

# PI5008KSvmOffLineCalibTool User Guide

ver. 0.70.00



- **PI5008KSvmOffLineCalibTool Overview**
- **PI5008K SVM Off-line Calibration Pattern**
- **How to use PI5008KSvmOffLineCalibTool**

# PI5008KSvmOffLineCalibTool Overview

# PI5008KSvmOffLineCalibTool Overview

## ➤ Main function

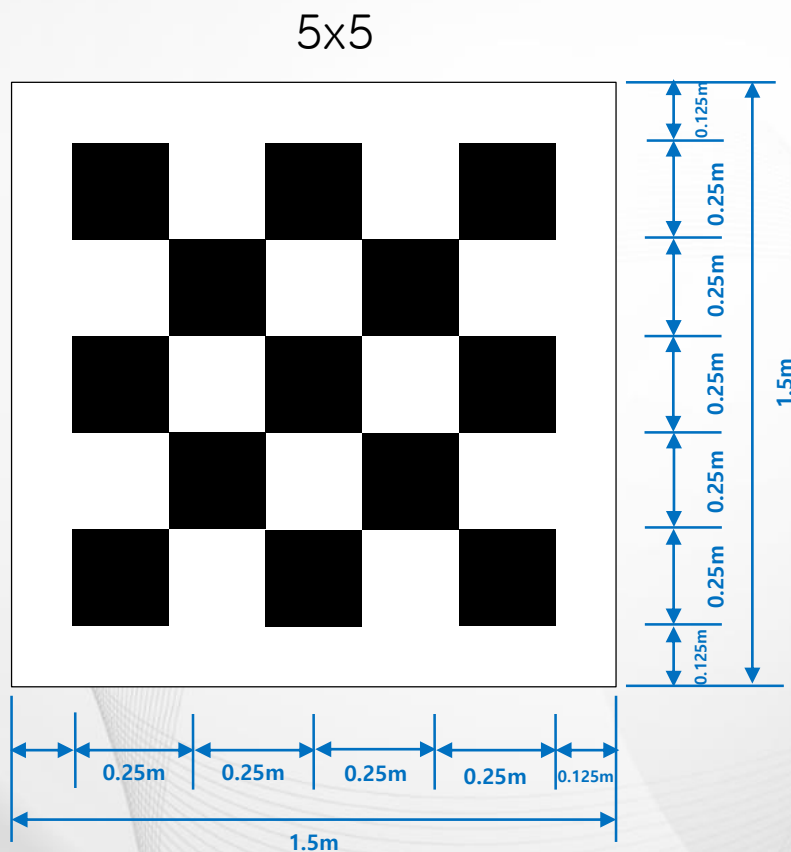
- (1) Automatic pattern recognition
- (2) Getting feature points image coordinates
- (3) Getting camera position and angle

## ➤ Specification

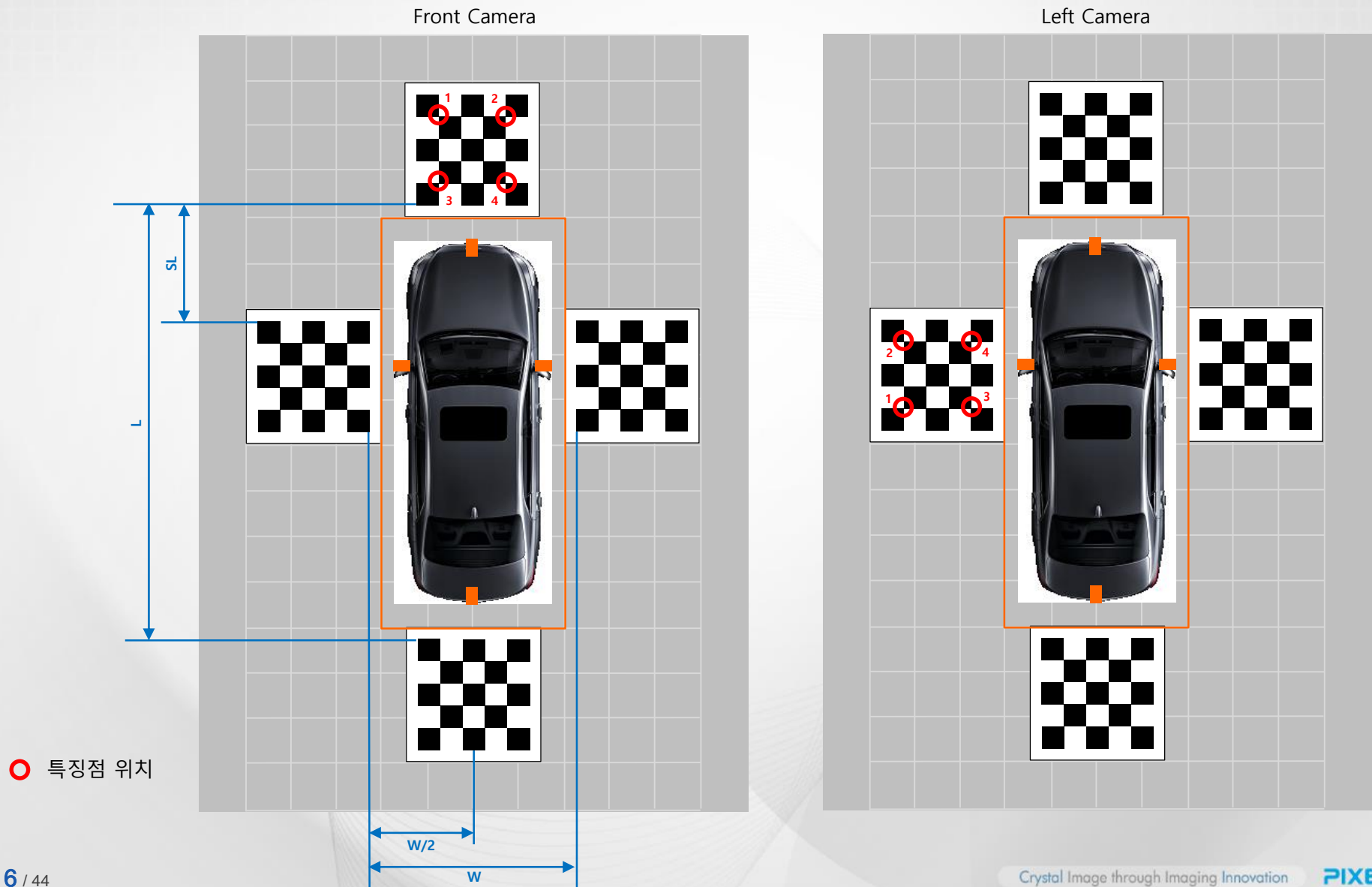
Item	Description
Pattern type	Type 1 ~ 6
Number of patterns	4 or 6EA
Pattern Recognition	Automatic
Number of feature point	4, 6 or 8EA for each camera
카메라 입력	4ch
Inputs	Camera image Camera intrinsic parameters Lens distortion table Pattern type
Outputs	Off-line calib. Information Camera Position & Angle
Supported OS	Windows7 or above

