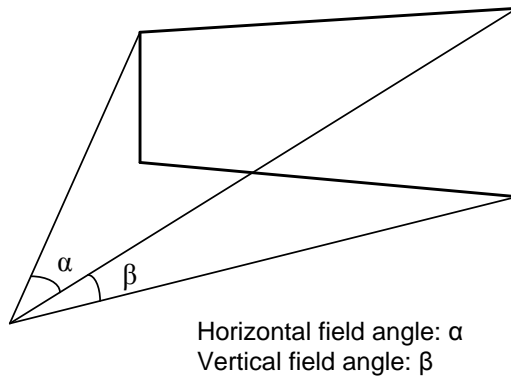
Figure 2-2 Rotation diagram of the horizontal field angle

Horizontal field angle rotated rightward by θ°

Figure 2-3 Rotation diagram of the vertical field angle

Vertical field angle rotated
upward by θ°

2.1.2 PMF

The perspective mapping function (PMF) implements projection mapping of images.

2.1.3 Coordinate Mapping

In fisheye correction, you can obtain the coordinate in the original image corresponding to a coordinate of an ROI in the output image using coordinate mapping.

2.2 Description of Parameter Debugging in Diverse Scenarios

2.2.1 Fisheye

Mount Modes

The fisheye subsystem supports three mount modes: floor mount, ceiling mount, and wall mount. The floor mount mode applies to the look-up scenario where the camera is installed on the desk or floor. The ceiling mount mode applies to the look-down scenario where the camera is installed on the ceiling. The wall mount mode applies to the scenario where the camera is installed on vertical planes such as the wall. You can select the correction mode that is appropriate to the installation scenario to achieve the optimal effect.
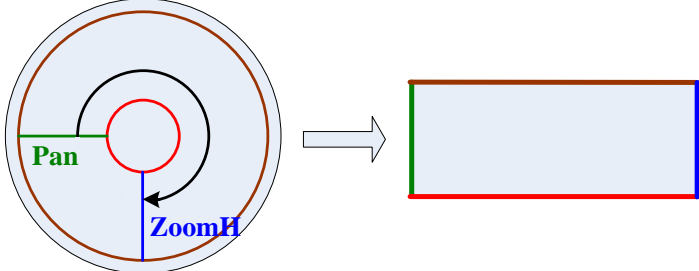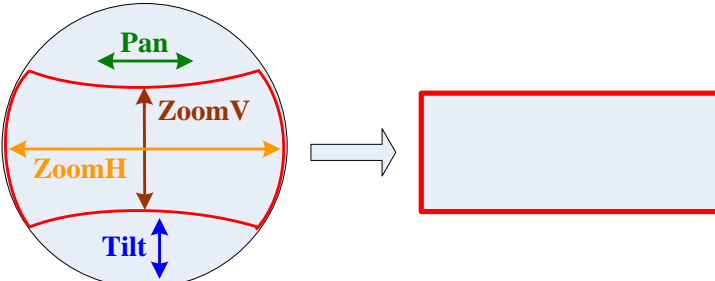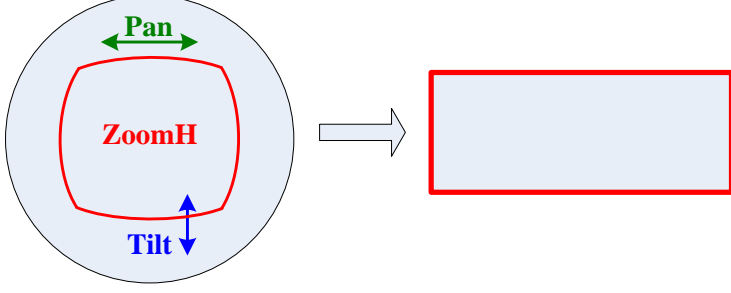
Correction Modes

The fisheye selects the correction region by setting the pan-tilt-zoom (PTZ) parameters in each correction mode to implement the electronic PTZ function. Table 2-1 describes the PTZ parameters and correction models of each correction mode in typical scenarios.

📖 **NOTE**

The outside radius parameter (**OutRadius**) of the fisheye is used to limit the boundary of the original image content for the fisheye. Hardware considers the parts that exceed **OutRadius** to be invalid contents (black). **OutRadius** should be set to the actual radius of the original image for the fisheye. The inside radius **InRadius** is valid only in 360° panoramic correction mode. **InRadius** and **OutRadius** determine the range of the correction region in the radius direction. **OutRadius** must be set to the radius of the original image regardless of the correction mode. The correction region should be determined by the PTZ parameters.

Table 2-1 Fisheye correction modes

Correction Mode	Typical Scenario	Parameter Description	Correction Model
360° panoramic correction	Ceiling mount and floor mount	• **Pan**: start position of the correction region • **Tilt**: movement of the correction region relative to the original image in the radius direction • **ZoomH**: range of the correction region (amplitude) • **ZoomV**: height of the correction region	
180° panoramic correction	Wall mount	• **Pan**: parameter indicating whether the field angle rotates leftward or rightward • **Tilt**: parameter indicating whether the field angle rotates upward or	

Correction Mode	Typical Scenario	Parameter Description	Correction Model
		downward • **ZoomH**: horizontal field angle • **ZoomV**: vertical field angle	
Normal correction	Wall mount, ceiling mount, and floor mount	• **Pan**: parameter indicating whether the field angle rotates leftward or rightward • **Tilt**: parameter indicating whether the field angle rotates upward or downward • **ZoomH**: horizontal and vertical field angles • **ZoomV**: invalid parameter	

☐ NOTE

Wall mount in 360° correction mode is not supported. Ceiling mount and floor mount in 180° correction mode are not supported.

Application Scenarios

- Wall mount

  In wall mount mode, the 180° panoramic correction mode and normal correction mode are recommended. Table 2-2 to Table 2-4 describe the effect demonstration and parameter description.

Table 2-2 Parameter description in wall mount 180° panoramic correction mode

Parameter	Description
Pan	Parameter indicating whether the field angle rotates leftward or rightward. If **Pan** is greater than **180**, the field angle rotates rightward. If **Pan** is less than **180**, the field angle rotates leftward. Rotation range: [−Width/2, Width/2] Note: **Width** indicates the width of the output image.
Tilt	Parameter indicating whether the field angle rotates upward or downward. If **Tilt** is greater than **180**, the field angle rotates upward. If **Tilt** is less than **180**, the field angle rotates downward. Rotation range: [−30°, +30°]
ZoomH	Horizontal field angle, 4095 at the maximum (180°)
ZoomV	Vertical field angle, 4095 at the maximum (90°)

Table 2-3 Effect demonstration in wall mount 180° panoramic correction mode

Typical Parameter Setting	Diagram	Correction Effect Demonstration
Input image width and height InWidth: 3000 InHeight: 3000 **180° correction parameters** Mount mode: Wall mount OutWidth: 3000 OutHeight: 1500 HorOffset: 0 VerOffset: 0 OutRadius: 1500 Pan: 180 Tilt: 180 ZoomH: 4095 ZoomV: 4095	The content on the left is the typical setting in wall mount 180° panoramic correction mode (the output image width is equal to the input image width, and the output image height is half of the input image height). The following diagrams are the demonstration diagrams when the value of a specific parameter is changed under the typical setting. The images on the right are the corresponding correction effect images.	
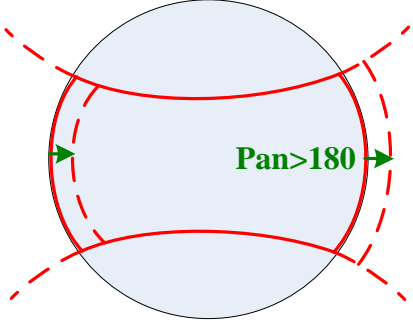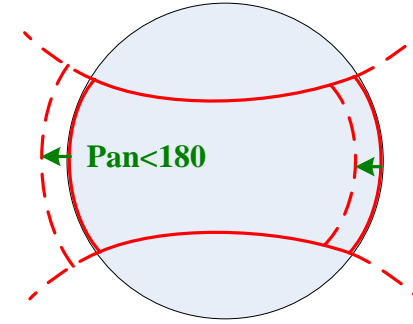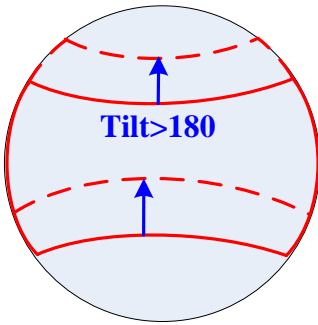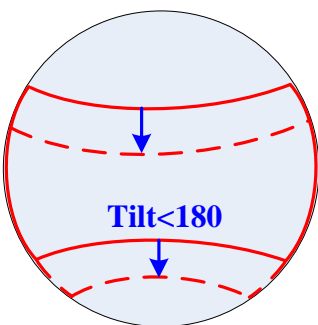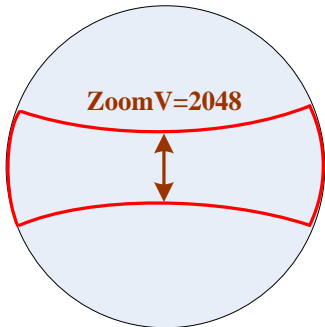
Typical Parameter Setting		Diagram	Correction Effect Demonstration
Trapezoid Coef	0		
FanStreng th	0		
TrapezoidCoef = 32 The trapezoid strength coefficient **TrapezoidCoef** is valid only during normal correction and 180° correction in wall mount mode.			
FanStrength = 500 The fan strength coefficient **FanStrength** is valid only in 180° correction mode and is used to adjust lines in the horizontal direction.			
FanStrength = −500			

