



HALCON

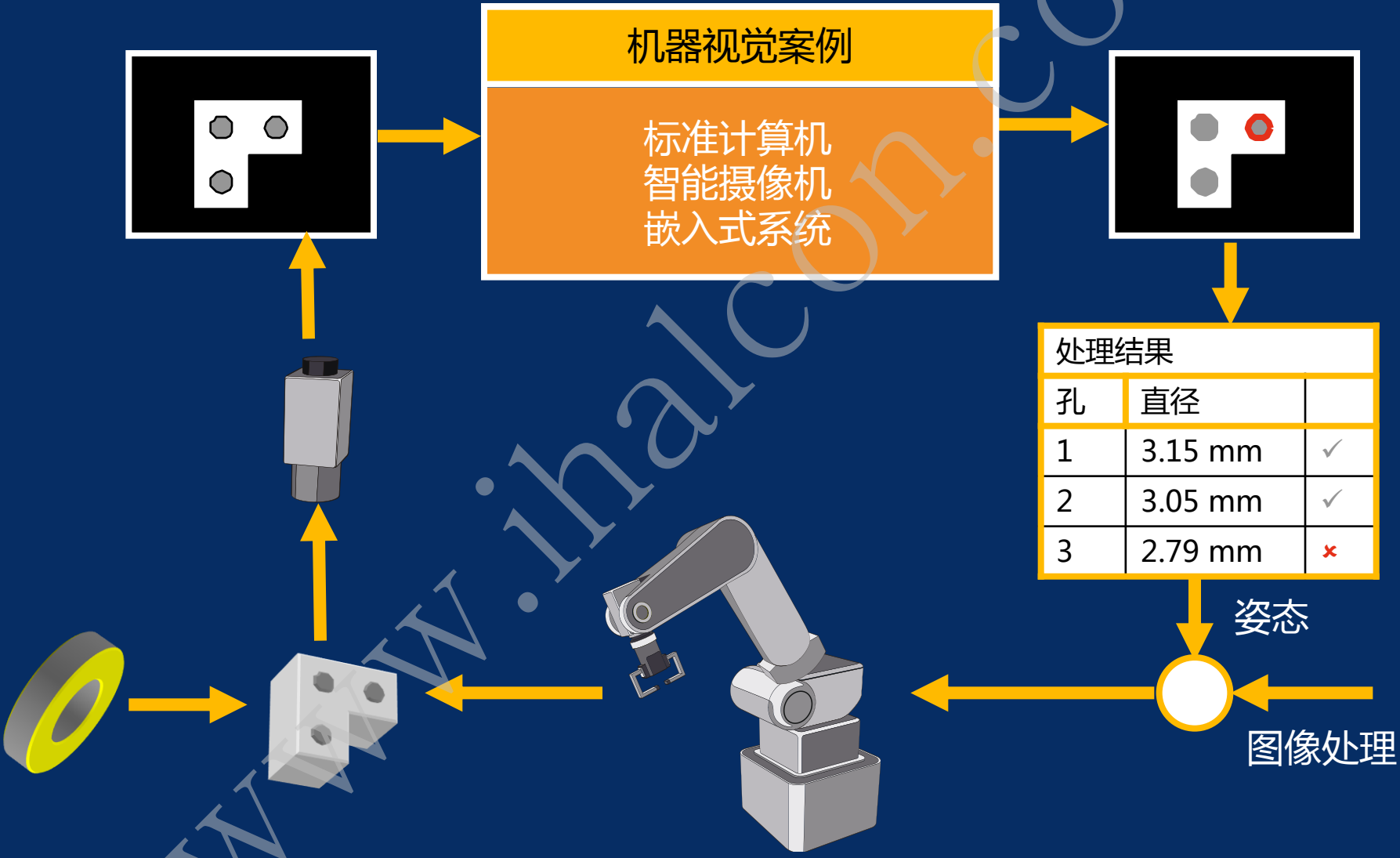
the power of machine vision

HALCON 介绍



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计算机视觉系统组成——图像处理软件



图像处理软件



MVTec提供机器视觉软件，方案和服务



HALCON
the power of machine vision



MERLIC
simply visionary