# PI5008K SVM Off-line Calibration Pattern

## ➤ Type 1

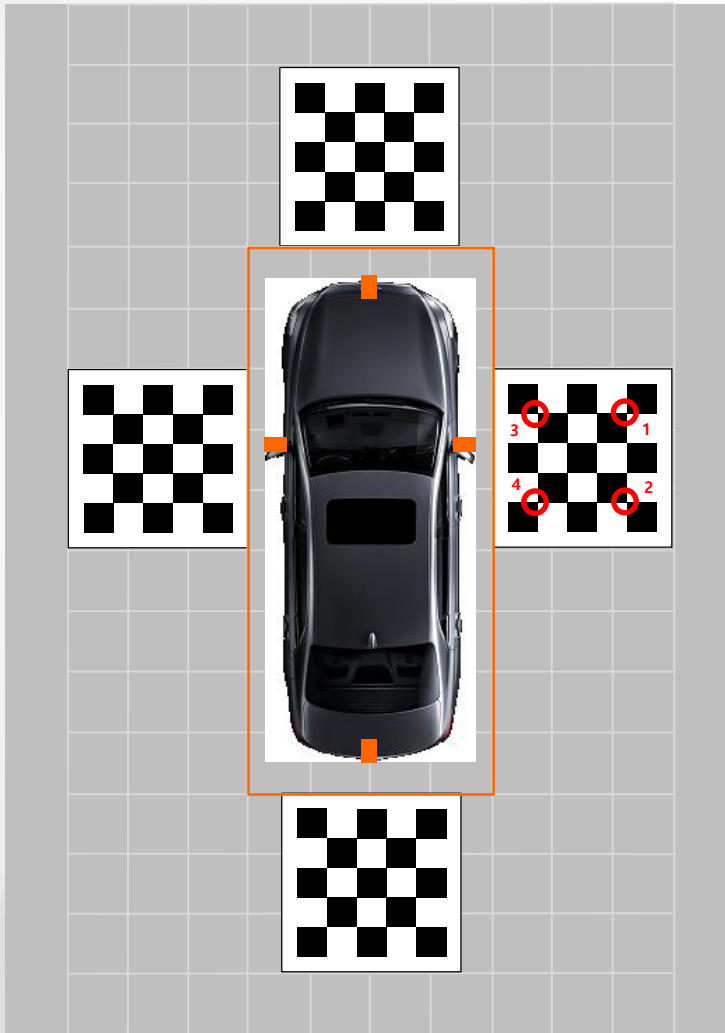


# PI5008K SVM Off-line Calibration Pattern

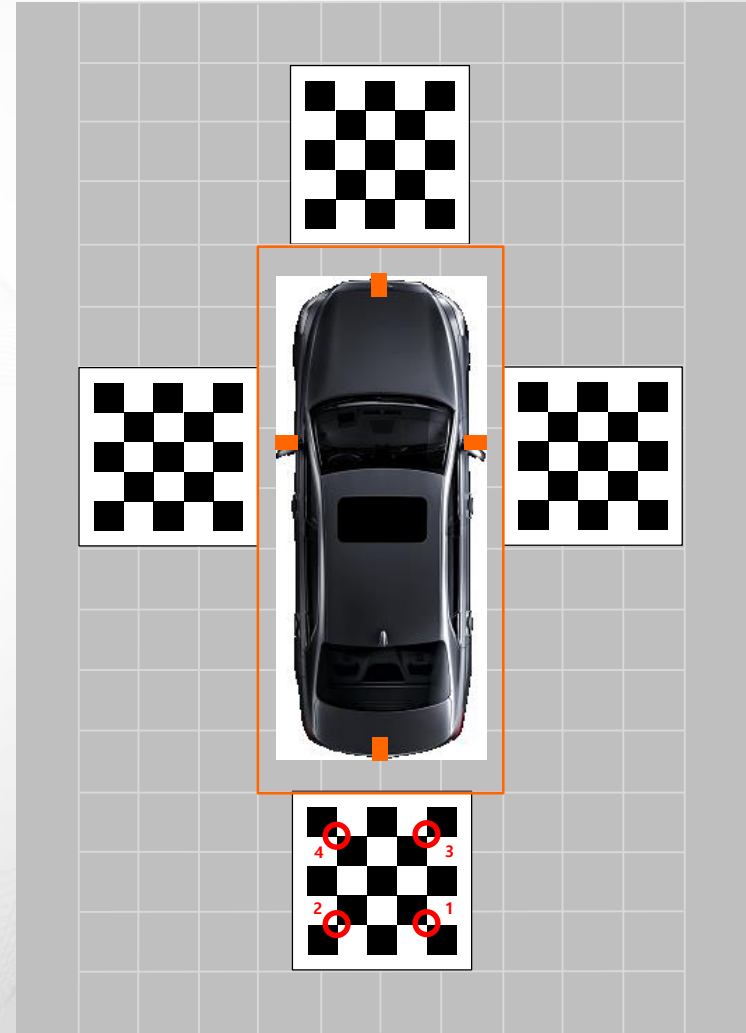


# PI5008K SVM Off-line Calibration Pattern

Right Camera



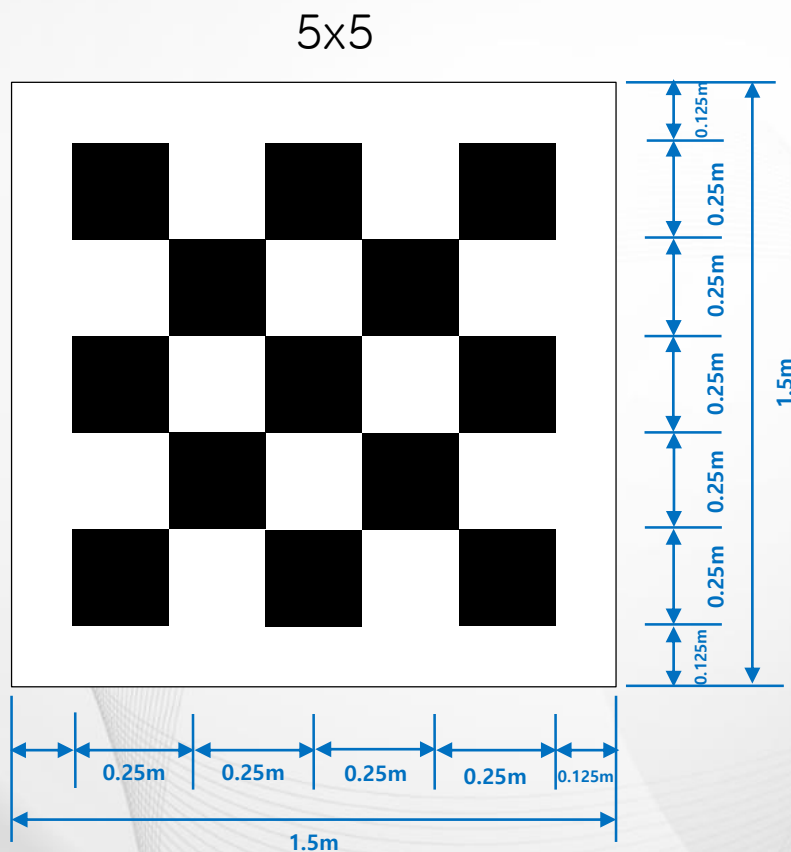
Rear Camera



○ 특징점 위치

# PI5008K SVM Off-line Calibration Pattern

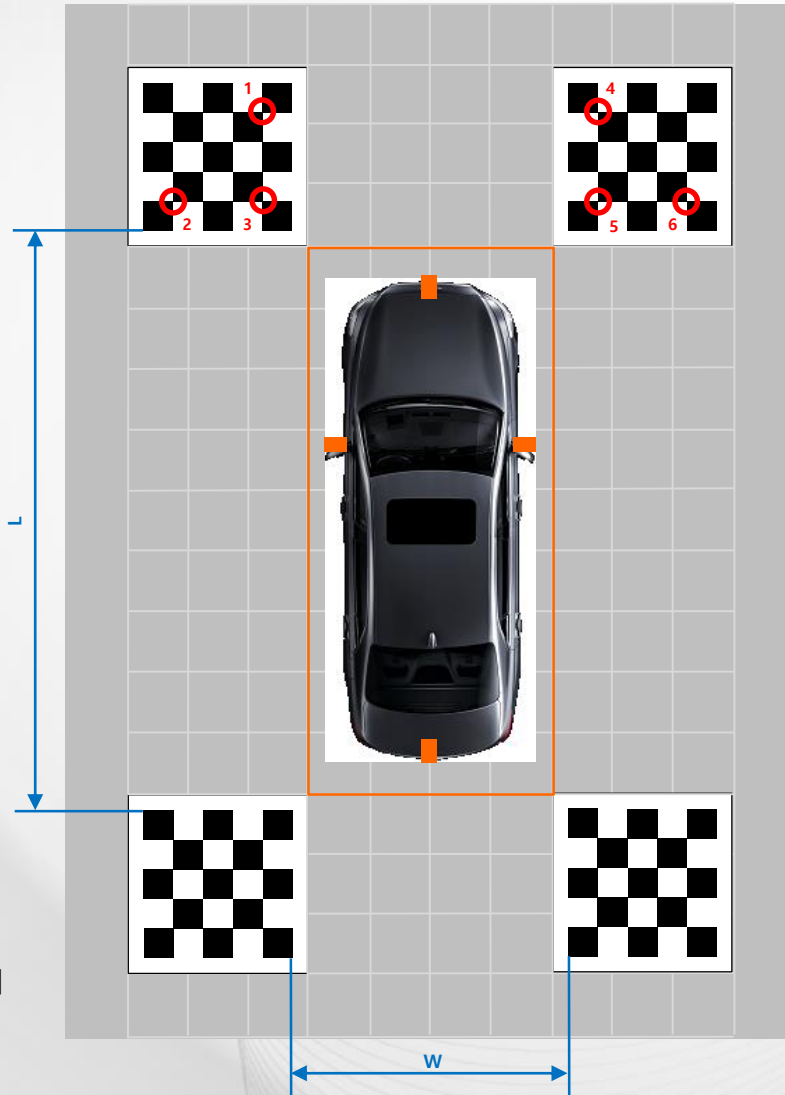