Typical Parameter Setting	Diagram	Correction Effect Demonstration
Pan = 270		
Pan = 90		
Tilt = 270		
Tilt = 90		

Typical Parameter Setting	Diagram	Correction Effect Demonstration
ZoomH = 2048		
ZoomV = 2048		

Table 2-4 Parameter description in wall mount normal correction mode
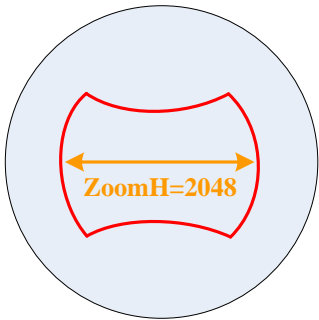
Parameter	Description
Pan	Parameter indicating whether the field angle rotates leftward or rightward. If **Pan** is greater than **180**, the field angle rotates rightward. If **Pan** is less than **180**, the field angle rotates leftward. Rotation range: $[-90°, +90°]$
Tilt	Parameter indicating whether the field angle rotates upward or downward. If **Tilt** is greater than **180**, the field angle rotates downward. If **Tilt** is less than **180**, the field angle rotates upward. Rotation range: $[-90°, +90°]$
ZoomH	Horizontal and vertical field angles, 4095 at the maximum (126°. The horizontal and vertical field angles are the same in normal mode.)
ZoomV	Invalid parameter

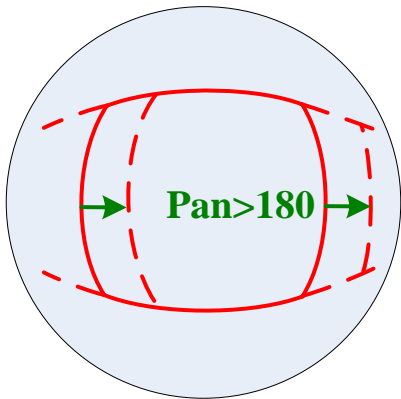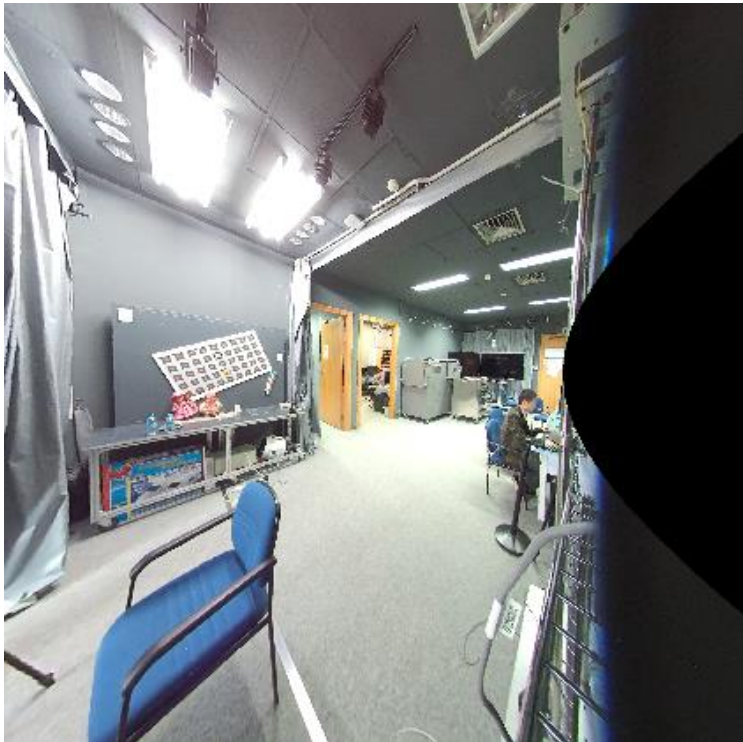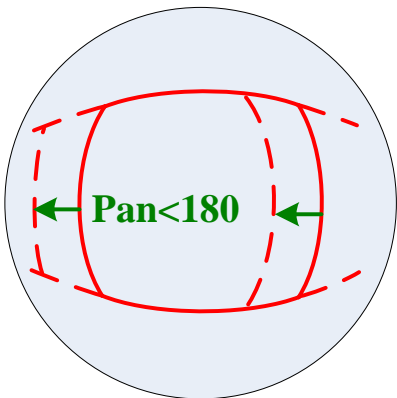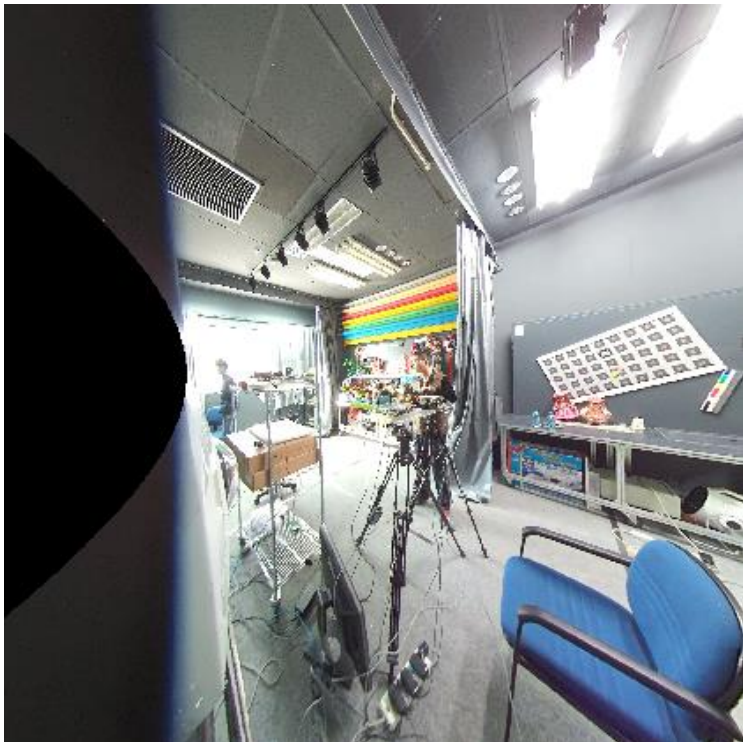| Parameter	Description
IsUseROIXY	Parameter indicating whether to use the coordinate of an ROI in the original image to automatically calculate the **Pan** and **Tilt** parameters and adjust the correction position. When this parameter is set to **true**, **Pan** and **Tilt** configurations are invalid, and the coordinate of (ROICenterX, ROICenterY) in the original image is used as the correction center. When this parameter is set to **false**, **Pan** and **Tilt** settings are used to adjust the correction position. In this situation, ROICenterX and ROICenterY are invalid.
ROICenterX	Center X coordinate of the ROI in the fisheye pie chart
ROICenterY	Center Y coordinate of the ROI in the fisheye pie chart

Table 2-5 Effect demonstration in wall mount normal correction mode

Typical Parameter Setting		Diagram	Correction Effect Demonstration
Input image width and height		The content on the left is the typical setting in wall mount normal correction mode (the output image width and height are equal to the input image width and height). The following diagrams are the demonstration diagrams when the value of a specific parameter is changed under the typical setting. The images on the right are the corresponding correction effect images.	
InWidth	3000		
InHeight	3000		
Normal correction parameters			
Mount mode	**Wall mount**		
OutWidth	3000		
OutHeight	3000		
HorOffset	0		
VerOffset	0		
OutRadius	1500		
Pan	180		
Tilt	180		
ZoomH	4095		
Trapezoid Coef	0		

Typical Parameter Setting		Diagram	Correction Effect Demonstration
FanStrength	0		
IsUseROIXY	False		
TrapezoidCoef = 32 The trapezoid strength coefficient **TrapezoidCoef** is valid only during normal correction and 180° correction in wall mount mode.			