**Solutions
+
Services**



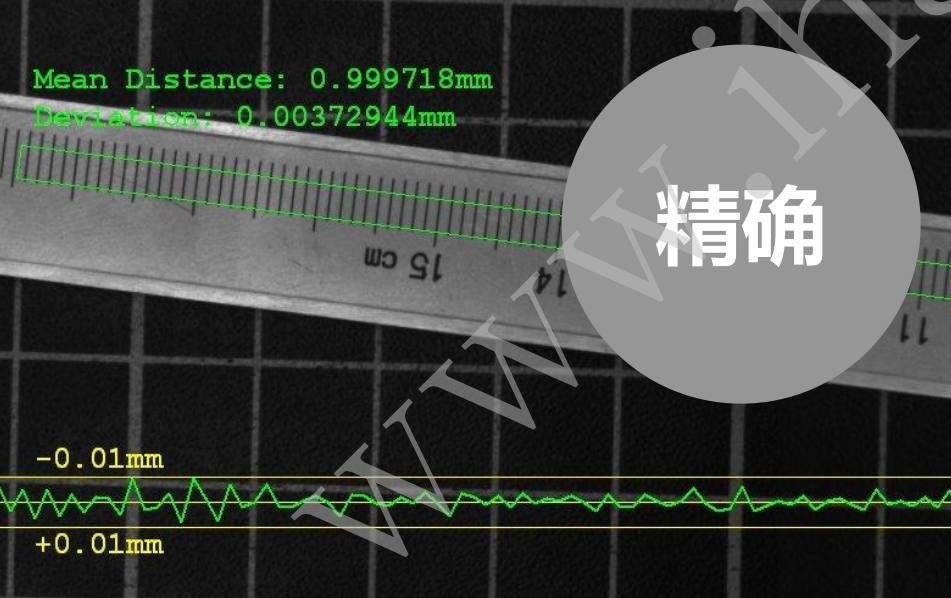
HALCON 特点



快速



全面



精确



鲁棒

HALCON 特点之一——快速性



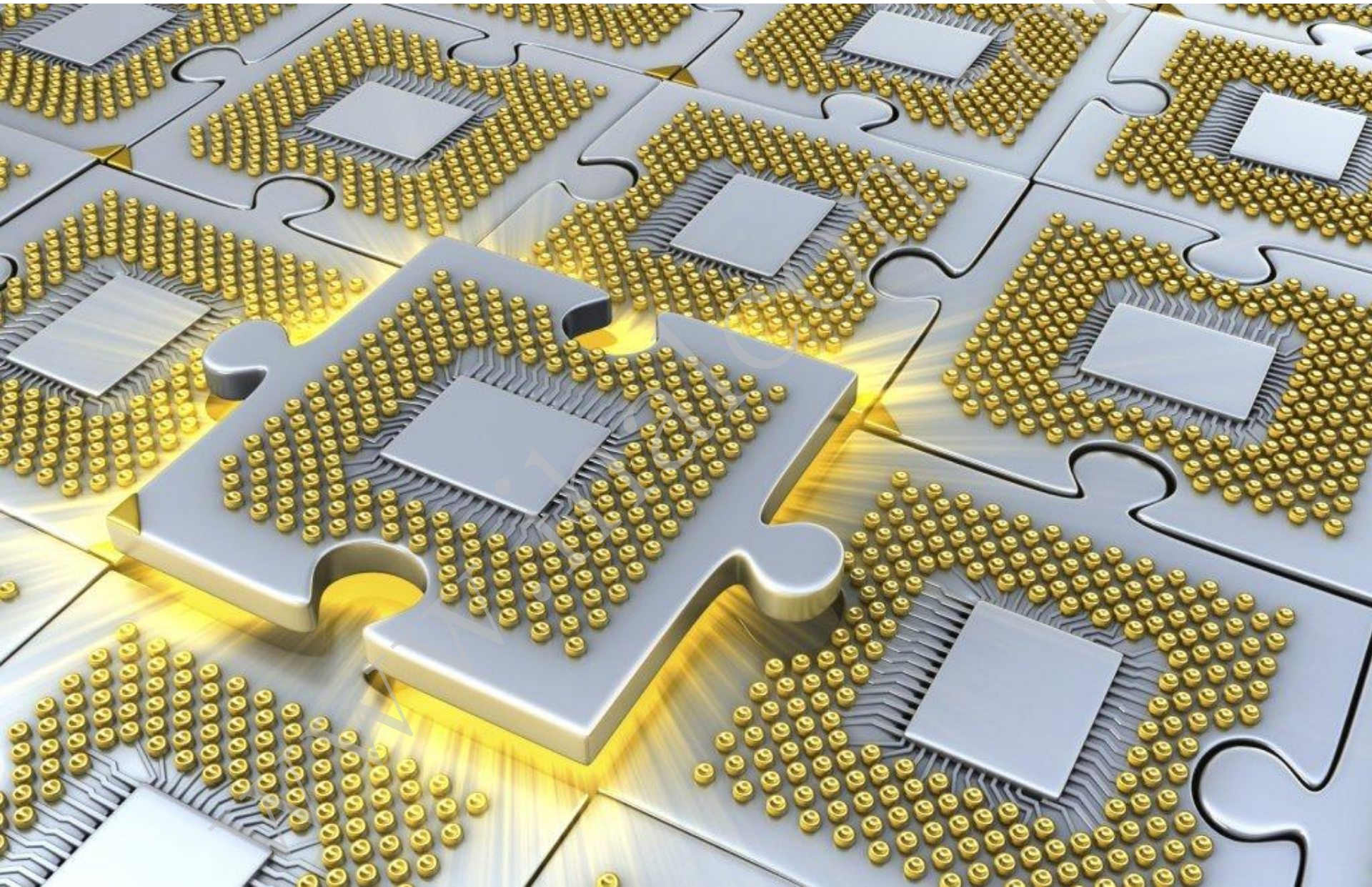
快速性

HALCON基于形状的匹配速度很快

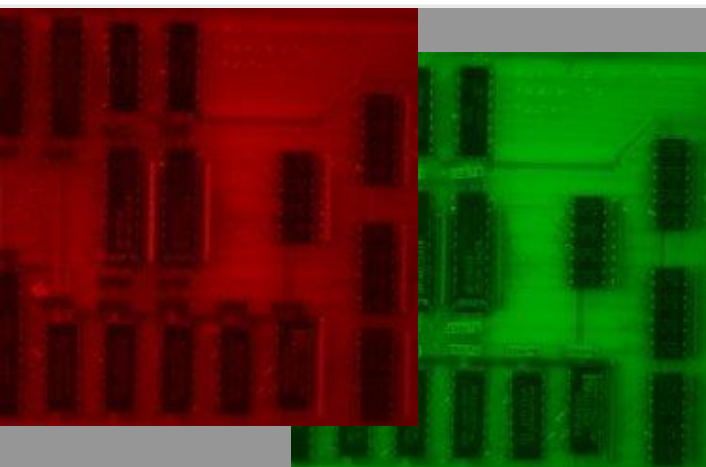
Model found in 0.87 ms