## ➤ Type 2



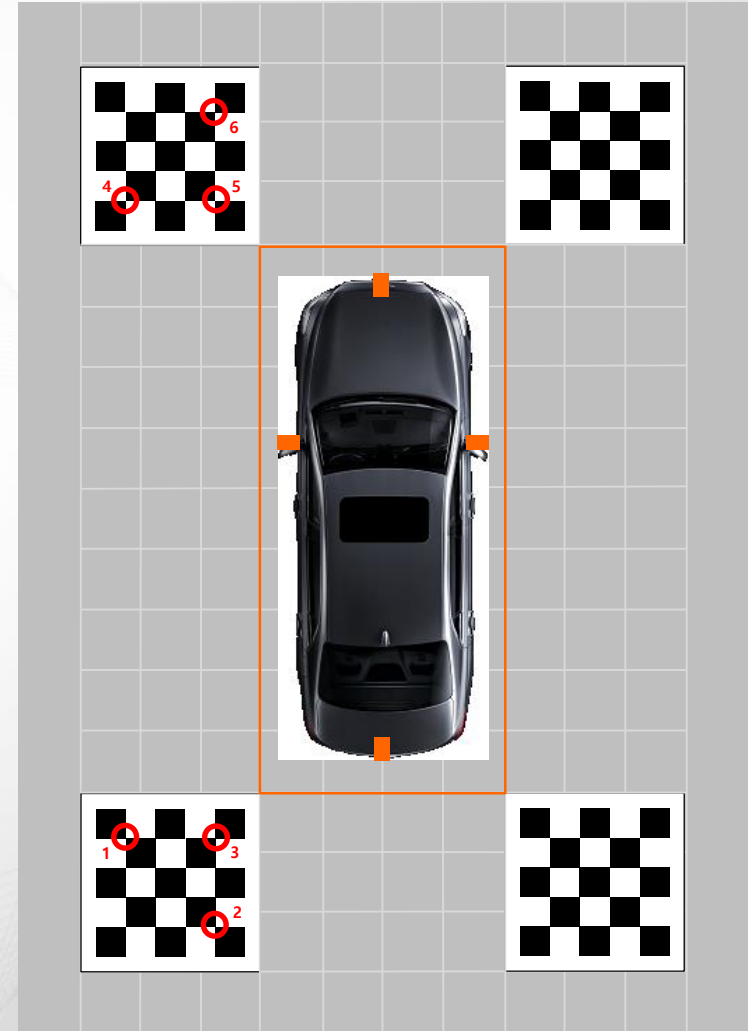


# PI5008K SVM Off-line Calibration Pattern

Front Camera



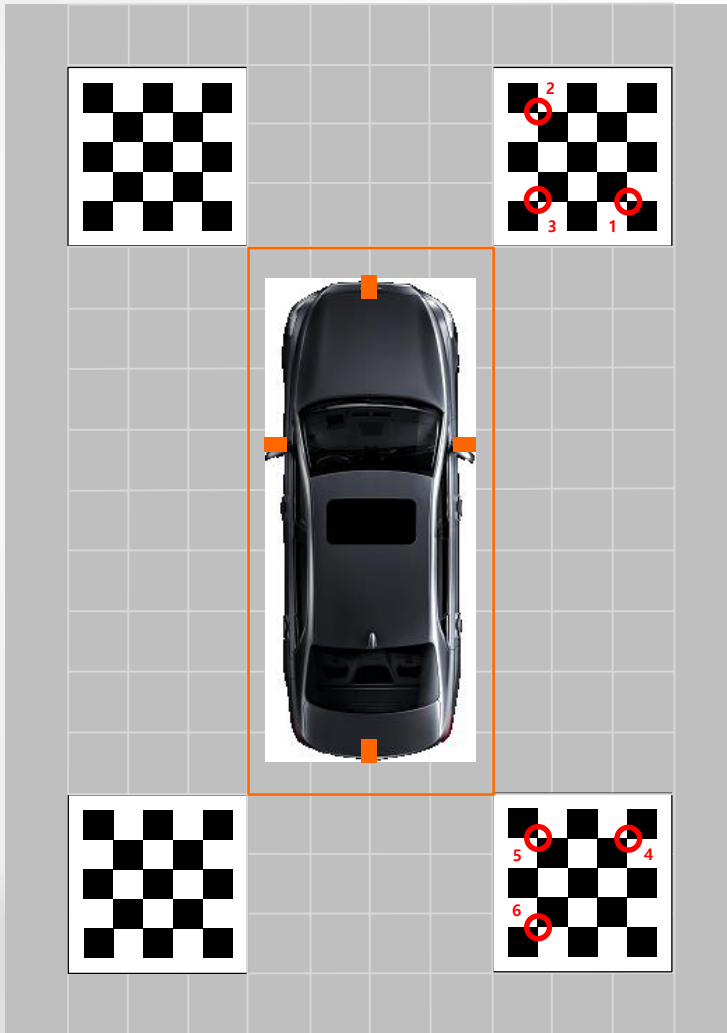
Left Camera



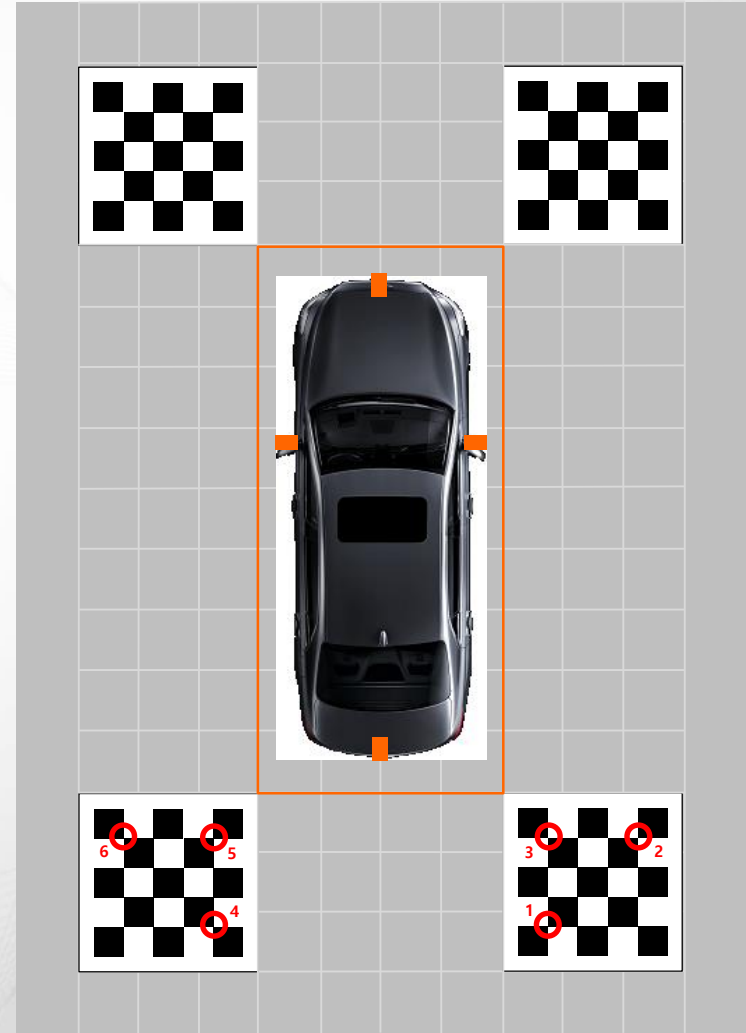
○ 특징점 위치

# PI5008K SVM Off-line Calibration Pattern

Right Camera



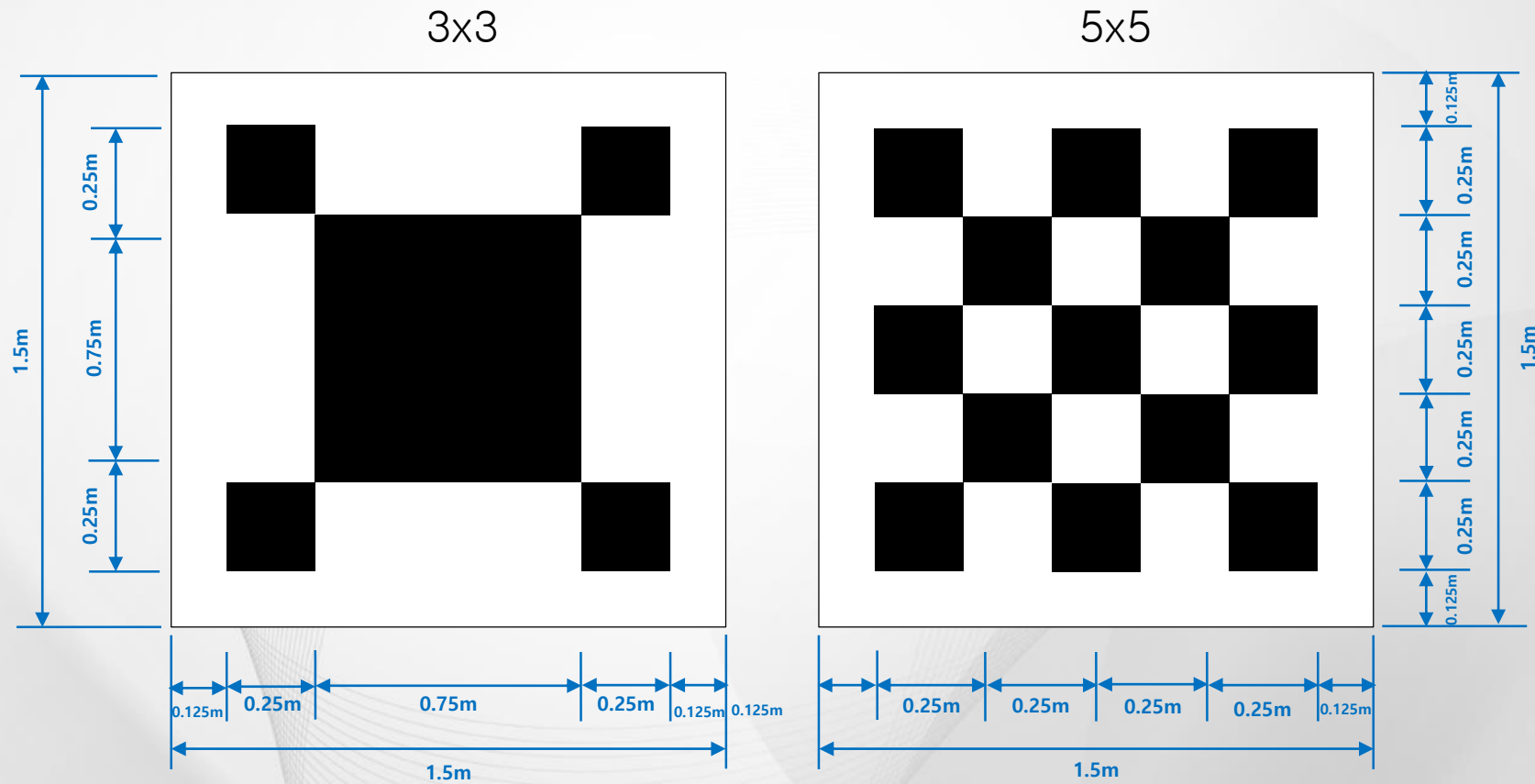
Rear Camera



○ 특징점 위치

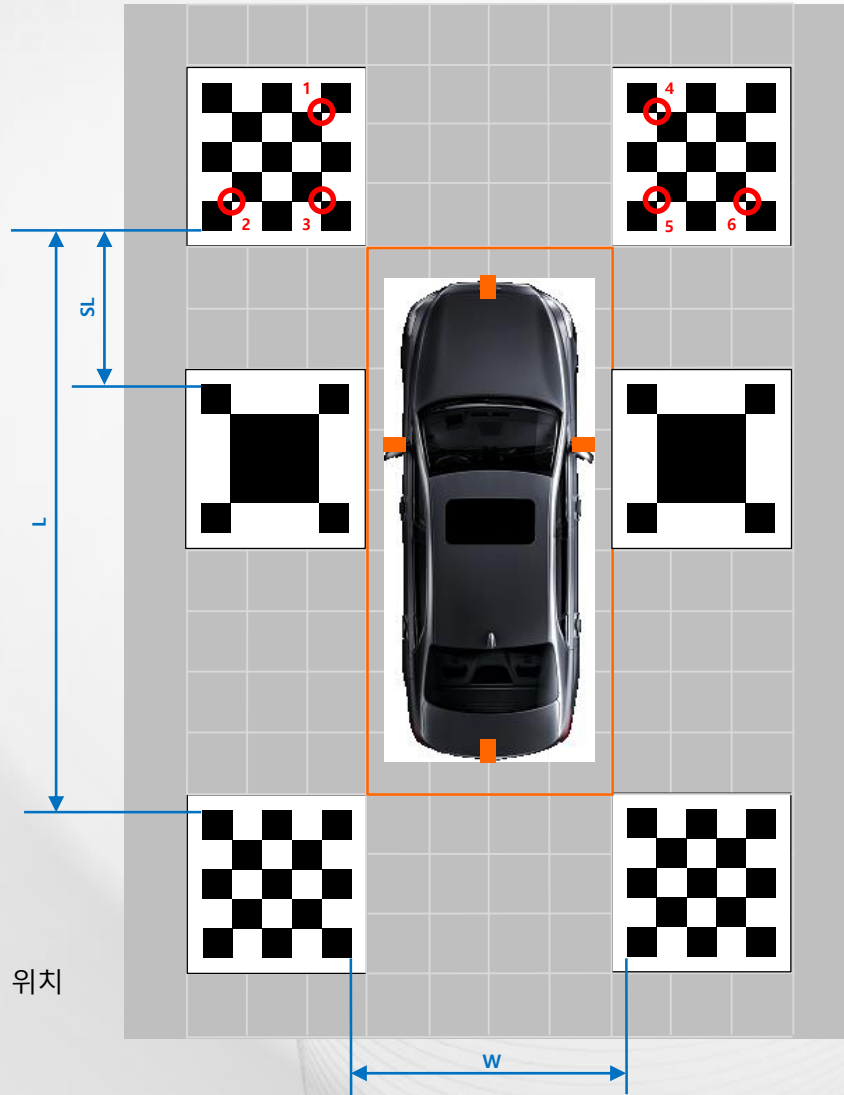
# PI5008K SVM Off-line Calibration Pattern