Typical Parameter Setting	Diagram	Correction Effect Demonstration
Pan = 270		
Pan = 90		

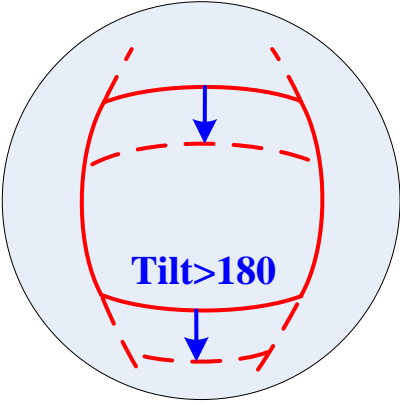| Typical Parameter Setting	Diagram	Correction Effect Demonstration
Tilt = 270	Tilt>180	
Tilt = 90	Tilt<180	

Typical Parameter Setting	Diagram	Correction Effect Demonstration
ZoomH = 2048 (The field angle when **ZoomH** is **2048** is 63°, which is only half of that when **ZoomH** is **4095**.) **ZoomH=2048**		
IsUseROIXY = 1 ROICenterX= 1000 ROICenterY= 1000 (Equivalent to the correction effect when **Pan** is **120** and **Tile** is **120**) (ROICenterX, ROICenterY)		

- Ceiling mount and floor mount

In ceiling mount and floor mount modes, the 360° panoramic correction mode and normal correction mode are recommended. Table 2-6 to Table 2-8 describe the effect demonstration and parameter description.

Table 2-6 Parameter description in ceiling/floor mount normal correction mode

Parameter	Description
Pan	The direction in the **Pan** angle of the original image is selected as the direction right above the corrected image. Rotation range: [0°, $360°$]
Tilt	The absolute value of the difference between **Tilt** and 180 indicates the amplitude of the field angle rotates to the direction determined by **Pan**. Rotation range: [0°, $90°$]
ZoomH	Horizontal and vertical field angles, 4095 at the maximum (126°. The horizontal and vertical field angles are the same in normal mode.)
ZoomV	The parameter is invalid.
IsUseROIXY	Parameter indicating whether to use the coordinate of an ROI in the original image to replace the **Pan** and **Tilt** parameters and adjust the correction position. When this parameter is set to **true**, **Pan** and **Tilt** configurations are invalid, and the coordinate of (ROICenterX, ROICenterY) in the original image is used as the correction center. When this parameter is set to **false**, **Pan** and **Tilt** settings are used to adjust the correction position. In this situation, ROICenterX and ROICenterY are invalid.
ROICenterX	Center X coordinate of the ROI in the fisheye pie chart
ROICenterY	Center Y coordinate of the ROI in the fisheye pie chart