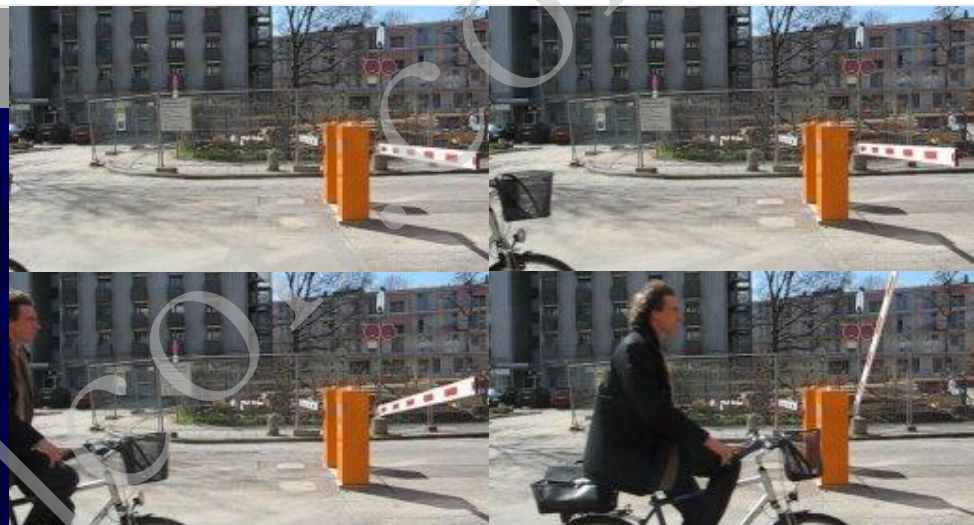
HALCON从2000年之后支持算子自动并行化



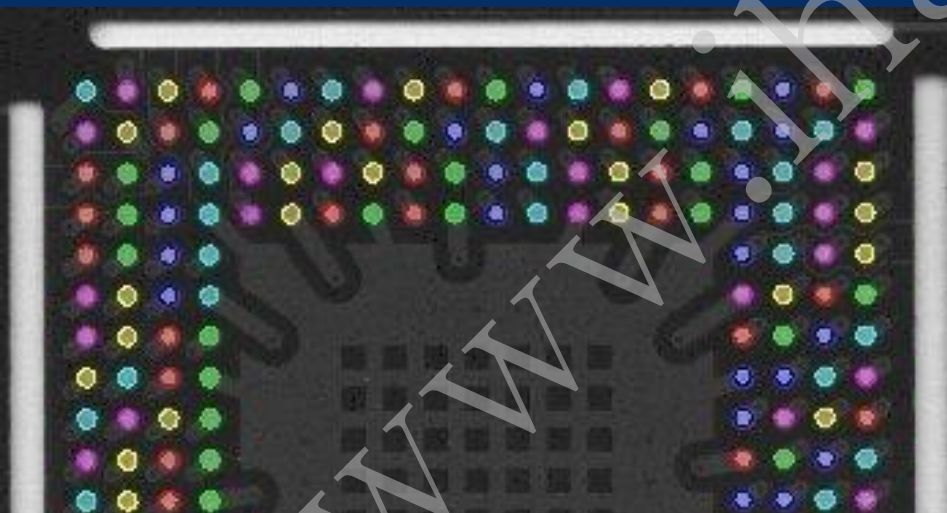
HALCON自动并行化支持全部常见的数据结构



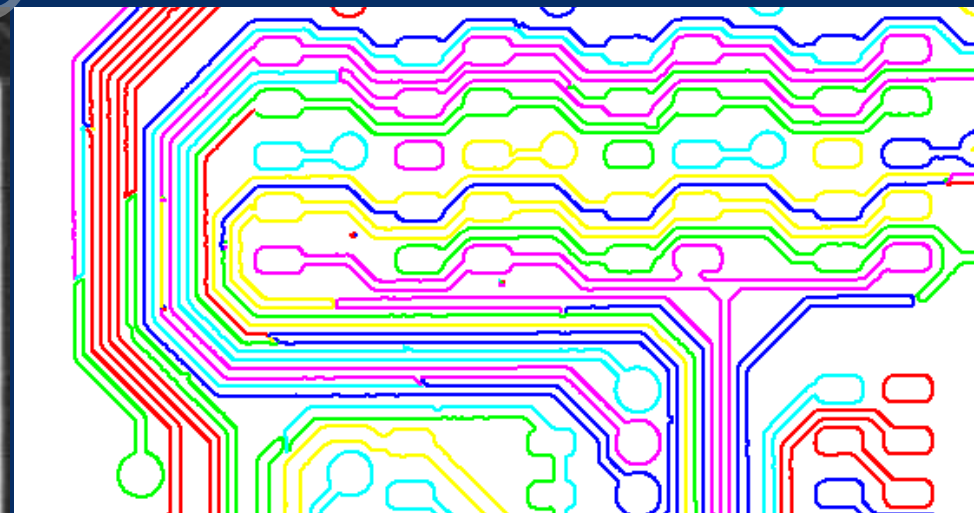
多通道图像处理



图像阵列



区域阵列

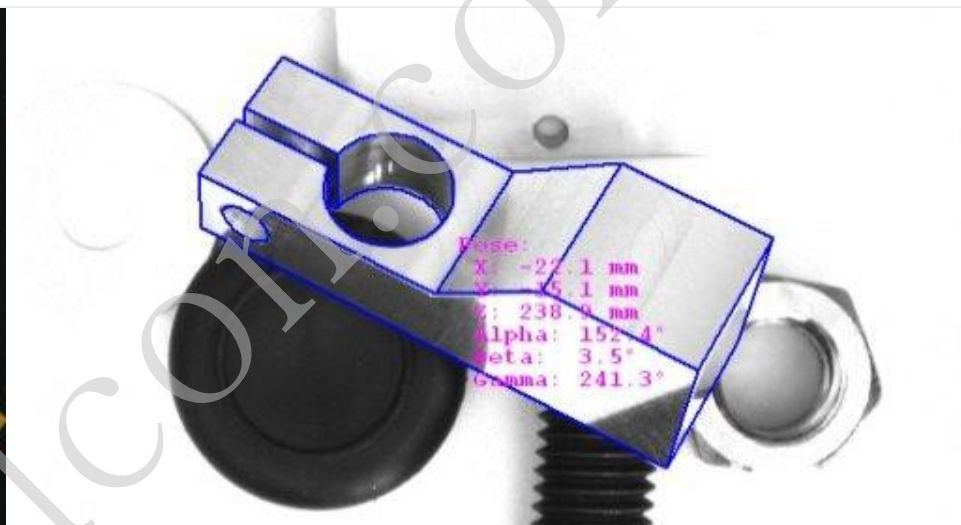


轮廓阵列

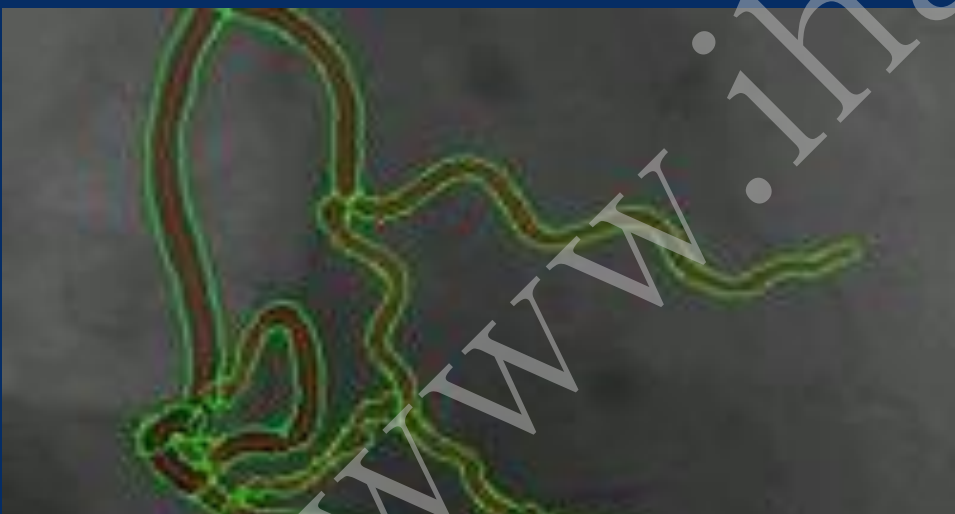