## ➤ Type 3

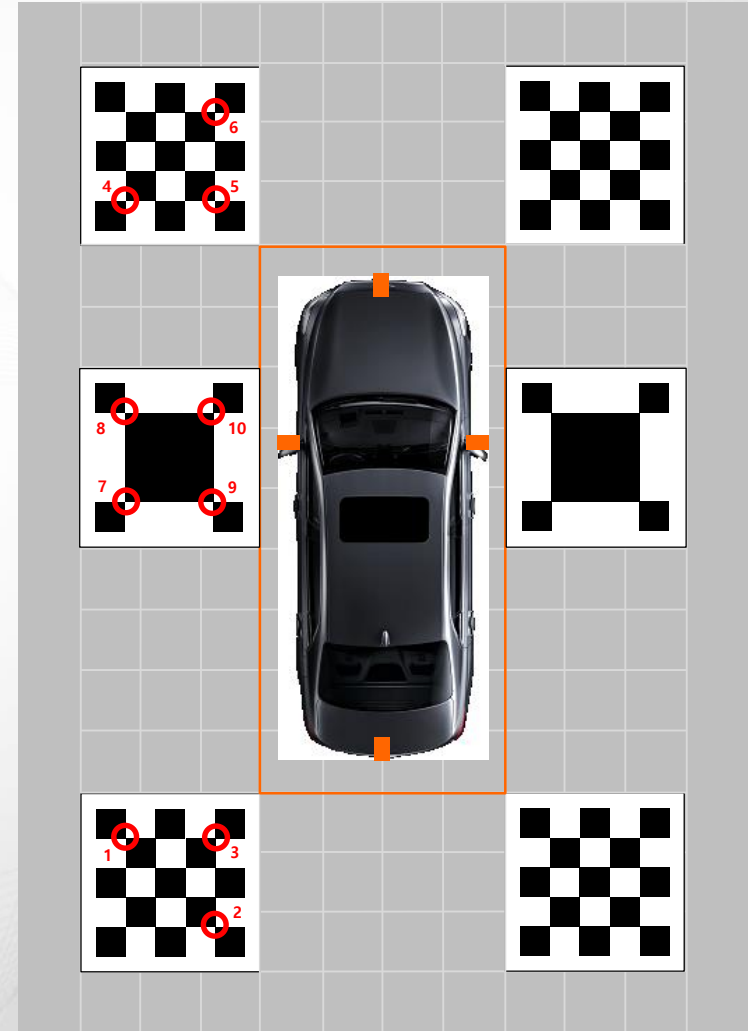


# PI5008K SVM Off-line Calibration Pattern

Front Camera

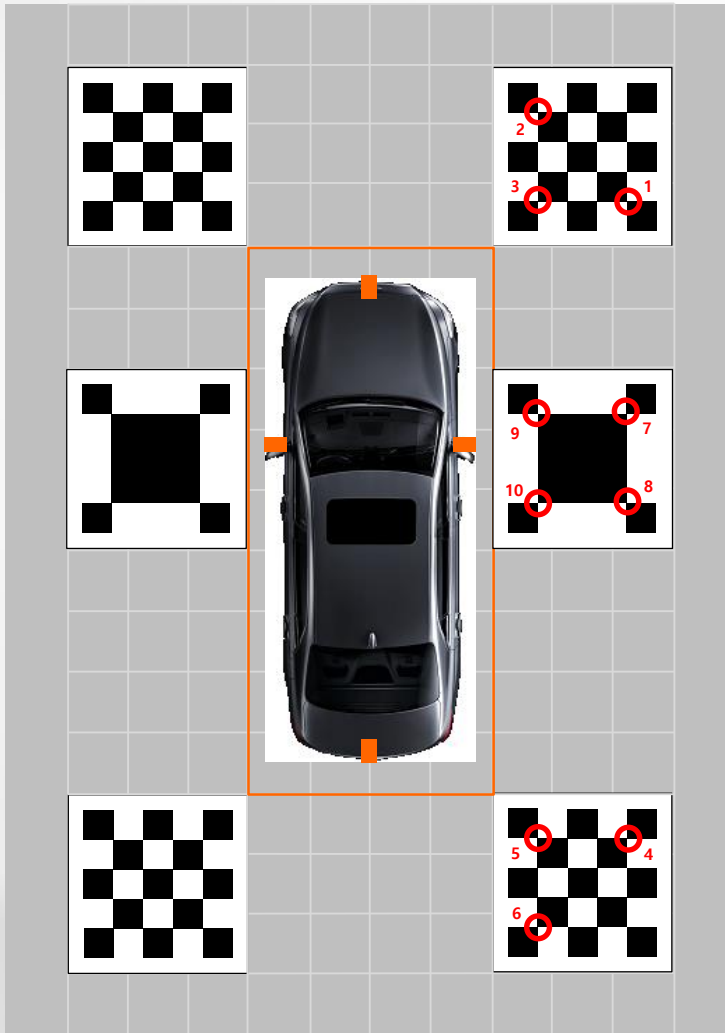


Left Camera

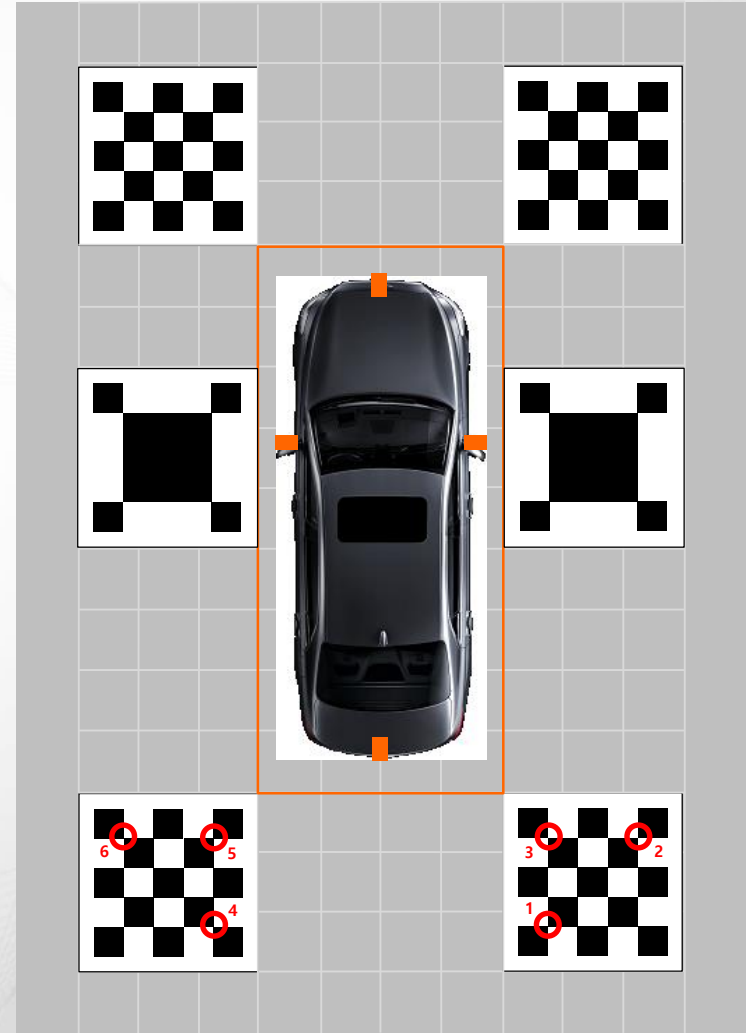


# PI5008K SVM Off-line Calibration Pattern

Right Camera



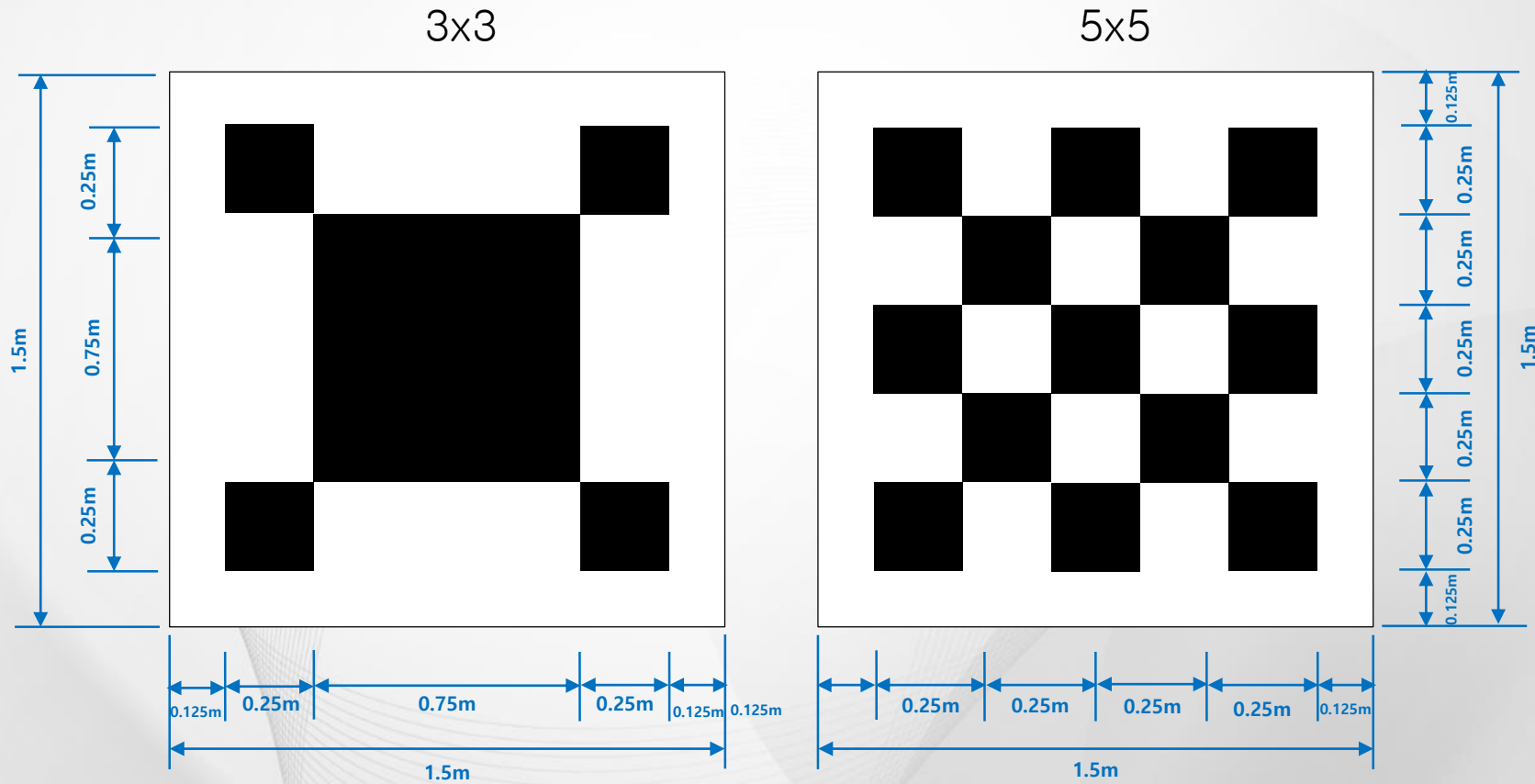
Rear Camera



○ 특징점 위치  
Point

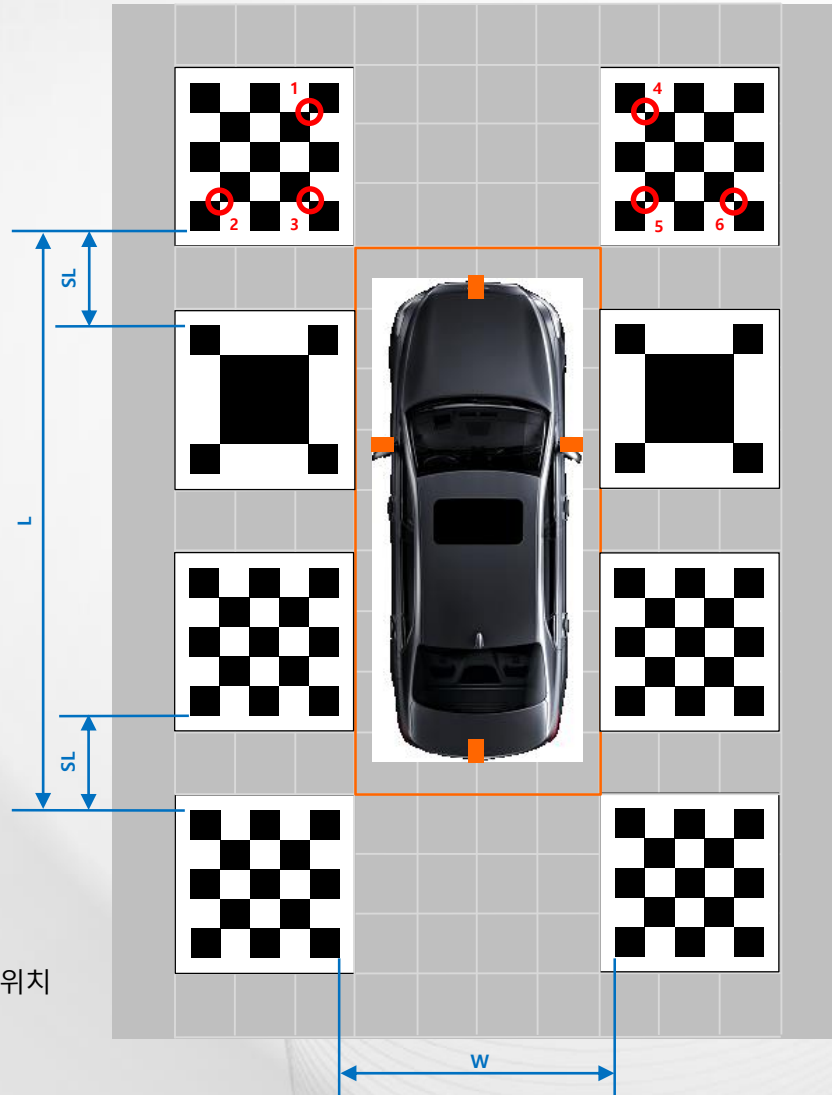
# PI5008K SVM Off-line Calibration Pattern