Table 2-7 Effect demonstration in ceiling/floor mount normal correction mode
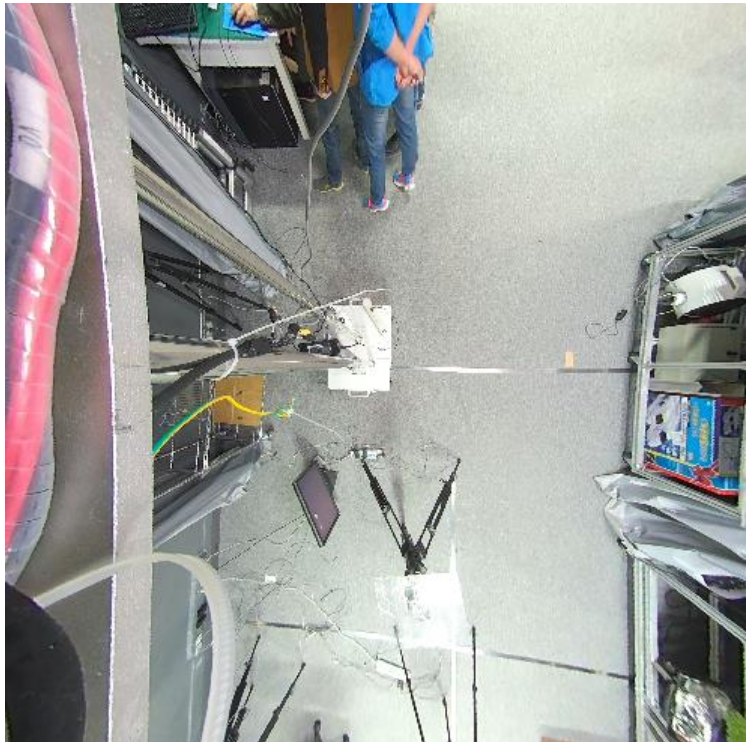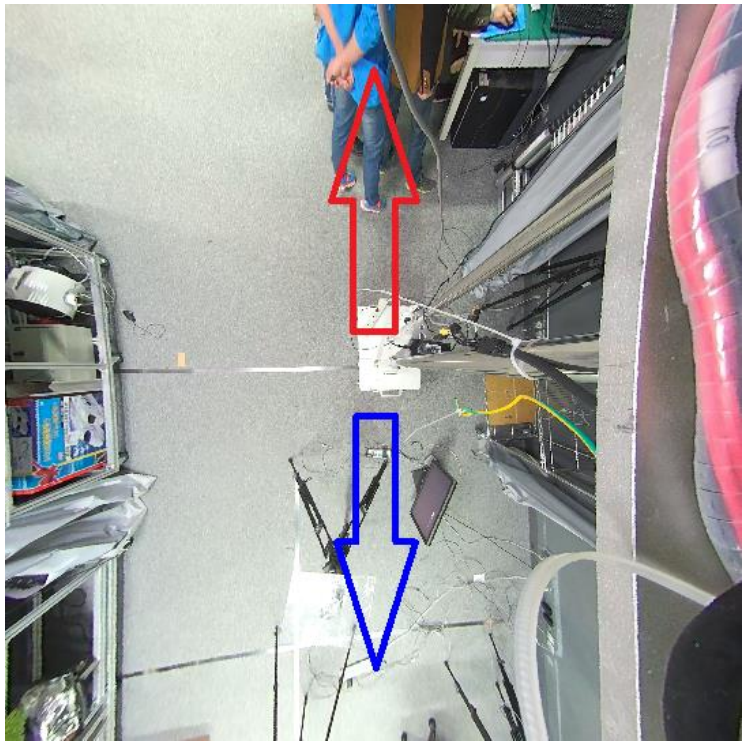
Typical Parameter Setting		Diagram	Correction Effect Demonstration
Input image width and height		The content on the left is the typical setting in ceiling mount normal correction mode (the output image width and height are equal to the input image width and height). The following diagrams are the	
InWidth	3000		
InHeight	3000		
Normal correction parameters			
Mount mode	**Ceiling**		
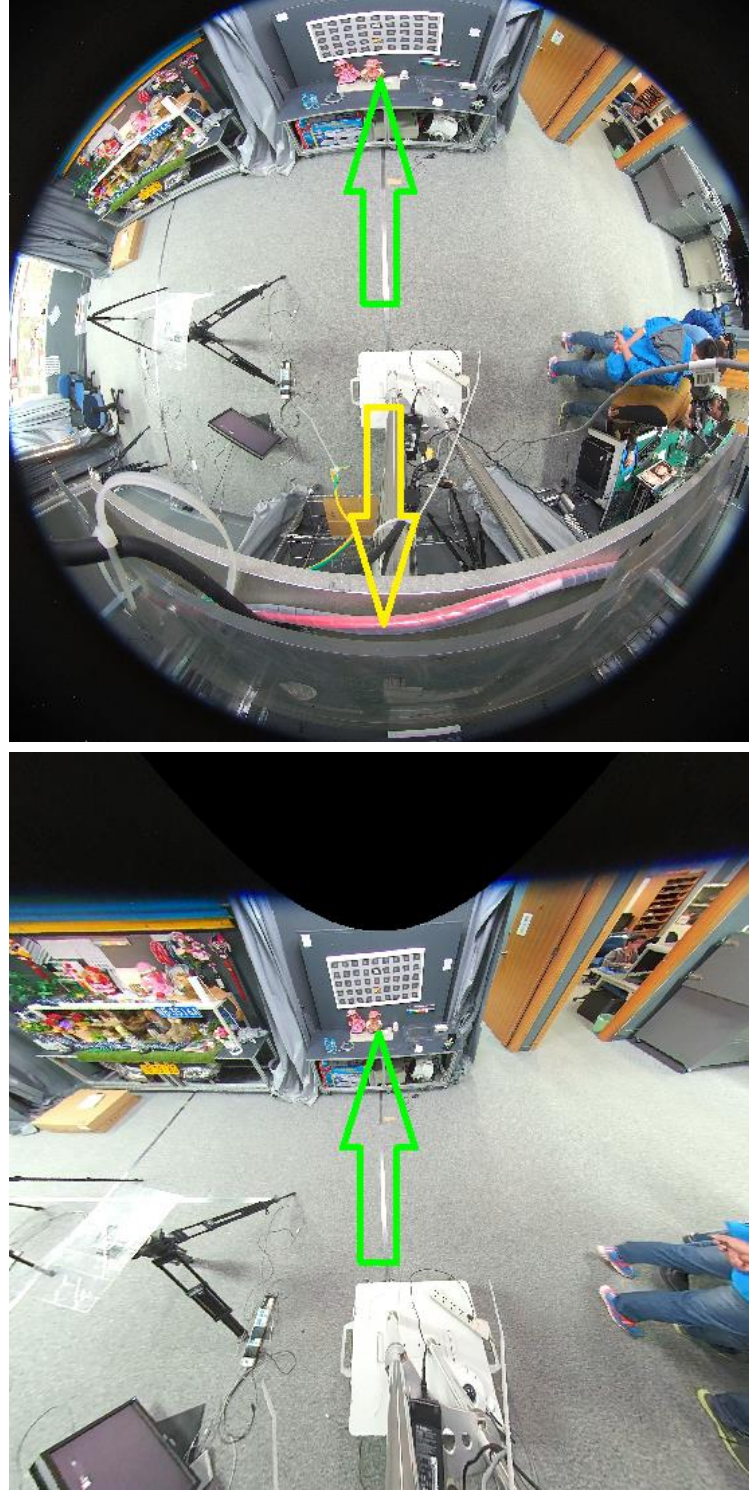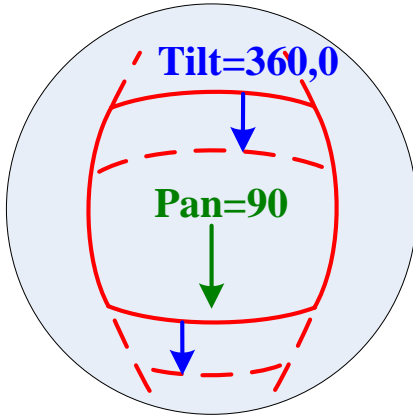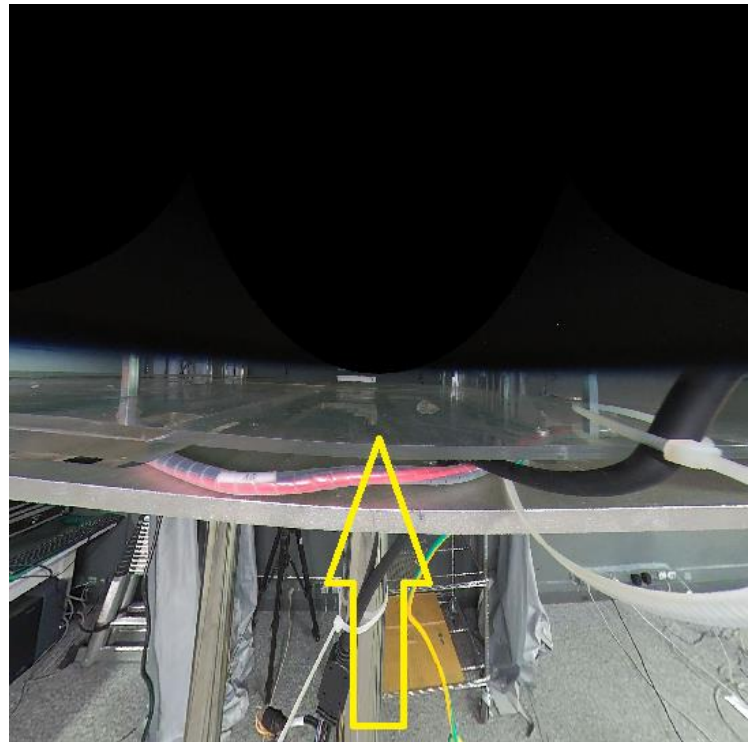
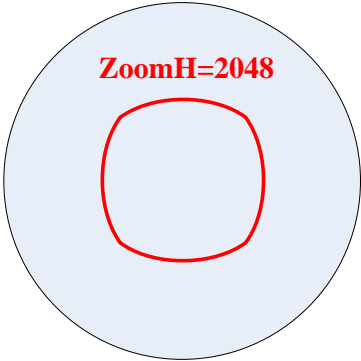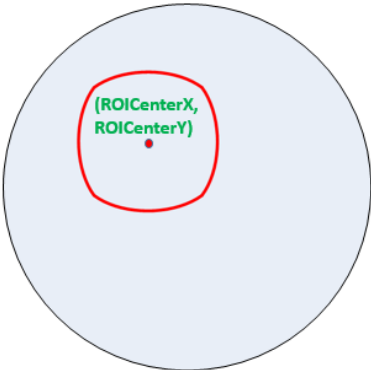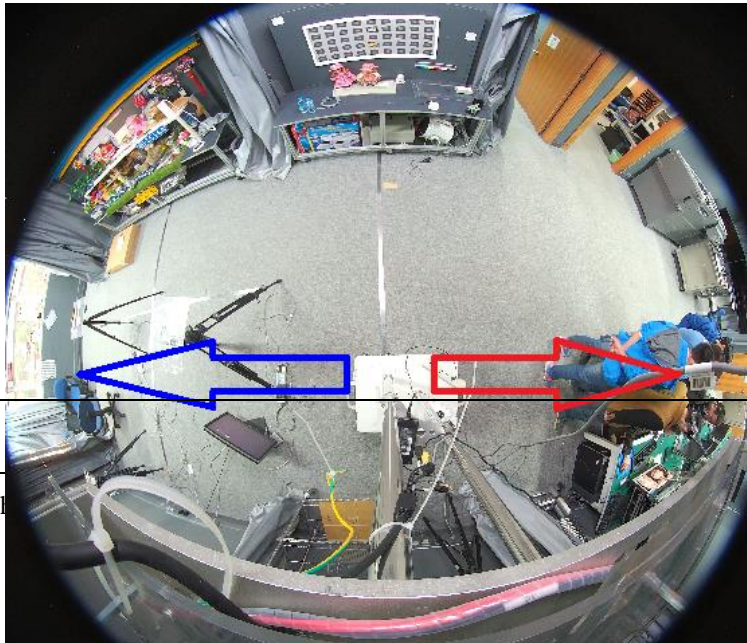| Typical Parameter Setting		Diagram	Correction Effect Demonstration
	mount	demonstration diagrams when the value of a specific parameter is changed under the typical setting. The images on the right are the corresponding correction effect images.	
OutWidth	3000		
OutHeight	3000		
HorOffset	0		
VerOffset	0		
OutRadius	1500		
Pan	180		
Tilt	180		
ZoomH	4095		

Pan is used to select the upward direction of the correction region in the corrected image after normal correction.

When **Pan** is **180**, the left part of the correction region is in the upward direction of the corrected image, as shown by the blue arrow in the right image.

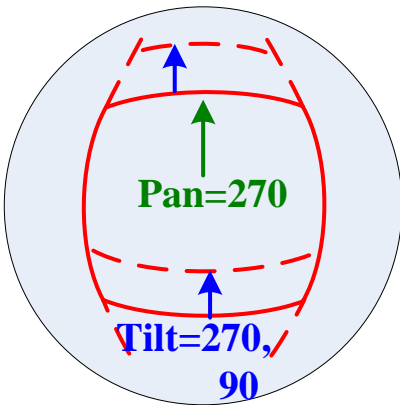| Typical Parameter Setting	Diagram	Correction Effect Demonstration
Mount mode: floor mount (The effect of normal correction in floor mount mode is similar to that in ceiling mount mode except that the image is flipped up/down on the basis of the image in ceiling mount mode.)		
When **Pan** is **0** or **360**, the right part of the correction region is in the upward direction of the corrected image, as shown by the red arrow in the right image.		