复杂的算子能自动并行化处理



二维匹配



三维匹配



轮廓提取



点的提取

HALCON特点之二——精确性

Mean Distance: 0.999718mm

Deviation: 0.00372944mm

精确性

-0.01mm

+0.01mm

HALCON的标定算法能实现世界坐标系内的精确测量

Mean Distance: 0.999718mm

Deviation: 0.00372944mm

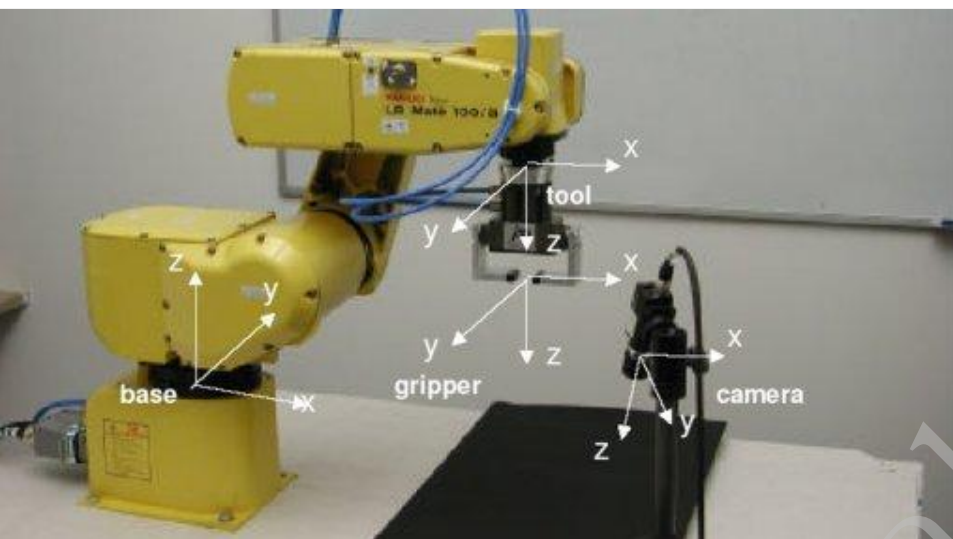