## ➤ Type 4

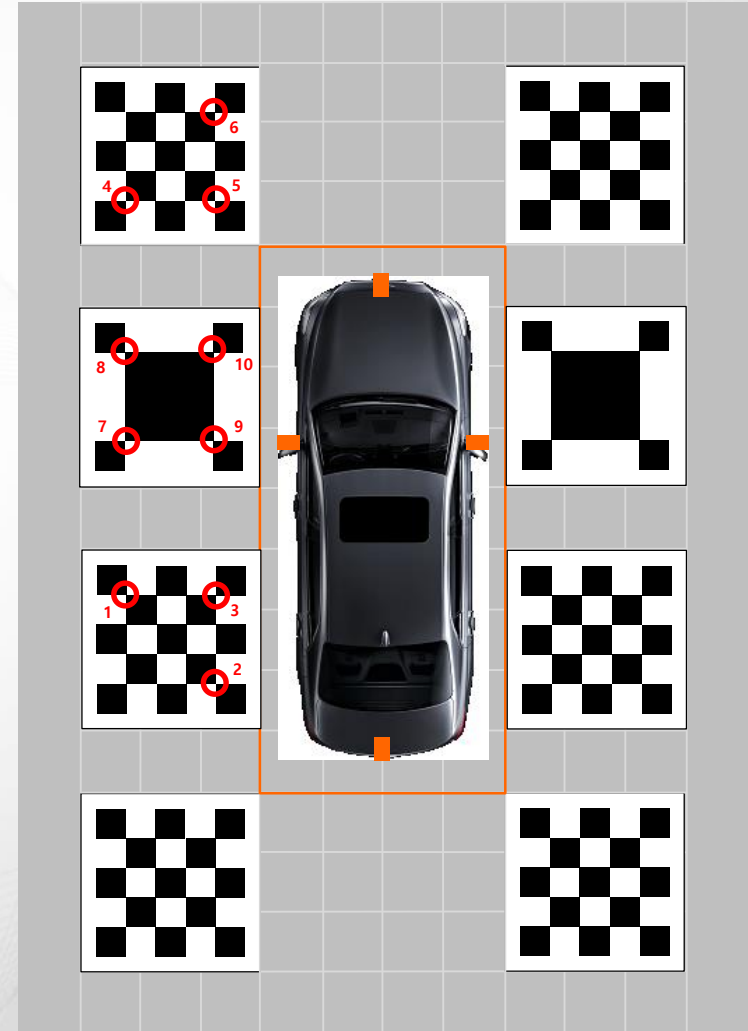


# PI5008K SVM Off-line Calibration Pattern

Front Camera



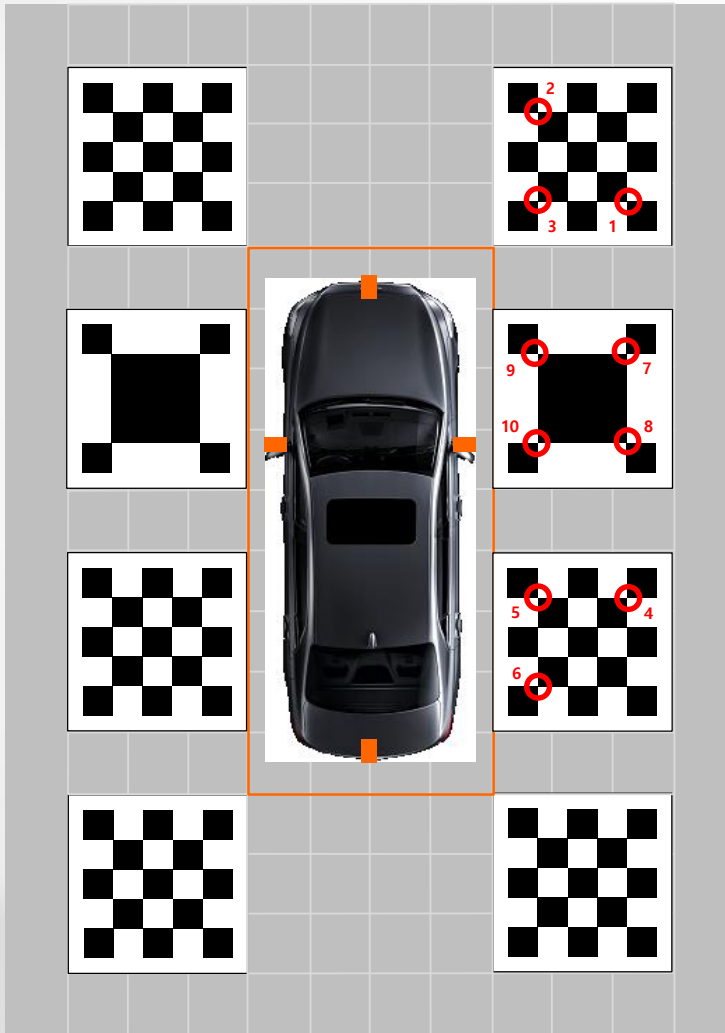
Left Camera



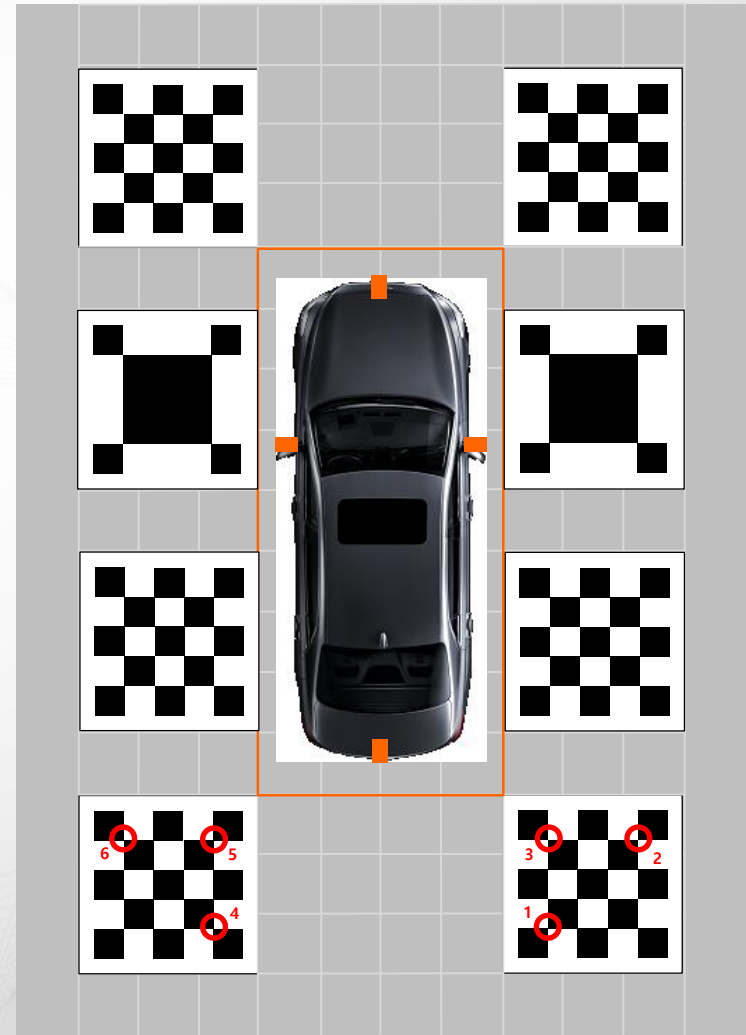
○ 특징점 위치

# PI5008K SVM Off-line Calibration Pattern

Right Camera



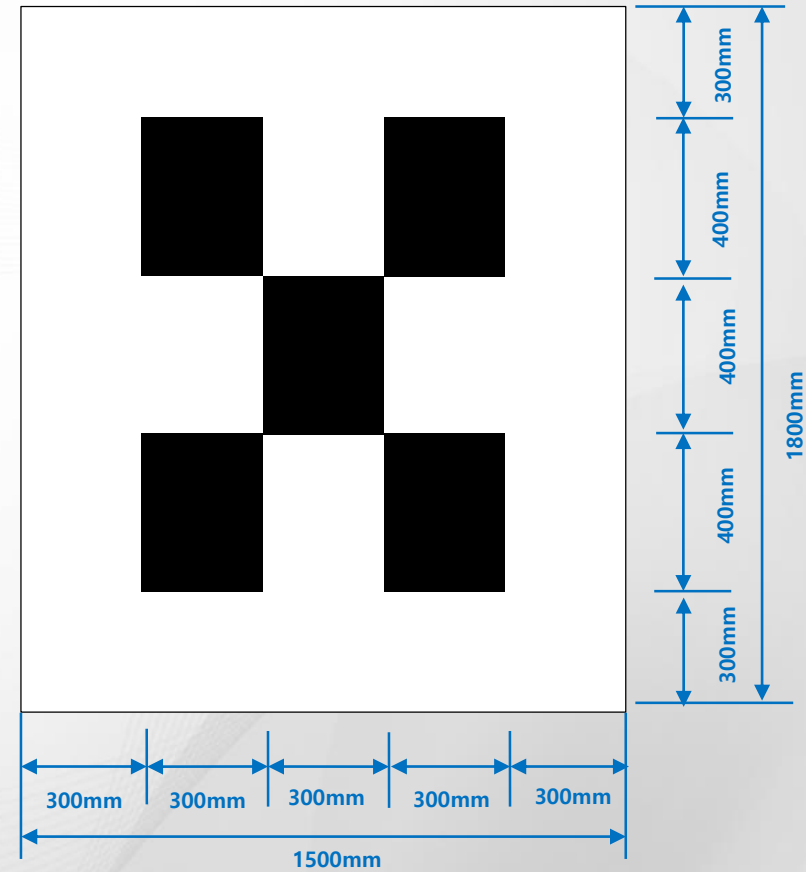
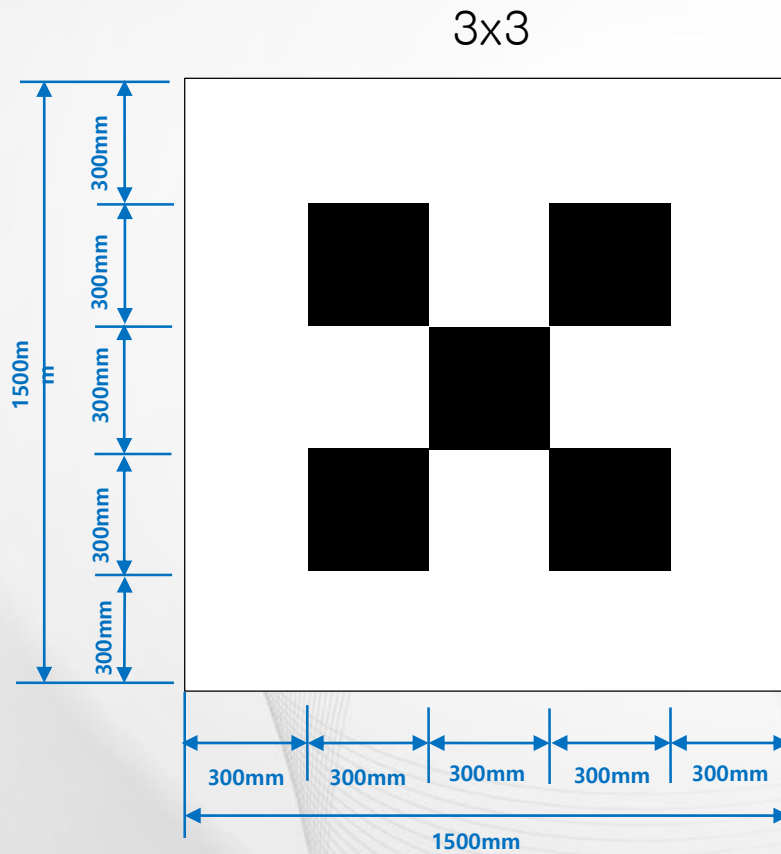
Rear Camera