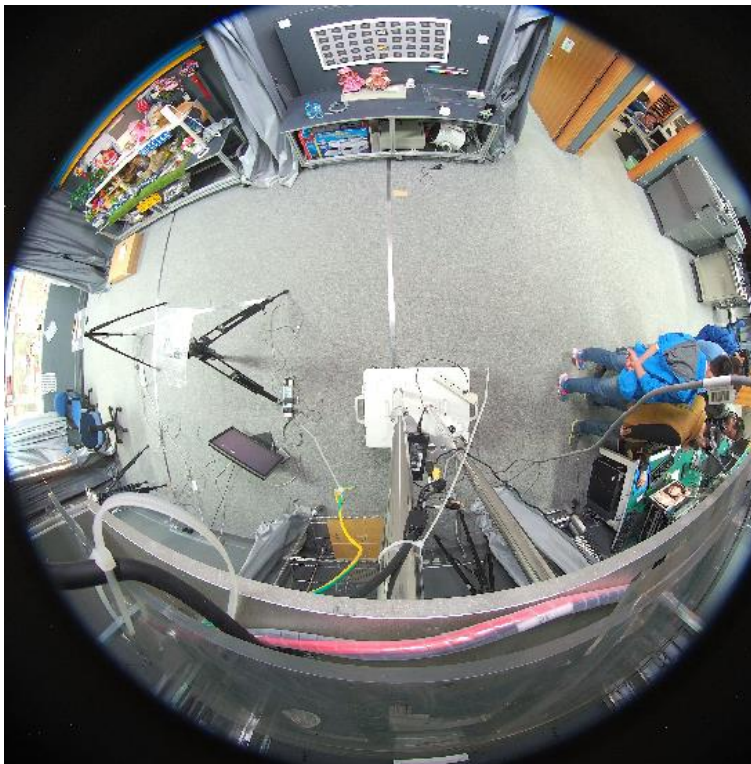| Typical Parameter Setting	Diagram	Correction Effect Demonstration
In normal correction ceiling mount mode, the absolute value of the difference between **Tilt** and 180 indicates the rotation angle of the field angle determined by **ZoomH**. The rotation direction is determined by **Pan**. Pan = 270 Tilt = 270 or 90 The green arrow in the original image points to the upward direction in the corrected image. The effect is the same when **Tilt** is **270** and **90**. 		

Typical Parameter Setting	Diagram	Correction Effect Demonstration
Pan = 90 Tilt = 360 or 0 The yellow arrow in the original image points to the upward direction in the corrected image. **Tilt=360,0** **Pan=90**		
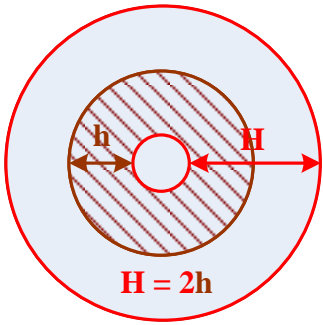
Table 2-8 Parameter description in ceiling/floor mount 360° panoramic correction mode

Parameter	Description
Pan	Start position for the leftmost part of the corrected image relative to the original image, that is, start position of the correction region in the original image
Tilt	Parameter indicating whether the correction region moves inward or outward relative to the original image. If **Tilt** is greater than **180**, the correction region moves outward. If **Tilt** is less than **180**, the correction region moves inward.
ZoomH	Range (Amplitude) of the correction region. The value 4095 indicates that one circle is selected, and the value 2048 indicates that half a circle is selected.
ZoomV	Height of the correction region within the range determined by **InRadius** and **OutRadius**
InRadius	Radius of the visible inner ring
OutRadius	Radius of the visible outer ring. This parameter is generally set to the radius of the original image for the fisheye.
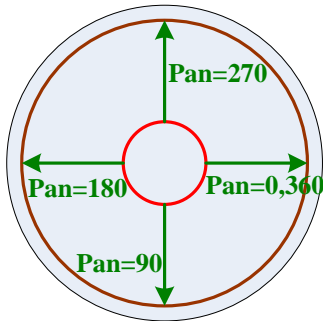
Table 2-9 Effect demonstration in ceiling/floor mount 360° panoramic correction mode
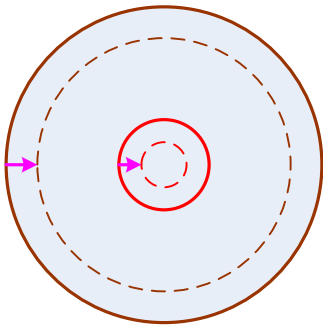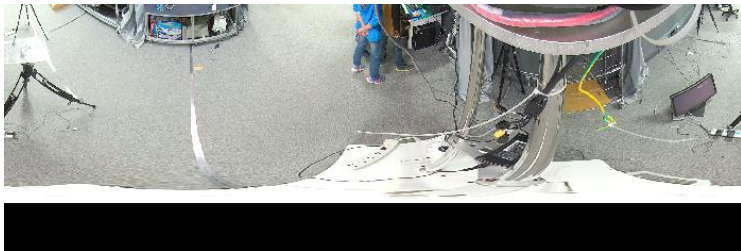
Typical Parameter Setting		Diagram	Correction Effect Demonstration
Input image width and height		The content on the left is the typical setting in ceiling mount 360° panoramic correction mode (the output image width is equal to the input image width, and the output image height is 1/3 of the input image height). The following diagrams are the demonstration diagrams when the value of a specific parameter is changed under the typical setting. The images on the right are the corresponding correction effect images.	
InWidth	3000		
InHeight	3000		
360° correction parameters			
Mount mode	**Ceiling mount**		
OutWidth	3000		
OutHeight	1000		
HorOffset	0		
VerOffset	0		
InRadius	0		
OutRadius	1500		
Pan	180		
Tilt	180		
ZoomH	4095		
ZoomV	4095		
Mount mode: floor mount (The effect of 360° panoramic correction in floor mount mode is similar to that in ceiling mount mode except that the image is flipped up/down on the basis of the image in ceiling mount mode.)			

Typical Parameter Setting	Diagram	Correction Effect Demonstration
ZoomV = 2048 OutRadius = 1500 InRadius = 100 **ZoomV** is used to adjust the height of the correction region within the range determined by **InRadius** and **OutRadius**. The height of the correction region can be calculated as follows: h = (OutRadius – InRadius) x ZoomV/4095 The shadow region in the following figure is the selected correction region: 		
ZoomV = 4095 OutRadius = 1300 (**OutRadius** is set to **1300** to demonstrate the effect. It should be set to the actual radius of the original image, which is **1500**. **ZoomV** needs to be used to select the correction region within the range determined by **InRadius** and **OutRadius**.) **InRadius = 200** (Compared with the corrected image under the typical setting, some regions in the upper and lower parts of the corrected image are cropped when **InRadius** is set to **200**.)		
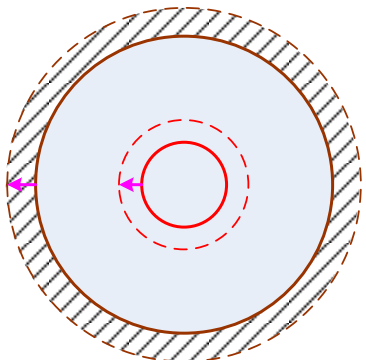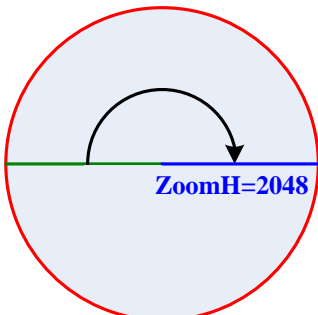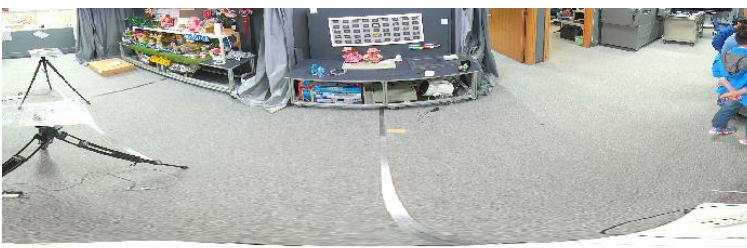
Typical Parameter Setting	Diagram	Correction Effect Demonstration
Pan = 270 (This parameter is used to select the start position of the correction region.) 		
Pan = 360		

Typical Parameter Setting	Diagram	Correction Effect Demonstration
ZoomV = 4095 OutRadius = 1500 InRadius = 100 **Tilt = 90** **Tilt** is used to move the correction region inward or outward. When **Tilt** is less than **180**, the correction region is moved inward. When **Tilt** is greater than **180**, the correction region is moved outward. The inside and outside boundaries of the correction region are determined by **OutRadius'** and **InRadius'** as follows: OutRadius' = OutRadius' + offset InRadius' = InRadius + offset where Offset = OutRadius $\times$ (Tilt -180) / 360 OutRadius' = InRadius + (OutRadius $-$ InRadius) $\times$ ZoomV/4095		

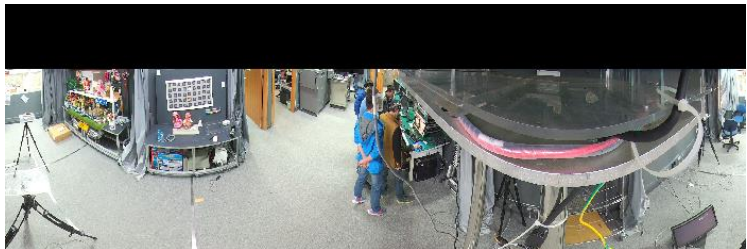| Typical Parameter Setting	Diagram	Correction Effect Demonstration
ZoomV = 4095 OutRadius = 1500 InRadius = 100 **Tilt = 270** For the fisheye hardware, **OutRadius** specifies the boundary of the image content. The parts that exceed **OutRadius** are considered to be invalid contents. To be specific: When **OutRadius'** is greater than **OutRadius**, black parts (shadow region in the following figure) appear in the corrected image. When **InRadius'** is less than **0**, black parts also appear.		
ZoomH = 2048 (The correction region is only half of the original image. To obtain better effect, you are advised to downscale the width of the output image based on a certain ratio.)		