-0.01mm

+0.01mm

测量误差



HALCON摄像机标定算法已发展10余年

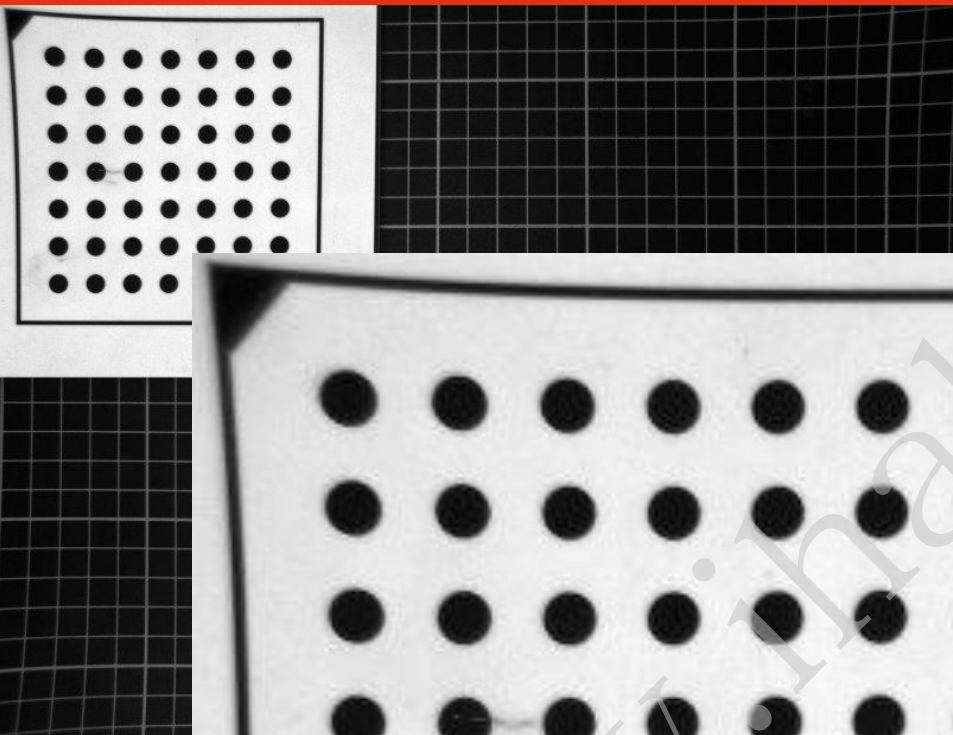


全面的三维标定

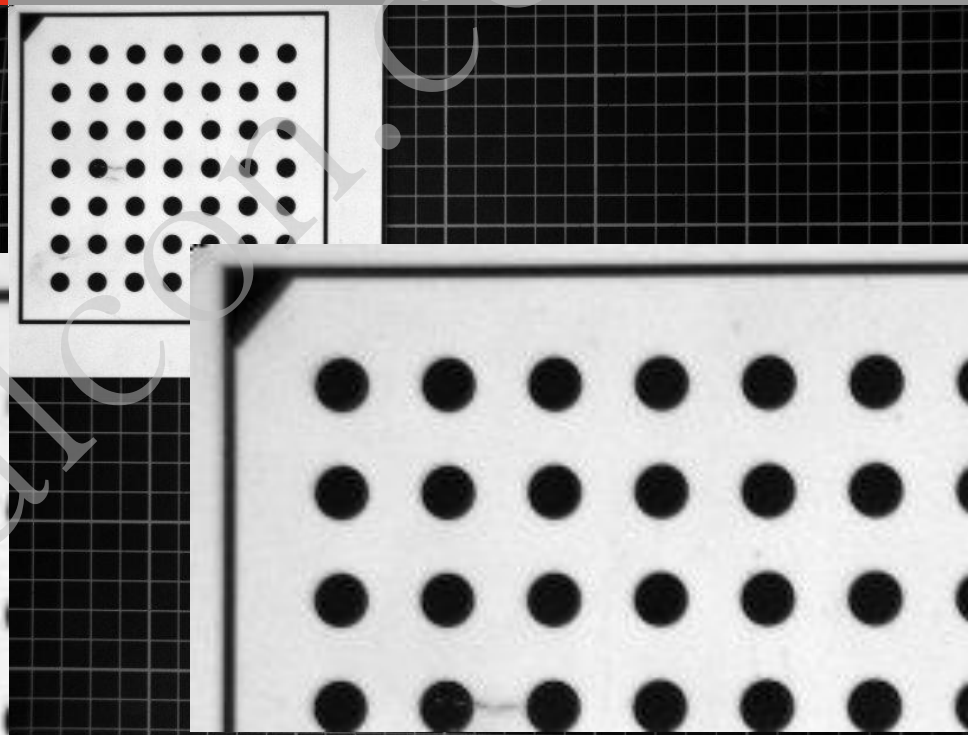
镜头畸变校正

HALCON的三维标定技术可校正畸变，其它软件不可以

畸变很大的图像



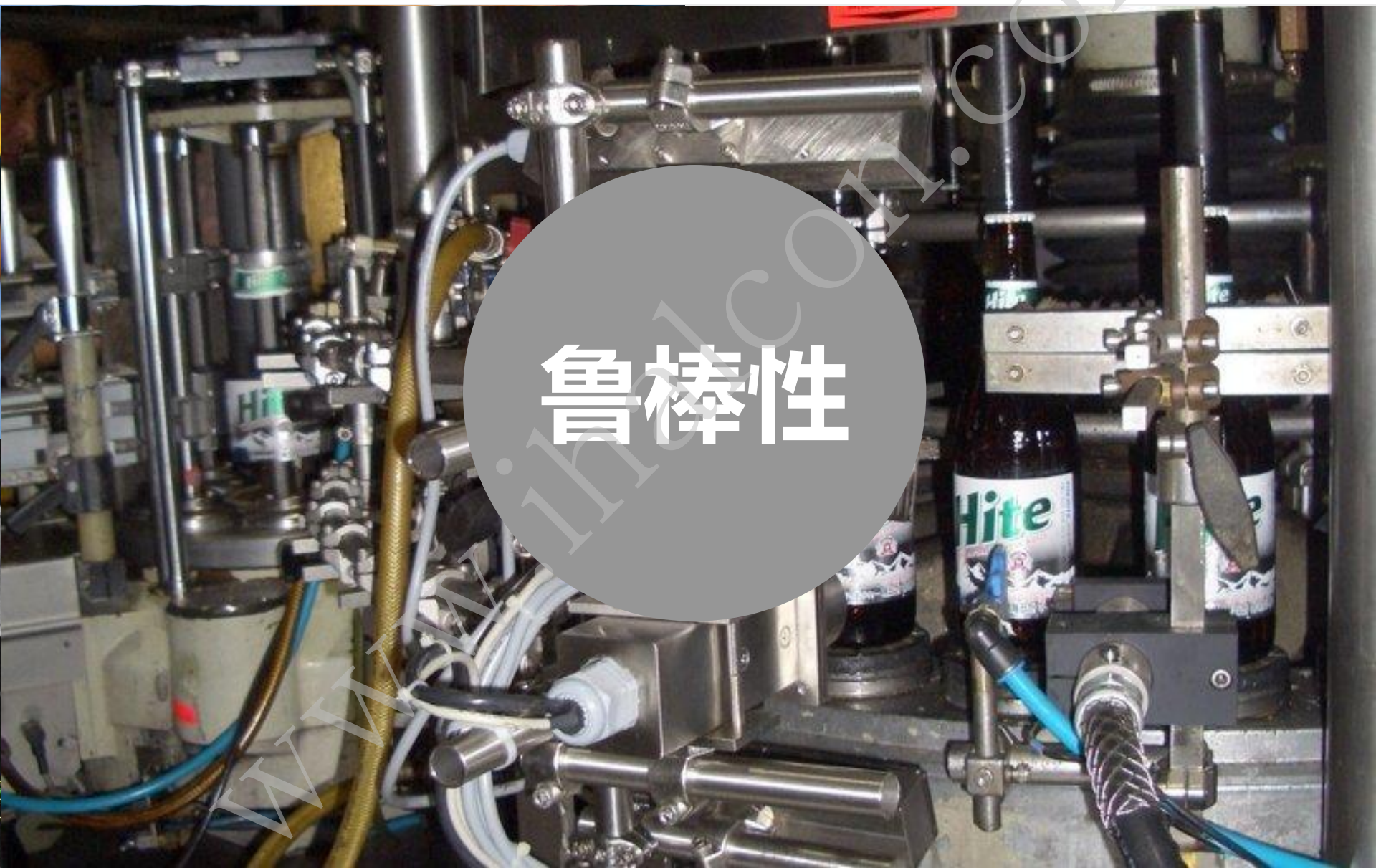
校正后的图像



畸变的网格与直线的对比:

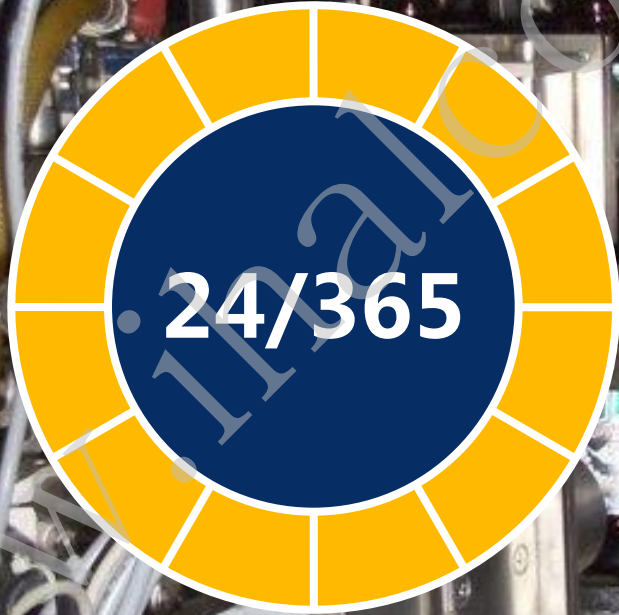
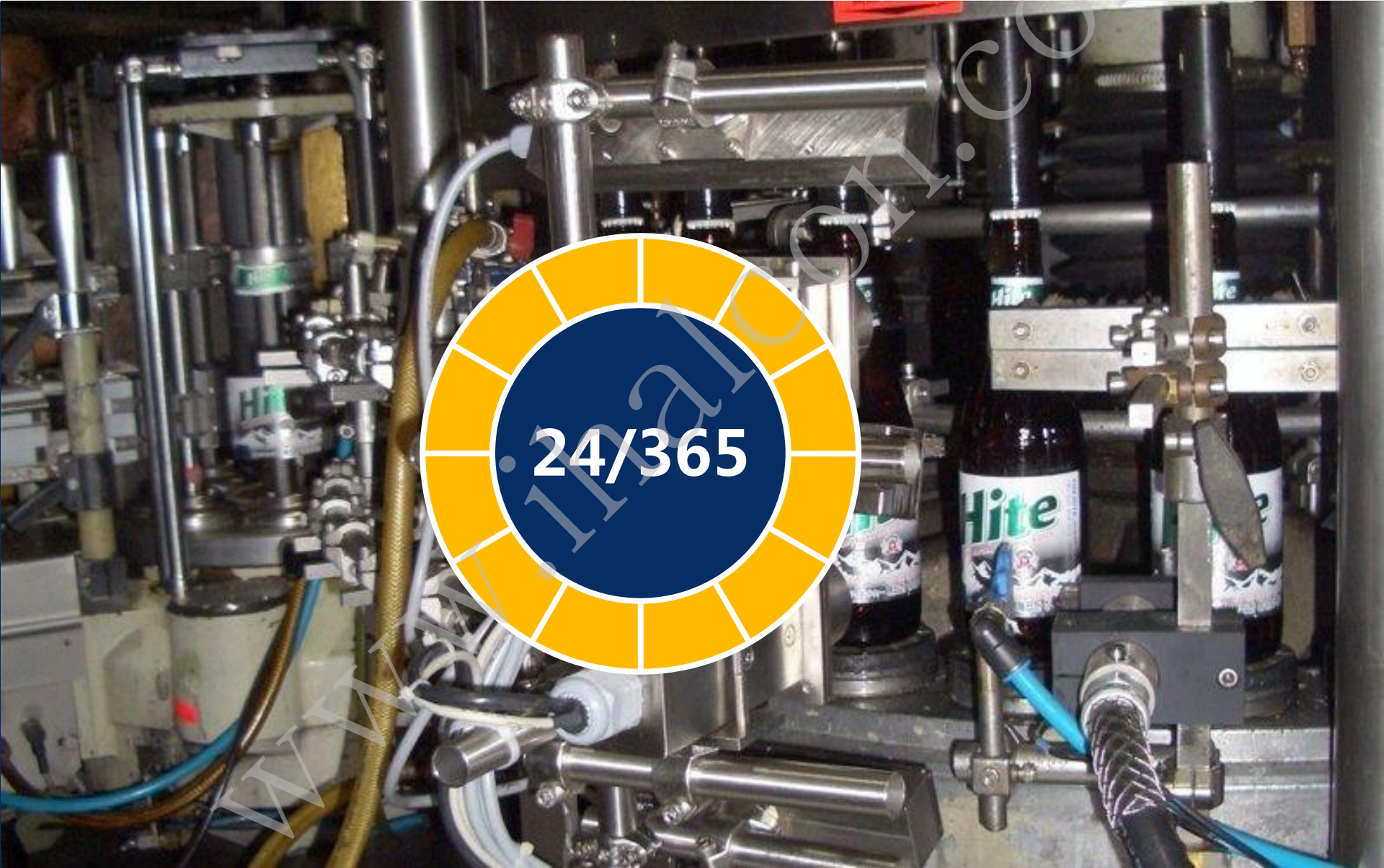


HALCON 特点之三——鲁棒性



鲁棒性

HALCON的鲁棒性得到世界范围内成千上万应用的证实