○ 특징점 위치

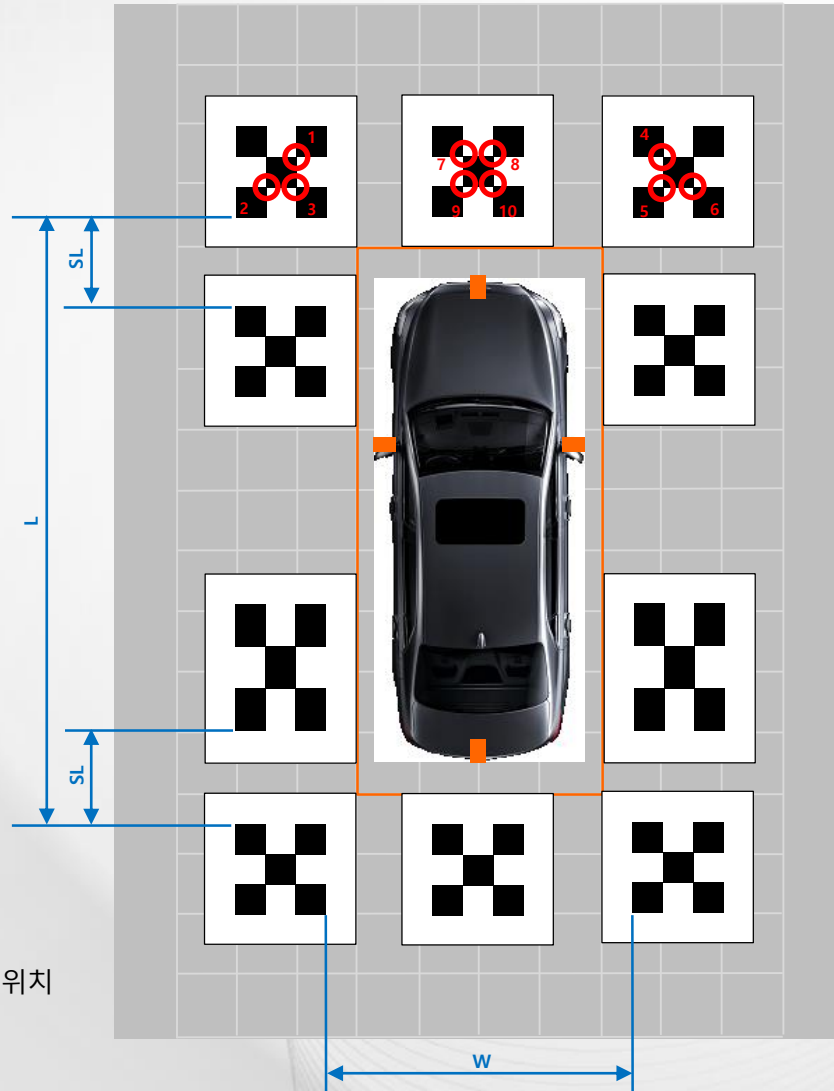


3x3

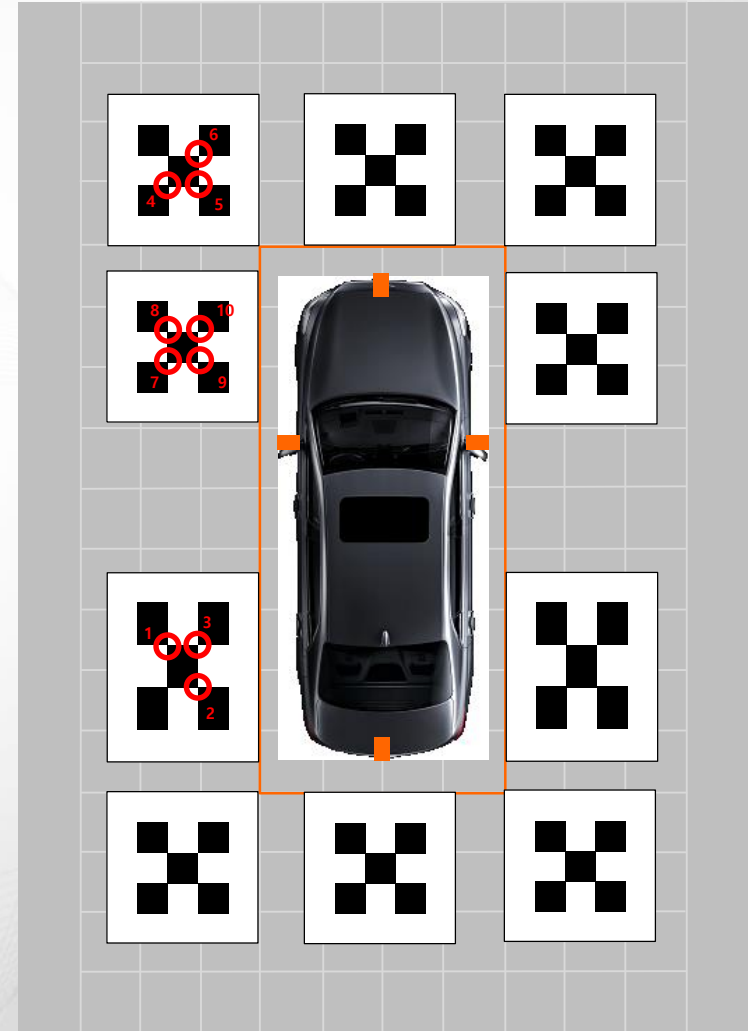


# PI5008K SVM Off-line Calibration Pattern

Front Camera



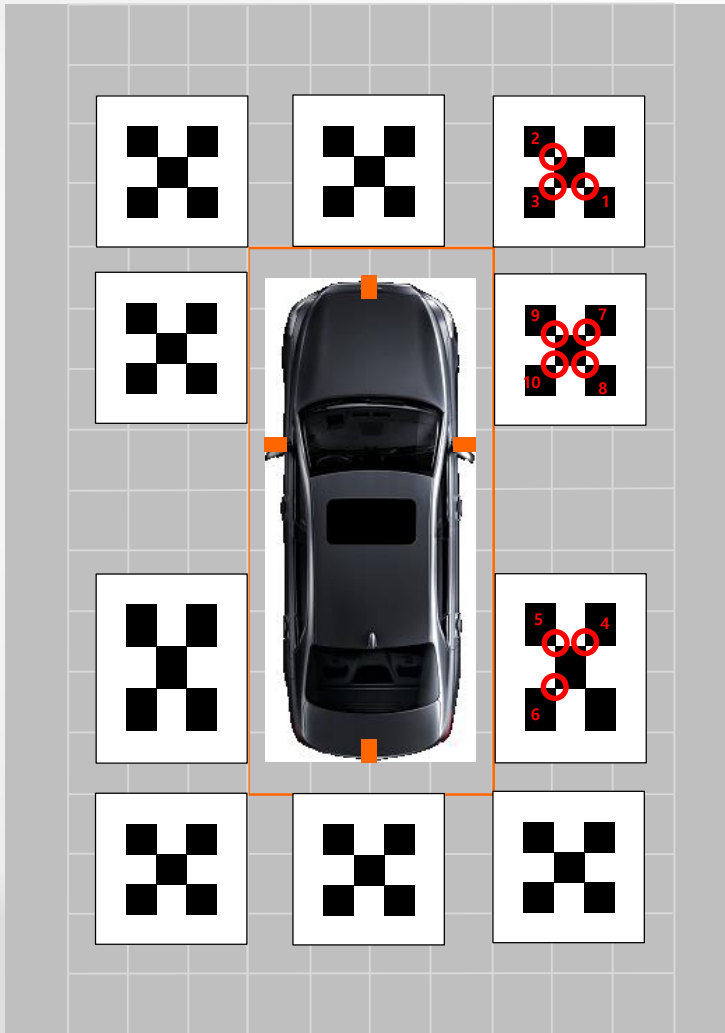
Left Camera



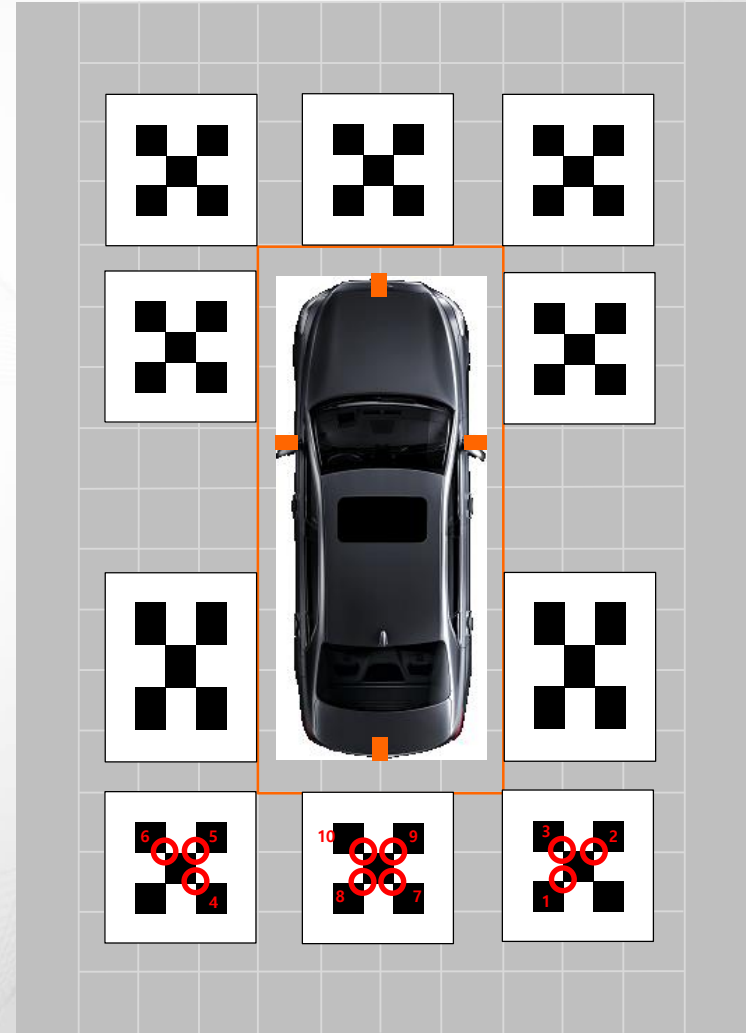
○ 특징점 위치

# PI5008K SVM Off-line Calibration Pattern

Right Camera



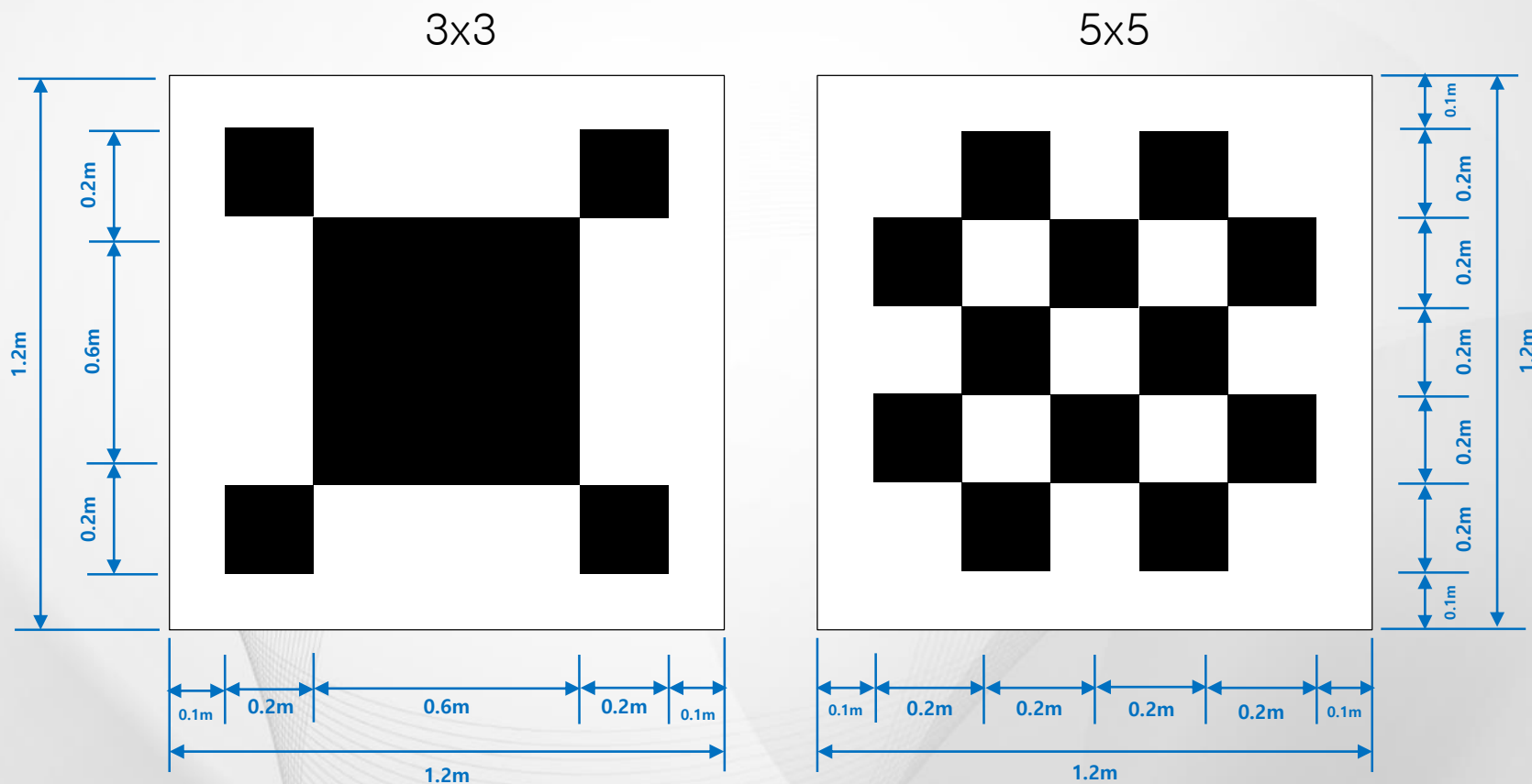
Rear Camera



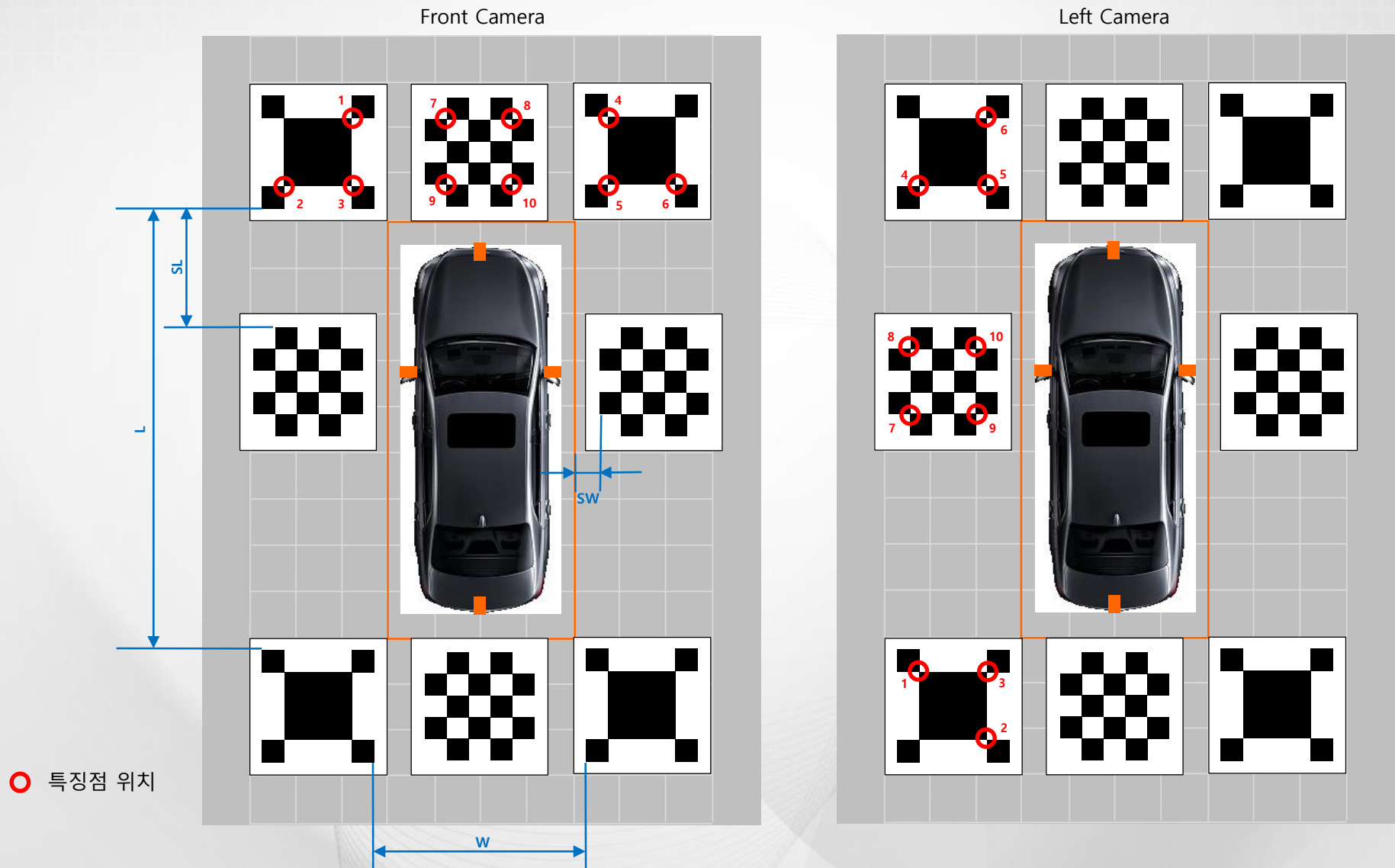
○ 특징점 위치  
Point

# PI5008K SVM Off-line Calibration Pattern

## ➤ Type 6

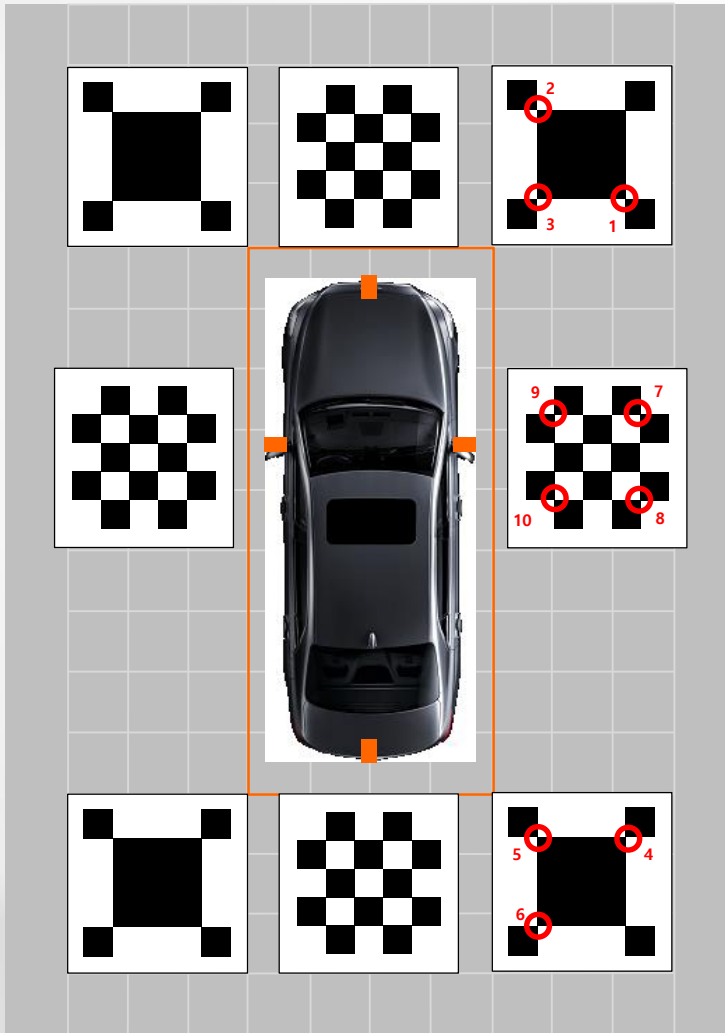


# PI5008K SVM Off-line Calibration Pattern

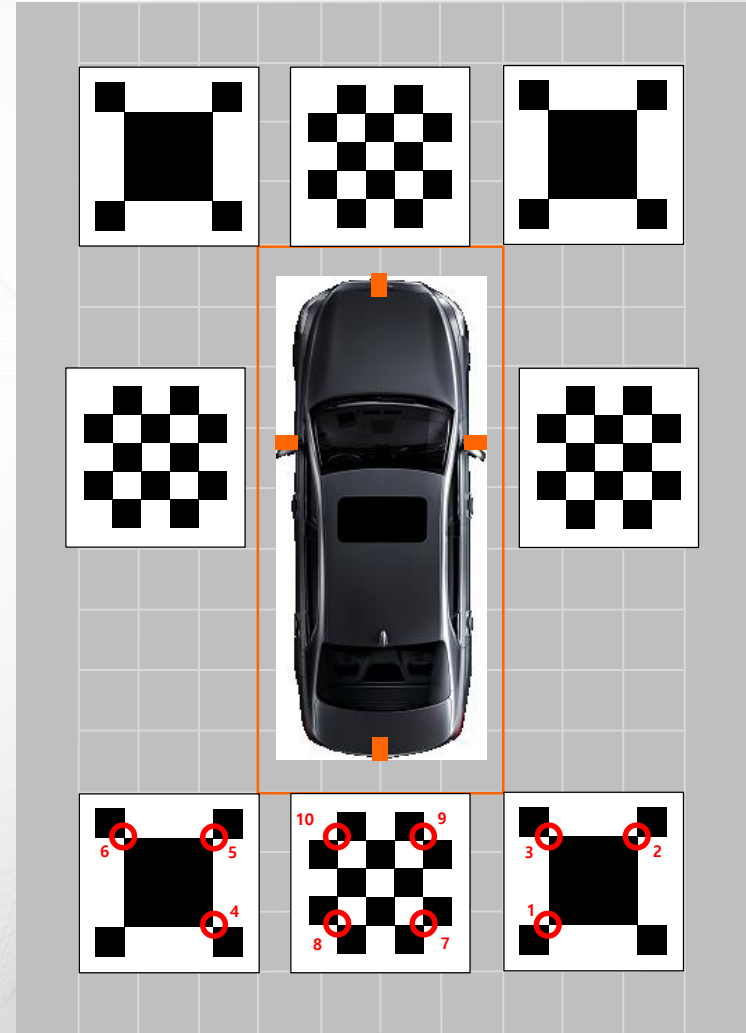


# PI5008K SVM Off-line Calibration Pattern

Right Camera



Rear Camera



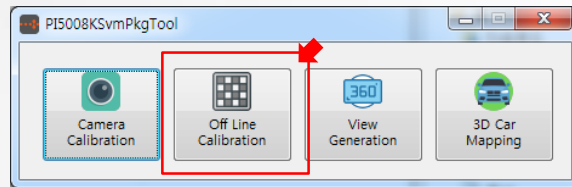
○ 특징점 위치

# How to use PI5008KSvmOffLineCalibTool

# How to use PI5008KSvmOffLineCalibTool

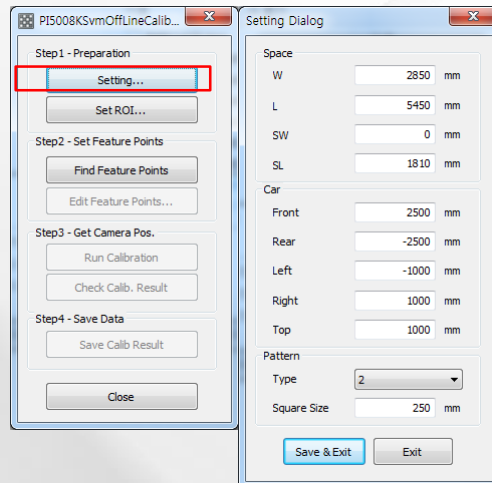
## (1) Start Program

Click <Off Line Calibration> button in PI5008KSvmPkgTool.



## (2) Set Parameters

Set Space, Car and Pattern parameters by clicking <Setting...> button.