Typical Parameter Setting	Diagram	Correction Effect Demonstration
ZoomH = 2048 OutWidth = 1500		

- Coordinate mapping

  After fisheye correction is enabled, you can call the coordinate mapping function (HI_MPI_VI_FisheyePosQueryDst2Src) and input the coordinate of an ROI in the corrected image to obtain the mapping coordinate in the original image.

  Coordinate mapping supports any installation mode and fisheye correction mode, but does not support mapping from the original image to the corrected image.

Table 2-10 Effect demonstration of coordinate mapping

Parameter	Effect Demonstration
Taking the Normal mode as an example, the coordinate P (x1,y1) of a license plate in the output corrected image diagram is known. Call the coordinate mapping function to obtain the corresponding coordinate Q (x2,y2) in the original image (fisheye pie chart).	Output corrected image Original image

 NOTE

- Hi3559 V200/Hi3556 V200 does not support the fisheye correction function.

- If the image is flipped after fisheye correction in the floor mount 360° panoramic correction mode or normal correction mode, it is recommended that mirroring be performed on the image in the VI or VPSS module.

- The calculation amount and bandwidth of fisheye processing differs greatly under different settings. The performance may be insufficient under atypical settings.

- Before you configure the LMF parameter, convert it from the parameter recommended by the lens vendor first.(The configured LMF parameter should satisfy the following relationship: au16LMFCoef[i + 1] $\geq$ au16LMFCoef[i] + 5 && au16LMFCoef[i + 1] $\leq$ au16LMFCoef[i] + 31 && au16LMFCoef[57] < 1024 < au16LMFCoef[85] && au16LMFCoef[0] = 0) If the relationship is not satisfied, an error is reported. If the configured LMF parameter is incorrect, exceptions such as bus errors may occur. If there is no parameter provided by the lens vendor, you are advised to disable the LMF function.

2.2.2 LDC

**Table 2-11** LDC parameter configuration

Parameter	Value Range	Description
CenterXOffset	[–511, +511]	Horizontal offset of the image center point relative to the physical center point
CenterYOffset	[–511, +511]	Vertical offset of the image center point relative to the physical center point
DistortionRatio	[–300, +500]	Correction strength. A negative value indicates the pincushion correction mode, and a positive value indicates the barrel correction mode.
bAspect	bool	Whether to reserve the aspect ratio during view adjustment
XYRatio	[0, 100]	Correction strength of FOV. This parameter is valid only when **bAspect** is set to **1**.
XRatio	[0, 100]	Correction strength of the horizontal FOV. This parameter is valid only when **bAspect** is set to **0**.
YRatio	[0, 100]	Correction strength of the vertical FOV. This parameter is valid only when **bAspect** is set to **0**.

 NOTE

- You are advised to use the checkerboard for correction and calibration.

- Hi3556 V200 does not support the LDC function.

2.2.2.1 LDC Model
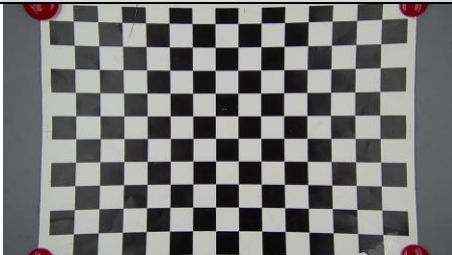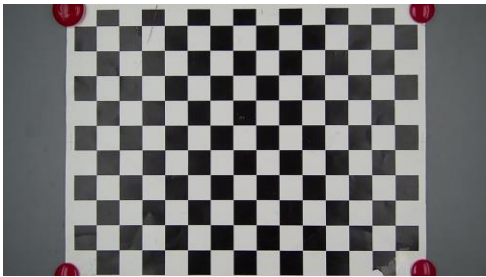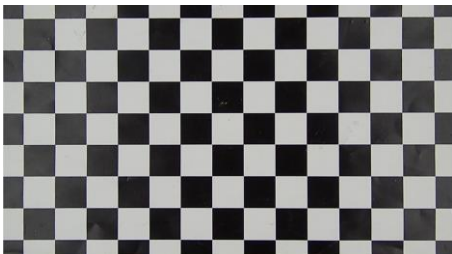
LDC supports two correction modes, barrel distortion correction and pincushion distortion correction, as shown in Figure 2-4 and Figure 2-5.

Figure 2-4 Barrel distortion correction mode
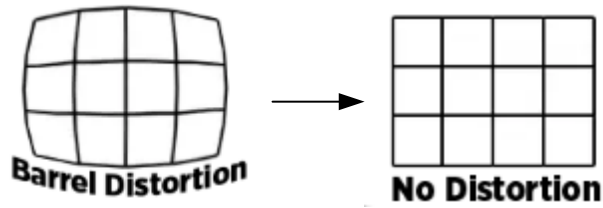
Figure 2-5 Pincushion distortion correction mode
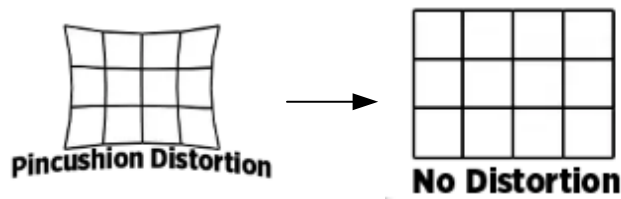
2.2.2.2 Examples of Barrel Distortion Correction
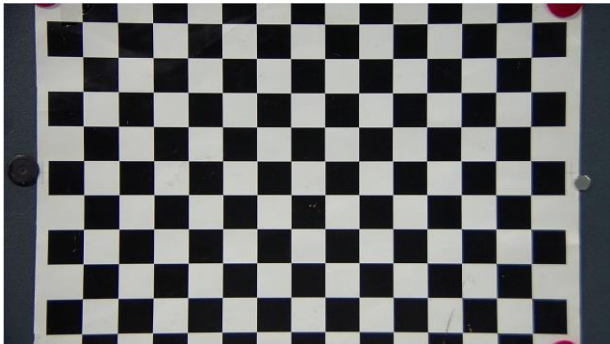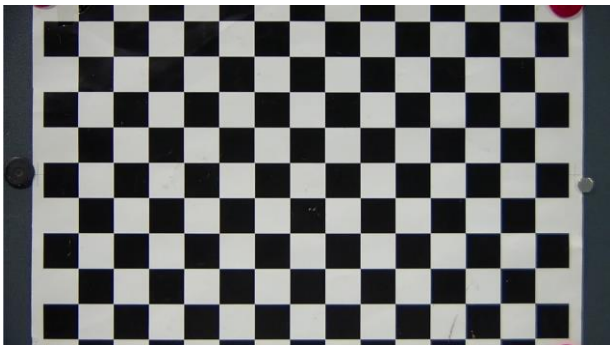
Table 2-12 Barrel distortion correction description

Parameter Description	Parameter Setting	Demonstration
Typical configuration: The distortion center and image center coincide with each other. The aspect ratio and the maximum FOV are reserved.	Width = 1920 Height = 1080 OutWidth = 1920 OutHeight = 1080 CenterXOffset / CenterYOffset = 0 DistortionRatio = 70 bAspect = 1 XYRatio = 100 XRatio = 100 YRatio = 100	Before correction After correction
Ratio: Correction strength. A larger value indicates lower correction strength.	DistortionRatio = 110	The correction strength is too high, and pincushion distortion occurs.