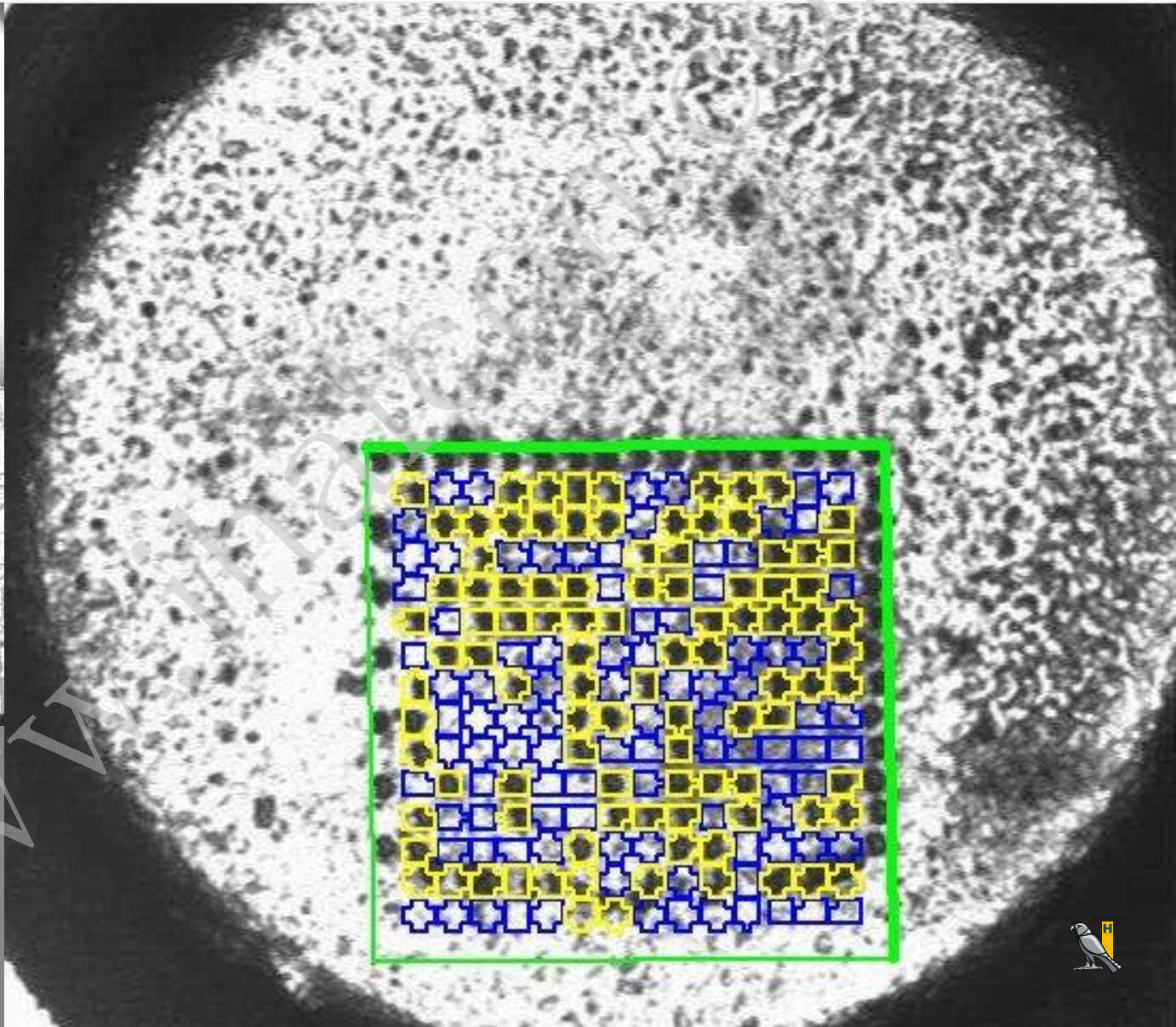
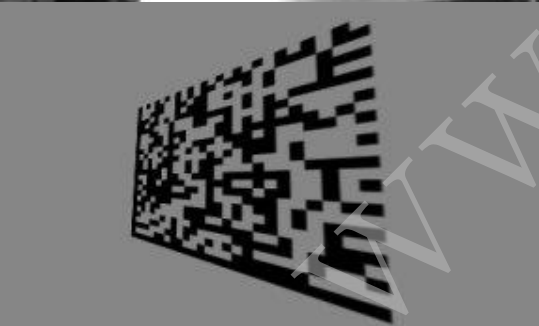
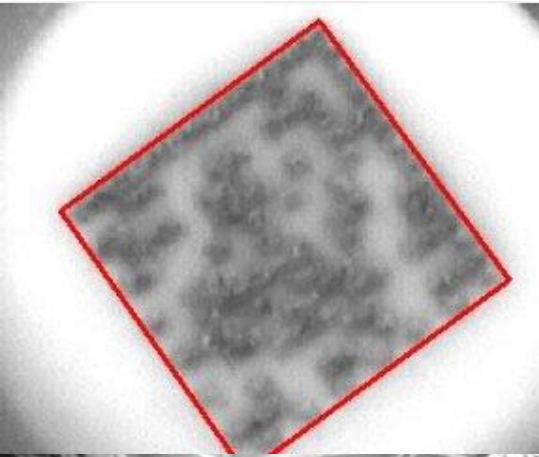
HALCON解决了很多具有挑战性的应用