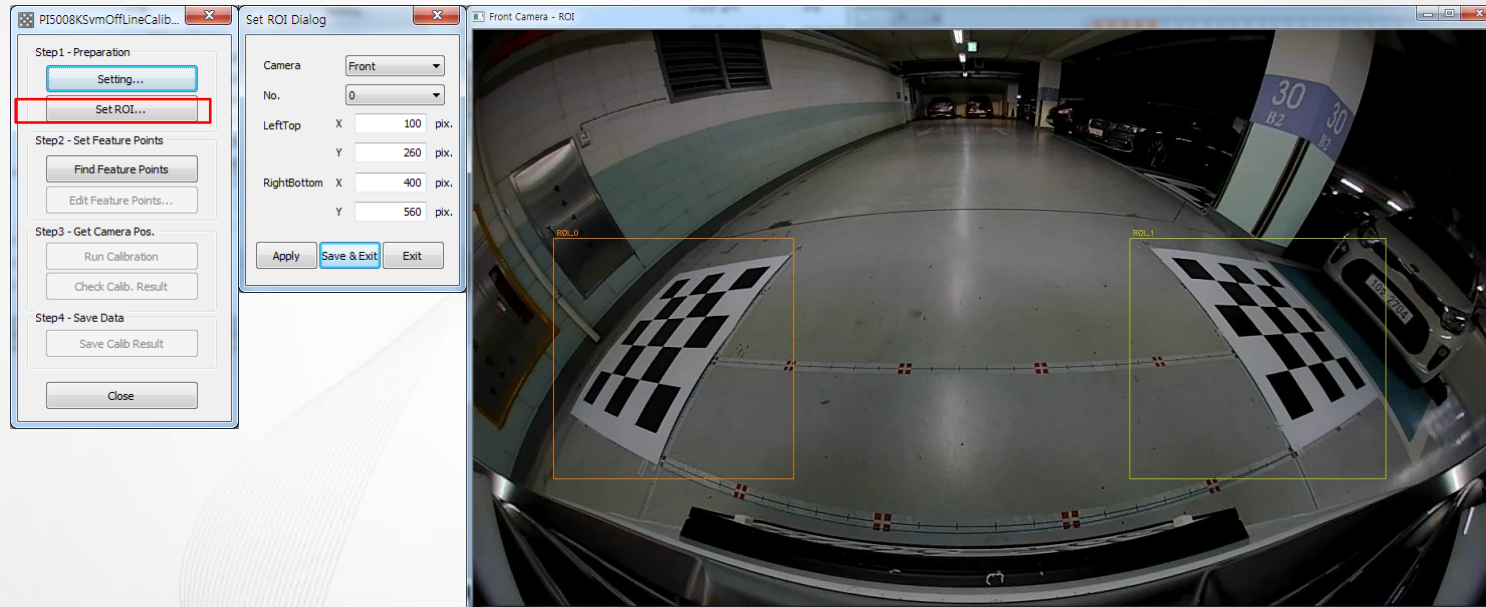




# How to use PI5008KSvmOffLineCalibTool

## (3) Set ROI

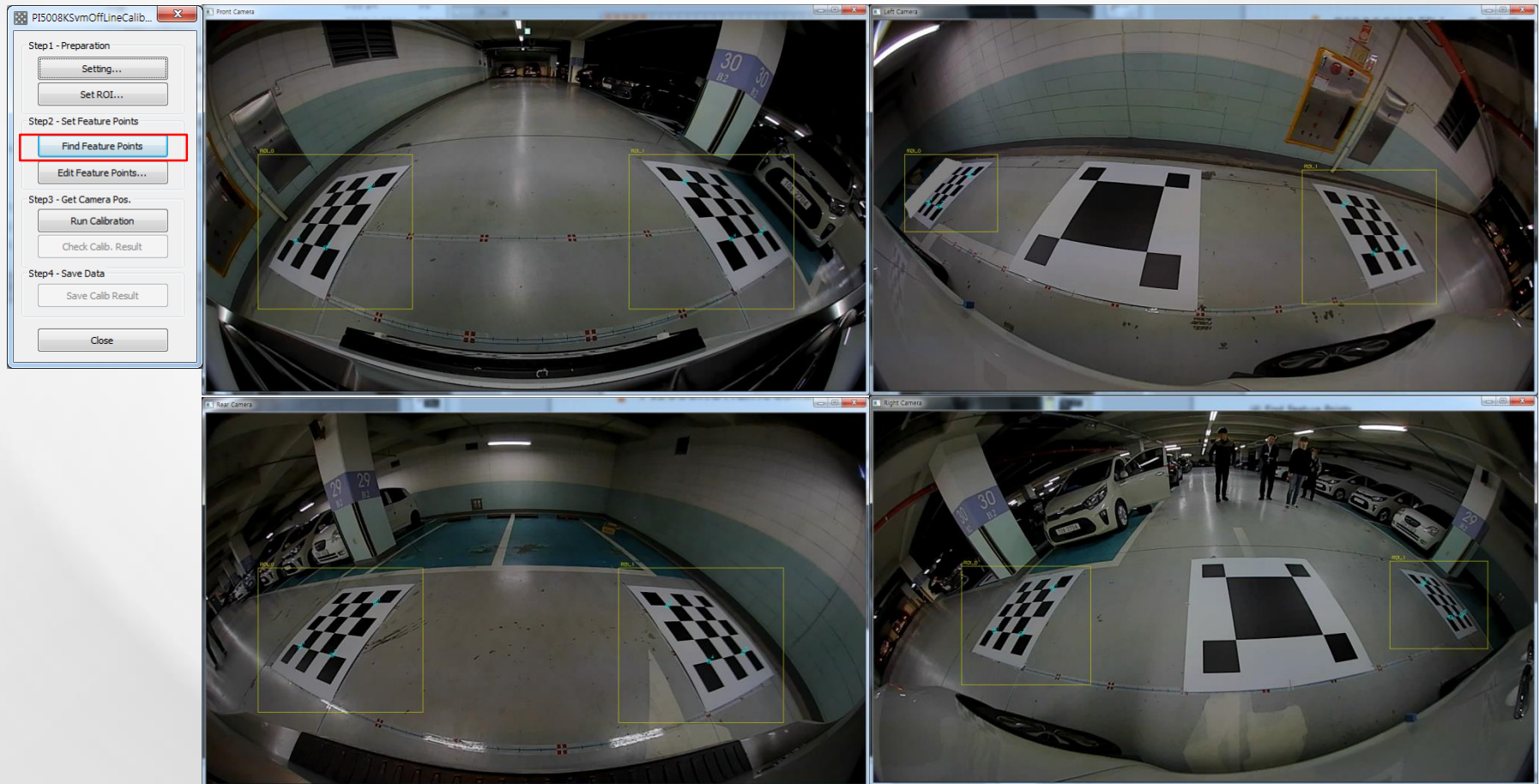
Set ROI position of patterns for each camera by clicking <Set ROI...> button.



# How to use PI5008KSvmOffLineCalibTool

## (4) Find Feature Points

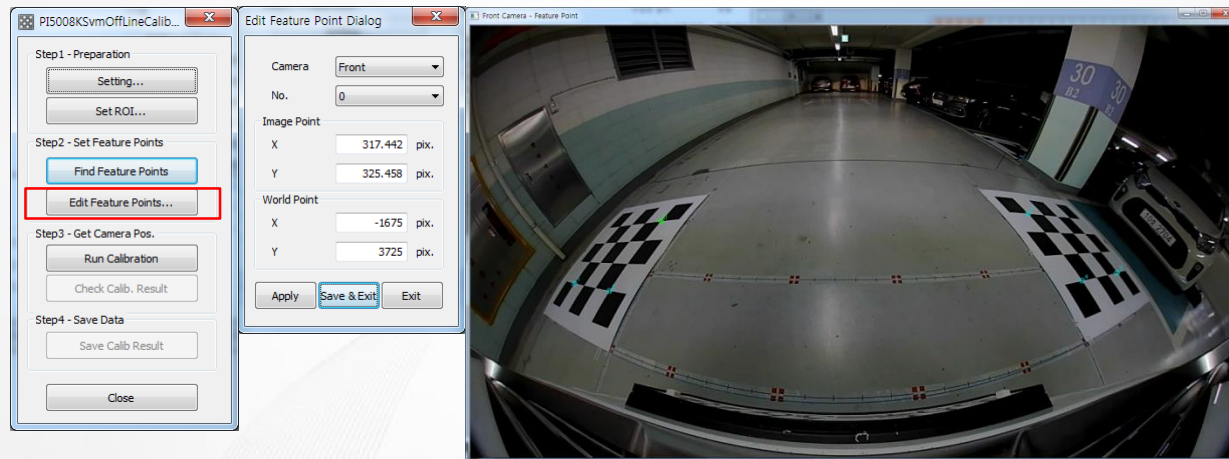
Find feature points using automatic pattern recognition by <Find Feature Points> button. Check if the position of feature point is correct or not. If the feature point is incorrect, try again after correcting the cause.



# How to use PI5008KSvmOffLineCalibTool

## (5) Edit Feature Points Position

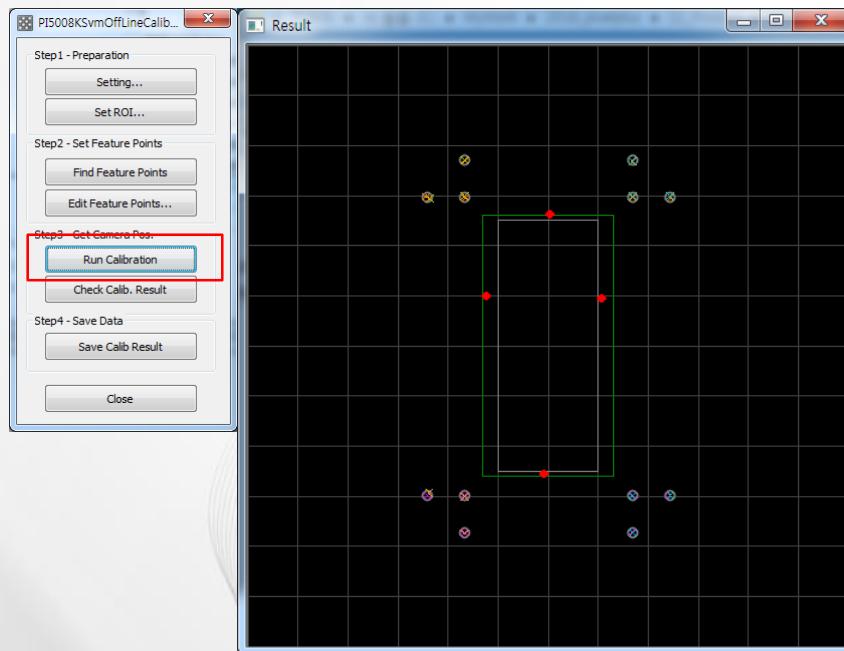
By clicking <Edit Feature Points...> button, edit the position of feature points if needed.



# How to use PI5008KSvmOffLineCalibTool

## (6) Get Camera Position & Angle (Extrinsic Parameters)

Click <Run Calibration> button. Camera position and angle can be obtained using feature point image coordinates and camera intrinsic parameters obtained previously.

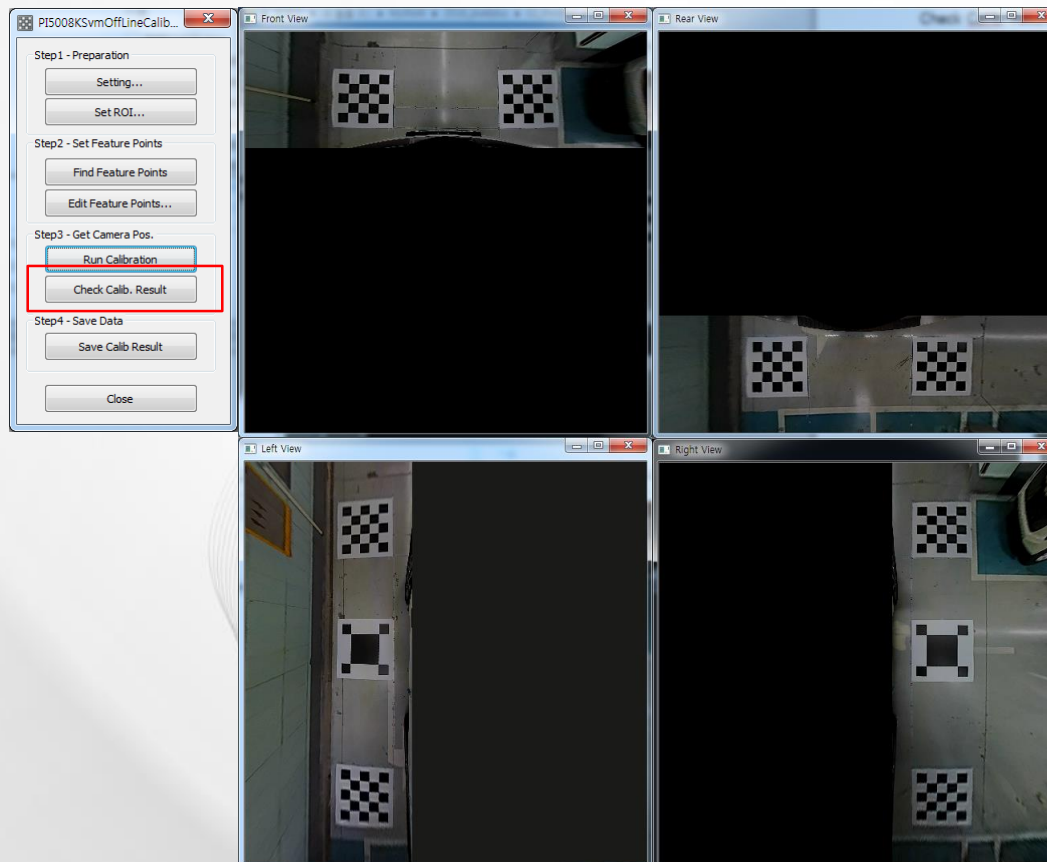




# How to use PI5008KSvmOffLineCalibTool

## (7) Check Calibration Result

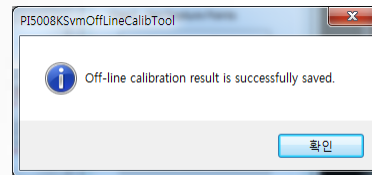
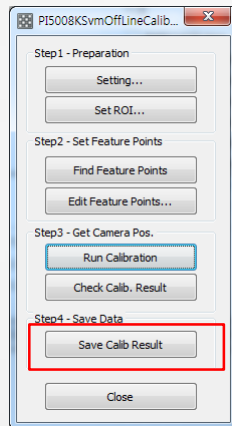
Check the converted top view for each camera by clicking <Check Calib. Result> button.