Parameter Description	Parameter Setting	Demonstration
bAspect: Whether to reserve the aspect ratio 1: Reserve the aspect ratio. 0: Change the aspect ratio, while reserve the maximum FOV.	bAspect = 0 DistortionRatio = 70	The aspect ratio is changed while the maximum FOV is reserved. The square checkerboard is compressed into a rectangle.
If **bAspect** is set to **0**, **XRatio** and **YRatio** can be configured. **XRatio**: reservation strength of the horizontal FOV. **YRatio**: reservation strength of the vertical FOV. If **bAspect** is set to **1**, **XYratio** can be configured. **XYRatio**: reservation strength of FOV in scenarios with the aspect ratio unchanged. Note: The value **100** indicates that the maximum FOV is reserved, and the value **0** indicates that 2/3 of the maximum FOV is reserved.	bAspect = 0 XRatio = 20	
	bAspect = 1 XYRatio = 20	

2.2.2.3 Example of Pincushion Distortion Correction

Table 2-13 Pincushion distortion correction description

Parameter Description	Parameter Setting	Demonstration
Typical configuration: The distortion center and image center coincide with each other. The aspect ratio and the maximum FOV are reserved.	Width = 1920 Height = 1080 OutWidth = 1920 OutHeight = 1080 CenterXOffset / CenterYOffset = 0 DistortionRatio = -40 bAspect = 1 XYRatio = 100 XRatio = 100 YRatio = 100	Before correction After correction

📖 **NOTE**

For the debugging effect of **bAspect**, **XRatio**, **YRatio**, and **XYRatio**, see the correction of the barrel distortion correction (to be confirmed).

The LDC may stretch or compress the image. When the input image has obvious noise, the noise grains around the image may become bigger after the barrel correction (the surrounding area is stretched). If the chip supports this function, configure LDC after 3DNR. For details, see the *HiMPP V4.0 Media Processing Software Development Reference*.

2.2.3 Free Rotation

📖 **NOTE**

Hi3556 V200 does not support free rotation.

**Table 2-14** Free rotation configuration

Parameter	Value Range	Description
CenterXOffset	[–511, +511]	Horizontal offset of the rotation center relative to the image center (enabled only when **ViewType** is set to **1**)

Parameter	Value Range	Description
CenterYOffset	[–511, +511]	Vertical offset of the rotation center relative to the image center (enabled only when **ViewType** is set to **1**)
ViewType	[0, 1, 2]	0: All contents of the image are reserved, the image may be compressed, and black borders may appear. 1: The image size is reserved, part of the image may be lost, and black borders may occur. 2: The image is adaptively zoomed out, and the image contents are reserved to the most under the premise that no black borders appear.
Angle	[0, 360]	Clockwise rotation angle
Outwidth	[480, 8192]	Output image width
OutHeight	[360, 8192]	Output image height

As shown in Figure 2-6, **ViewType** is set to **0** to reserve all contents. The inner blue rectangle is the input image. The inner yellow rectangle is the rotated image. The outer purple rectangle is the final output image, with the regions non-overlapped with the yellow rectangle filled with black color.

Figure 2-6 Rotation diagram (1)
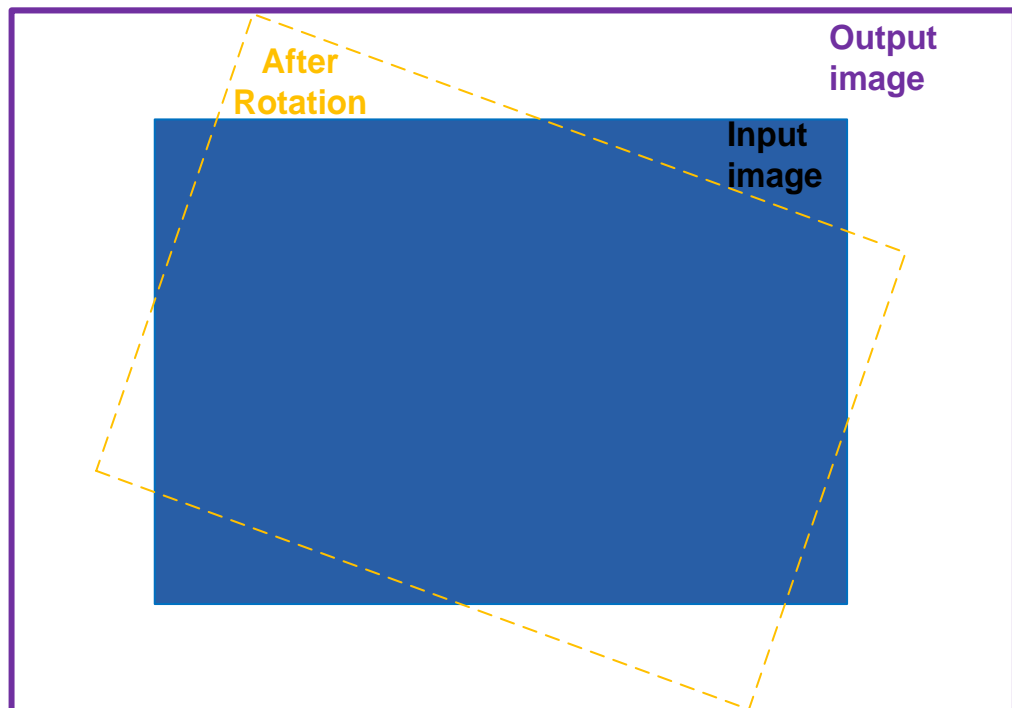
As shown in Figure 2-7, **ViewType** is set to **1** to reserve the image size. Part of the image may be lost, and black borders may occur. The blue rectangle is the input image. The yellow

rectangle is the rotated image. The purple rectangle (completely overlapping with the input image) is the final output image, with the region overlapped with the yellow rectangle being the image content and the regions non-overlapped with the yellow rectangle filled with black color.

Figure 2-7 Rotation diagram (2)
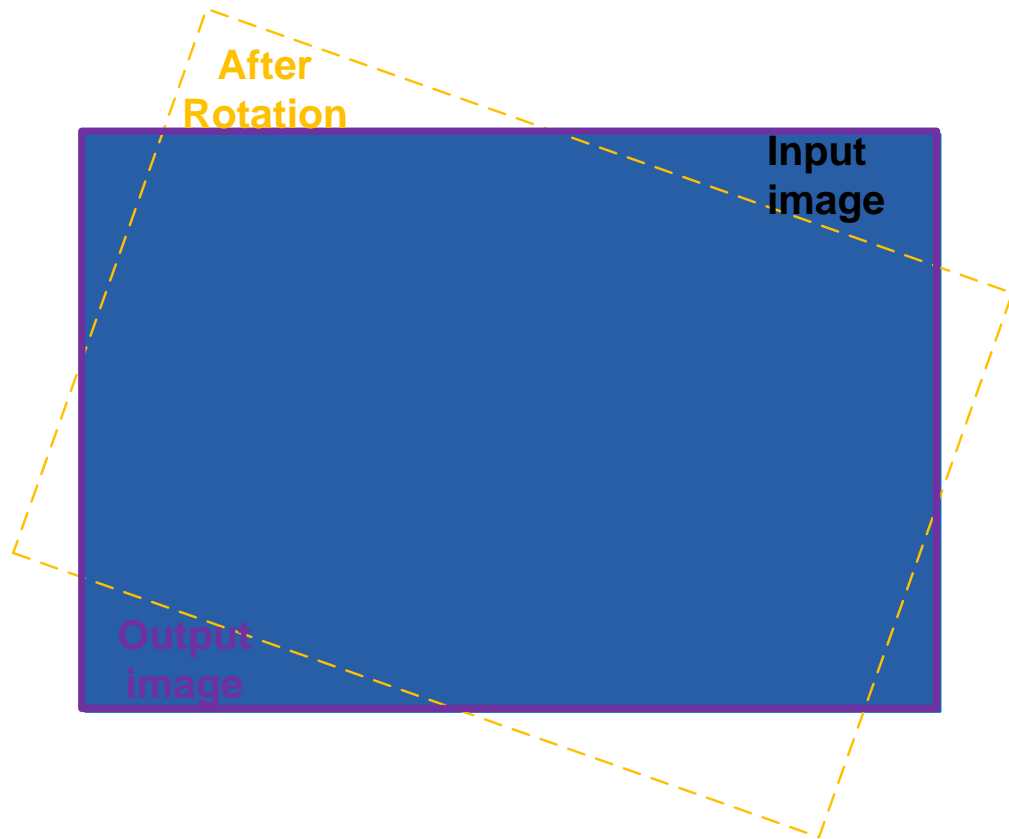
As shown in Figure 2-8, **ViewType** is set to **1** and the image is adaptively zoomed out, that is, the image contents are reserved to the most under the premise that no black borders appear. The inner blue rectangle is the input image. The yellow rectangle is the rotated image. The inner purple rectangle is the final output image without black filling.

Figure 2-8 Rotation diagram (3)
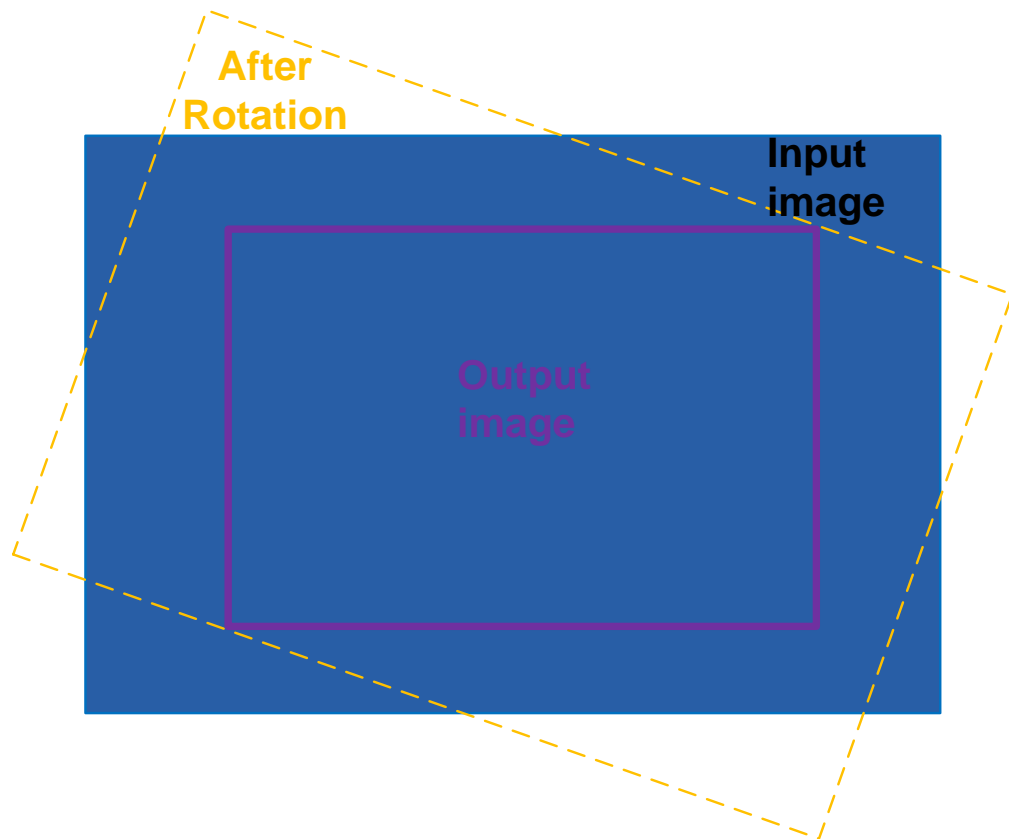
2.2.4 PMF

The PMF can implement projection transformation of planar images. Common planar geometric transformation models include translation transformation, rigid transformation, affine transformation, and projection transformation. The projection transformation has eight degrees of freedom (DoFs) and may cover several other transformation models, as shown in Figure 2-9.

Figure 2-9 Common geometric transformation models

(a) Original image   (b) Translation transformation   (c) Rigid transformation   (d) Affine transformation   (e) Projection transformation
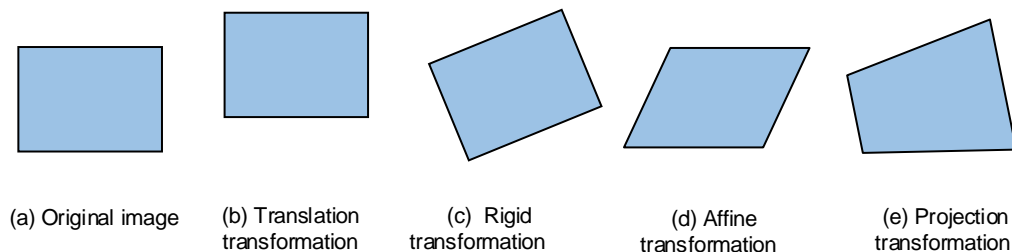
The transformation relationships can be represented by matrix transformation. For example,

$$\begin{bmatrix} x \\ y \\ 1 \end{bmatrix} = \begin{bmatrix} m_0 & m_1 & m_2 \\ m_3 & m_4 & m_5 \\ m_6 & m_7 & m_8 \end{bmatrix} \begin{bmatrix} x' \\ y' \\ 1 \end{bmatrix}$$

x and **y** indicate the coordinates of an input image. **x'** and **y'** indicate the coordinates of an output image. The coordinates of the input image are calculated based on the coordinates of the output image. m_0, m_1, m_3, and m_4 represent the scaling and rotation of an image, respectively; m_2 indicates the horizontal displacement of the image. m_5 indicates the vertical displacement of the image. m_6 and m_7 indicate the transformation in the horizontal and vertical directions, respectively. m_8 is a weight factor. Under normalized conditions, m_8 is always **1**.

Table 2-15 PMF configurations

Parameter	Value Range	Description
as64PMFCoef [9]	**as64PMFCoef [0]**: The value range is [157286, 891289]. **as64PMFCoef [1]**: The value range is [−367001, +367001]. **as64PMFCoef [2]**: The value range is [−1073741824, +1073741823]. **as64PMFCoef [3]**: The value range is [−367001, +367001]. **as64PMFCoef [4]**: The value range is [157286, 891289]. **as64PMFCoef [5]**: The value range is [−1073741824, +1073741823]. **as64PMFCoef [6]**: The value range is [−26, +104]. **as64PMFCoef [7]**: The value range is [−26, +104]. **as64PMFCoef [8]**: The value is fixed at **524288**.	Projection transformation matrix, indicating that the coordinates of the input image are calculated based on the coordinates of the output image, that is, (x, y) = F (x', y'), where **x** and **y** indicate the coordinates of an input image. **x'** and **y'** indicate the coordinates of an output image.
Outwidth	480–8192	Output image width
OutHeight	360–8192	Output image height

Table 2-16 PMF example

Parameter Description	Parameter Setting	Demonstration
PMF example	Width = 1920 Height = 1080 OutWidth = 1920 OutHeight = 1080	Before correction:

| Parameter Description	Parameter Setting	Demonstration
	as64PMFCoef [0] = 524331 as64PMFCoef [1] = − 5654 as64PMFCoef [2] = 13349309 as64PMFCoef [3] = − 20158 as64PMFCoef [4] = 524976 as64PMFCoef [5] = 51434029 as64PMFCoef [6] = 25 as64PMFCoef [7] = 50 as64PMFCoef [8] = 524288	 After correction:

📖 **NOTE**

The eight DoFs in the PMF geometric transformation matrix are interrelated. Generally, a required transformation matrix parameter must be calculated by means of calibration rather than simple manual adjustment.

2.2.5 Data Flowchart
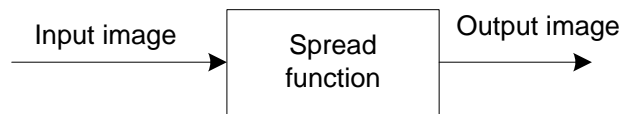
Scenario 1: Common fisheye correction function
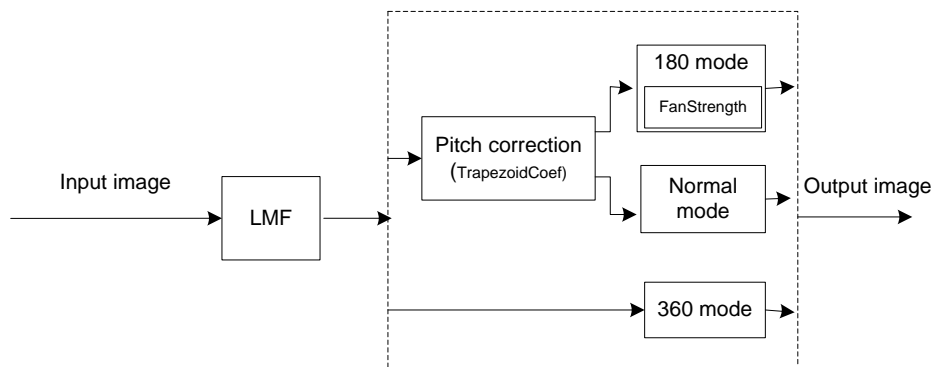
Scenario 2: LDC function
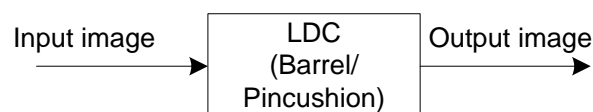
Scenario 3: Spread function

3 Calibration Tool

3.1 Fisheye Calibration Tool Library

The fisheye calibration tool library is provided to automatically determine the position features (offset and radius) of the fisheye lens based on the image captured by the fisheye lens. During calibration, this tool library needs to work with the fisheye lens.

To guarantee that the tool can correctly determine the fisheye outline, ensure that the fisheye image region and corners in the black borders are clear and identifiable during snapshot.