# How to use PI5008KSvmOffLineCalibTool

## (8) Save Camera Pose Data

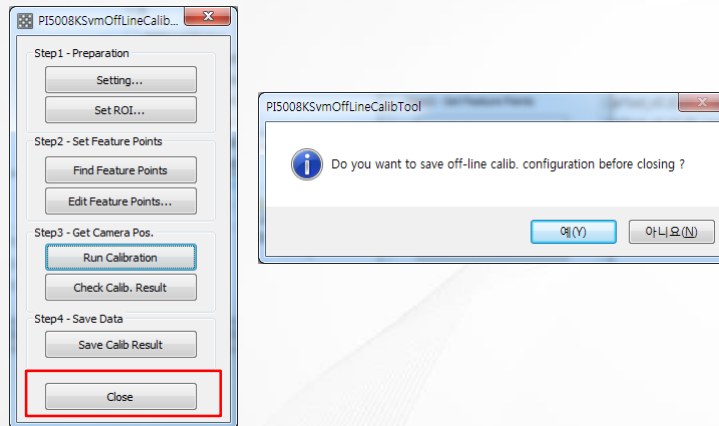
Click <Save Camera Pose> button and choose target folder which files will be saved. In the chosen target folder, extrinsic parameter files(front.epm, rear.epm, left.epm, right.epm) are saved.



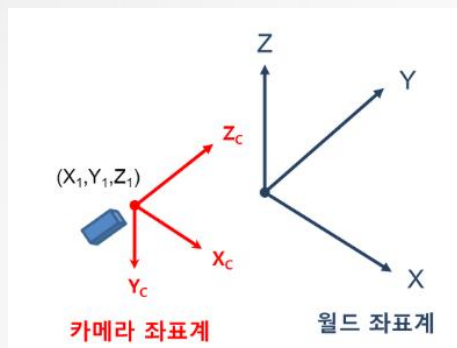
# How to use PI5008KSvmOffLineCalibTool

## (9) Close Program

Click <Close> button to exit program. Select if you will save the changed parameter values in config. file.



## ❖ Camera Extrinsic Parameter



- World coordinate system : X and Y-axis are parallel to ground plane and Z-axis is upper direction.
- Camera coordinate system:  $Z_c$  is camera optical axis.  $X_c$ -axis is right hand and  $Y_c$ -axis is down.

### (1) Camera Position

Position of origin of camera coordinate axis in world coordinate system  $(X_1, Y_1, Z_1)$

### (2) Camera Angle

Tilt : Rotation angle for the X-axis

0 deg. when optical axis ( $Z_c$ ) is parallel to Y-axis of world coordinate system. Up(+), Down(-)

Roll : Rotation angle for the Y-axis

Counterclockwise (+). Clockwise(-)

Pan : Rotation angle for the Z-axis

0 deg. when optical axis ( $Z_c$ ) is parallel to Y-axis of world coordinate system. Left(+), Right(-)



## ❖ Camera Configuration File (.cnf)

[Information]

name=Camera Configuration .....> File information

version=1.5 .....> File version

[Common]

offLineCalib=WoffLineCalib.ppm .....> Off-line calibration parameter file path

[Front]

hFlip=0 .....> Flip state for front camera image (1 – yes, 0 – no)

image="front.bmp" .....> Front camera image file

intrinsic="front.ipm" .....> File for Intrinsic parameter of front camera

extrinsic="front.epm" .....> File for extrinsic parameter of front camera

[Left]

hFlip=0 .....> Flip state for left camera image (1 – yes, 0 – no)

image="left.bmp" .....> Left camera image file

intrinsic="left.ipm" .....> File for intrinsic parameter of left camera

extrinsic="left.epm" .....> File for extrinsic parameter of left camera

[Rear]

hFlip=0 .....> Flip state for rear camera image (1 – yes, 0 – no)

image="rear.bmp" .....> Rear camera image file

intrinsic="rear.ipm" .....> File for intrinsic parameter of rear camera

extrinsic="rear.epm" .....> File for extrinsic parameter of rear camera

[Right]

hFlip=0	.....>	Flip state for right camera image (1 – yes, 0 – no)
image="right.bmp"	.....>	Right camera image file
intrinsic="right.ipm"	.....>	File for intrinsic parameter of right camera
extrinsic="right.epm"	.....>	File for extrinsic parameter of right camera

## ❖ Off-line Calibration Configuration File (.cnf)

### [Information]

name=PI5008KOffLineCalibTool Configuration .....> File information (PI5008KOffLineCalibTool Configuration)

version=1.5 .....> File version

### [Car]

front=2500 .....> Length of the front end of car (unit : mm)

left=-1000 .....> Length of the left end of car (unit : mm)

rear=-2500 .....> Length of the rear end of car (unit : mm)

right=1000 .....> Length of the right end of car (unit : mm)

top=1300 .....> Height of the car (unit : mm)

### [Space]

W=2850.000000 .....> Pattern install width (unit : mm)

L=5450.000000 .....> Pattern install length (unit : mm)

SW=0.000000 .....> Side pattern install width (unit : mm)

SL=1810.000000 .....> Side pattern install length (unit : mm)

### [Pattern]

type=1 .....> Pattern type (1 ~ 3)

squareSize=250.000000 .....> Square size (unit : mm)

### [Front]

roi0Left=100 .....> ROI 0 left top image x coordinate (unit : pixel)

roi0Top=260 .....> ROI 0 left top image y coordinate (unit : pixel)

roi0Right=400 .....> ROI 0 right bottom image x coordinate (unit : pixel)

roi0Bottom=560 .....> ROI 0 right bottom image y coordinate (unit : pixel)

# Appendix

roi1Left=820	.....>	ROI 1 left top image X coordinate (unit : pixel)
roi1Top=260	.....>	ROI 1 left top image Y coordinate (unit: pixel)
roi1Right=1140	.....>	ROI 1 right bottom X coordinate (unit : pixel)
roi1Bottom=560	.....>	ROI 1 right bottom image Y coordinate (unit : pixel)
roi2Left=50	.....>	ROI 2 left top image X coordinate (unit : pixel)
roi2Top=10	.....>	ROI 2 left top image Y coordinate (unit: pixel)
roi2Right=60	.....>	ROI 2 right bottom X coordinate (unit : pixel)
roi2Bottom=20	.....>	ROI 2 right bottom image Y coordinate (unit : pixel)
roi3Left=70	.....>	ROI 3 left top image X coordinate (unit : pixel)
roi3Right=80	.....>	ROI 3 left top image Y coordinate (unit: pixel)
roi3Top=10	.....>	ROI 3 right bottom X coordinate (unit : pixel)
roi3Bottom=20	.....>	ROI 3 right bottom image Y coordinate (unit : pixel)
[Left]		
roi0Left=60		
roi0Right=240		
roi0Top=260		
roi0Bottom=410		
roi1Left=830		
roi1Right=1090		
roi1Top=290		
roi1Bottom=550		

```
roi2Left=50
roi2Top=10
roi2Right=60
roi2Bottom=20
roi3Left=70
roi3Top=10
roi3Right=80
roi3Bottom=20
[Rear]
roi0Left=100
roi0Top=300
roi0Right=420
roi0Bottom=580
roi1Left=800
roi1Top=300
roi1Right=1120
roi1Bottom=600
roi2Left=50
roi2Top=10
roi2Right=60
roi2Bottom=20
```

```
roi3Left=70
roi3Top=10
roi3Right=80
roi3Bottom=20
[Right]
roi0Left=170
roi0Top=300
roi0Right=420
roi0Bottom=530
roi1Left=1000
roi1Top=290
roi1Right=1190
roi1Bottom=460
roi2Left=50
roi2Top=10
roi2Right=60
roi2Bottom=20
roi3Left=70
roi3Top=10
roi3Right=80
roi3Bottom=20
```

## ❖ Camera Intrinsic Parameter File (.ipm)

### [Information]

name=Camera Intrinsic Parameters .....> File information (Camera Intrinsic Parameters)

version=1.2 .....> File version

### [Focal Length]

fx=297.680237 .....> Camera X-axis focal length (unit : pixel)

fy=297.904572 .....> Camera Y-axis focal length (unit : pixel)

### [Principal Point]

cx=628.888367 .....> X-axis principal point (unit : pixel)

cy=377.742218 .....> Y-axis principal point (unit : pixel)

### [Distortion Table]

n=110 .....> Size of distortion table

deg0=0.000000 .....> Length for 0 deg. view angle in the normalized image plane

deg1=0.017454 .....> Length for 1 deg. view angle in the normalized image plane

deg2=0.034915

deg3=0.052387

deg4=0.069877

...

deg107=2.152534

deg108=2.118180

deg109=2.076101 .....> Length for 109 deg. view angle in the normalized image plane

※ Normalized image plane : virtual image plane which camera focal length is 1



## ❖ Camera Extrinsic Parameter File (.epm)

### [Information]

name=Camera Extrinsic Parameters .....> File information (Camera Extrinsic Parameters)

version=1.3 .....> File version

### Position]

X=18.57109 .....> X-axis position of camera in world coordinate system (unit: mm)

Y=2630.37329 .....> Y-axis position of camera in world coordinate system (unit : mm)

Z=761.92139 .....> Z-axis position of camera in world coordinate system (unit : mm)

### [Angle]

X=-49.53154 .....> Tilt angle of camera in world coordinate system (unit : degree)

Y=-0.63797 .....> Roll angle of camera in world coordinate system (unit : degree)

Z=-0.66864 .....> Pan angle of camera in world coordinate system (unit : degree)



## ❖ Off-line Calibration Parameter File (.ppm) 정보

### [Information]

name=Off-Line Calib. Parameters .....> File information (Off-line Calib. Parameters)

version=1.0 .....> File version

### [Car]

front=2500 .....> Length of the front end of car (unit : mm)

rear=-2500 .....> Length of the left end of car (unit : mm)

left=-1000 .....> Length of the rear end of car (unit : mm)

right=1000 .....> Length of the right end of car (unit : mm)

top=1300 .....> Height of the car (unit : mm)

### [Pattern]

W=2850.00000 .....> Pattern install width (unit : mm)

L=5450.00000 .....> Pattern install length (unit : mm)

SW=0.00000 .....> Side pattern install width (unit : mm)

SL=1810.00000 .....> Side pattern install length (unit : mm)

### [Pattern]

type=1 .....> Pattern type (1 ~ 3)

squareSize=250.00000 .....> Square size (unit : mm)

### [Front]

roi0Left=100 .....> ROI 0 left top image x coordinate (unit : pixel)

roi0Top=260 .....> ROI 0 left top image y coordinate (unit : pixel)

roi0Right=400 .....> ROI 0 right bottom image x coordinate (unit : pixel)

roi0Bottom=560 .....> ROI 0 right bottom image y coordinate (unit : pixel)

# Appendix

roi1Left=820	.....>	ROI 1 left top image X coordinate (unit : pixel)
roi1Top=260	.....>	ROI 1 left top image Y coordinate (unit: pixel)
roi1Right=1140	.....>	ROI 1 right bottom X coordinate (unit : pixel)
roi1Bottom=560	.....>	ROI 1 right bottom image Y coordinate (unit : pixel)
roi2Left=50	.....>	ROI 2 left top image X coordinate (unit : pixel)
roi2Top=10	.....>	ROI 2 left top image Y coordinate (unit: pixel)
roi2Right=60	.....>	ROI 2 right bottom X coordinate (unit : pixel)
roi2Bottom=20	.....>	ROI 2 right bottom image Y coordinate (unit : pixel)
roi3Left=70	.....>	ROI 3 left top image X coordinate (unit : pixel)
roi3Top=10	.....>	ROI 3 left top image Y coordinate (unit: pixel)
roi3Right=80	.....>	ROI 3 right bottom X coordinate (unit : pixel)
roi3Bottom=20	.....>	ROI 3 right bottom image Y coordinate (unit : pixel)
[Left]		
roi0Left=60		
roi0Top=260		
roi0Right=240		
roi0Bottom=410		
roi1Left=830		
roi1Top=290		
roi1Right=1090		
roi1Bottom=550		

```
roi2Left=50
roi2Top=10
roi2Right=60
roi2Bottom=20
roi3Left=70
roi3Top=10
roi3Right=80
roi3Bottom=20
[Rear]
roi0Left=100
roi0Top=300
roi0Right=420
roi0Bottom=580
roi1Left=800
roi1Top=300
roi1Right=1120
roi1Bottom=600
roi2Left=50
roi2Top=10
roi2Right=60
roi2Bottom=20
```

```
roi3Left=70
roi3Top=10
roi3Right=80
roi3Bottom=20
[Right]
roi0Left=170
roi0Top=300
roi0Right=420
roi0Bottom=530
roi1Left=1000
roi1Top=290
roi1Right=1190
roi1Bottom=460
roi2Left=50
roi2Top=10
roi2Right=60
roi2Bottom=20
roi3Left=70
roi3Top=10
roi3Right=80
roi3Bottom=20
```