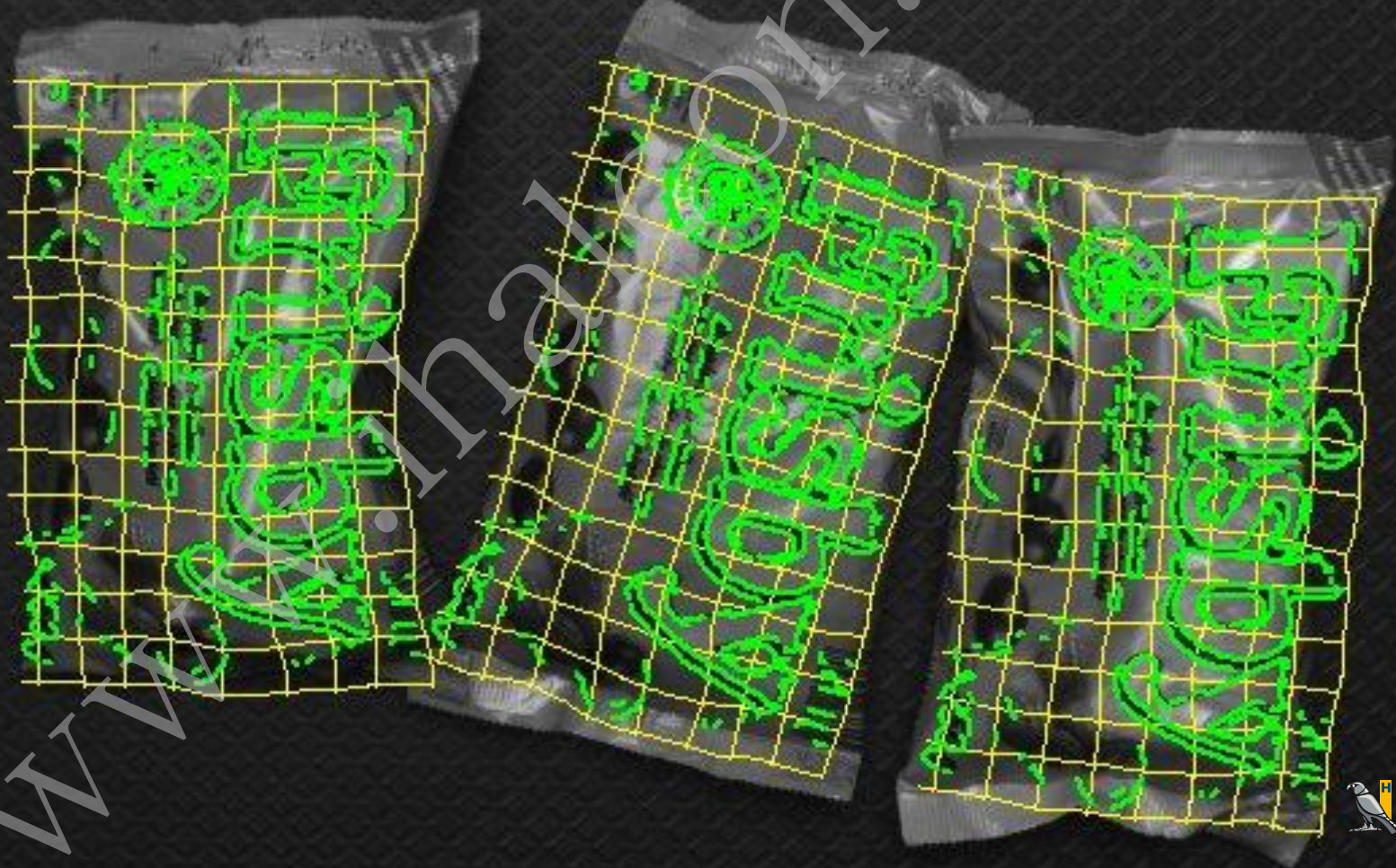
HALCON解决了很多具有挑战性的应用



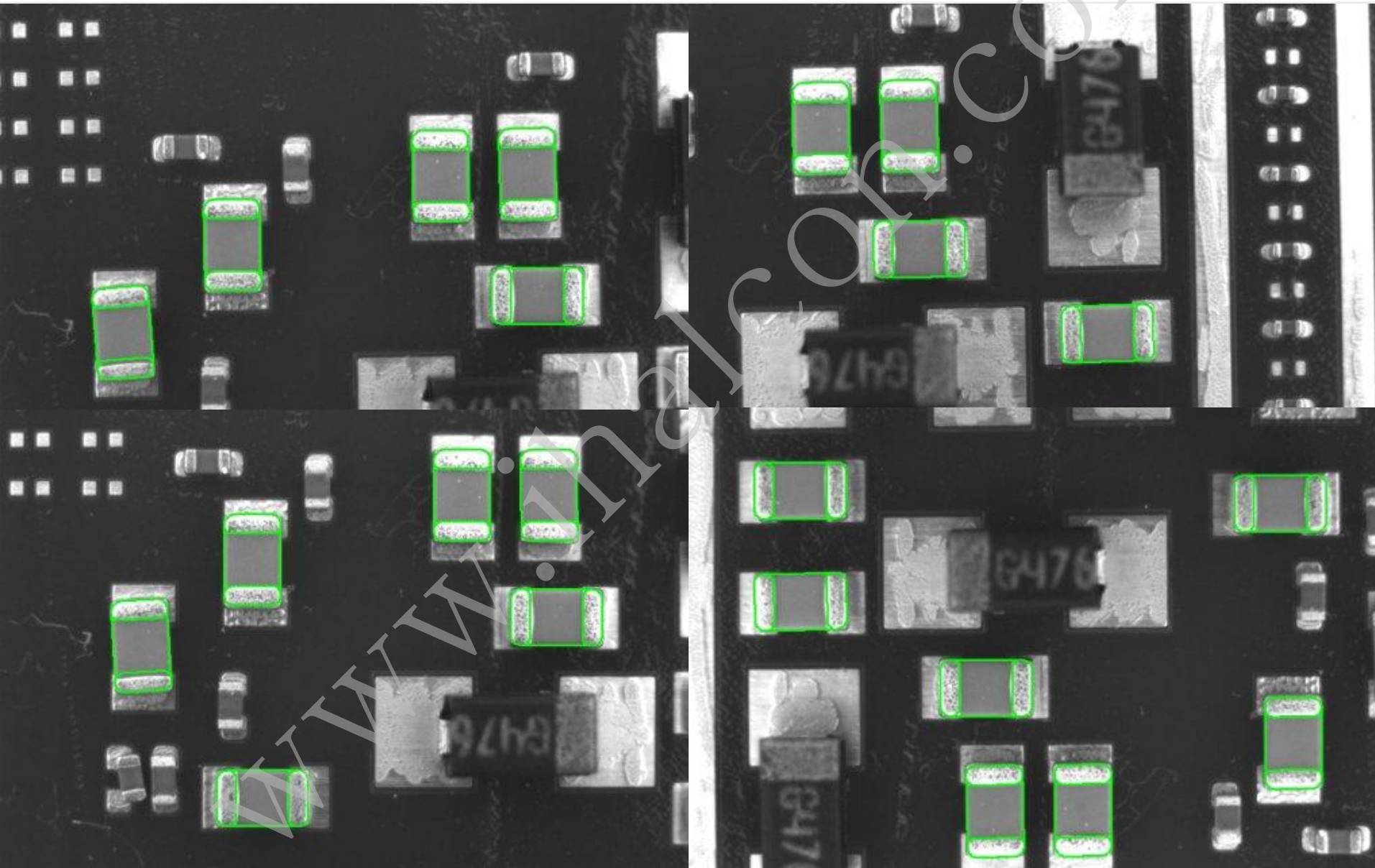
HALCON提供了目前最鲁棒的二维码读取算法



HALCON能实现变形模板匹配



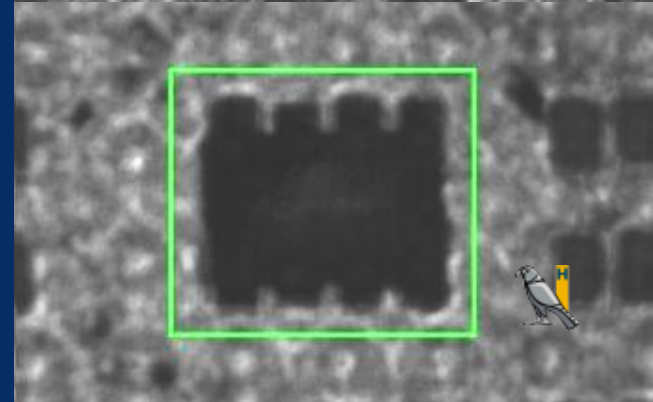
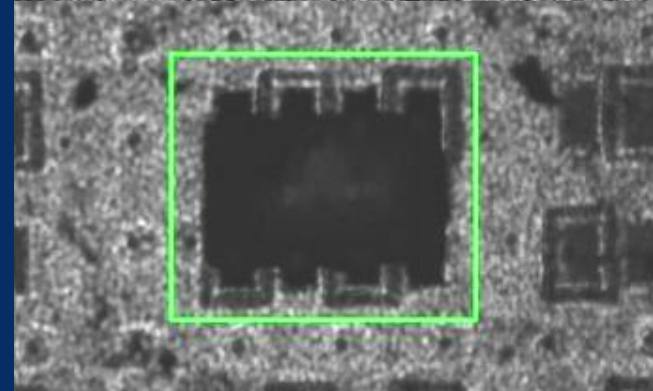
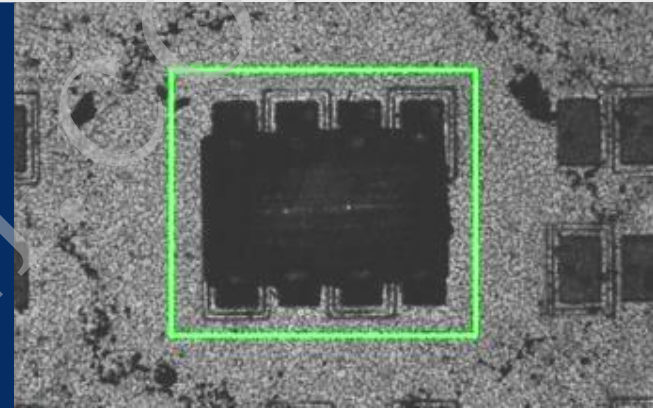
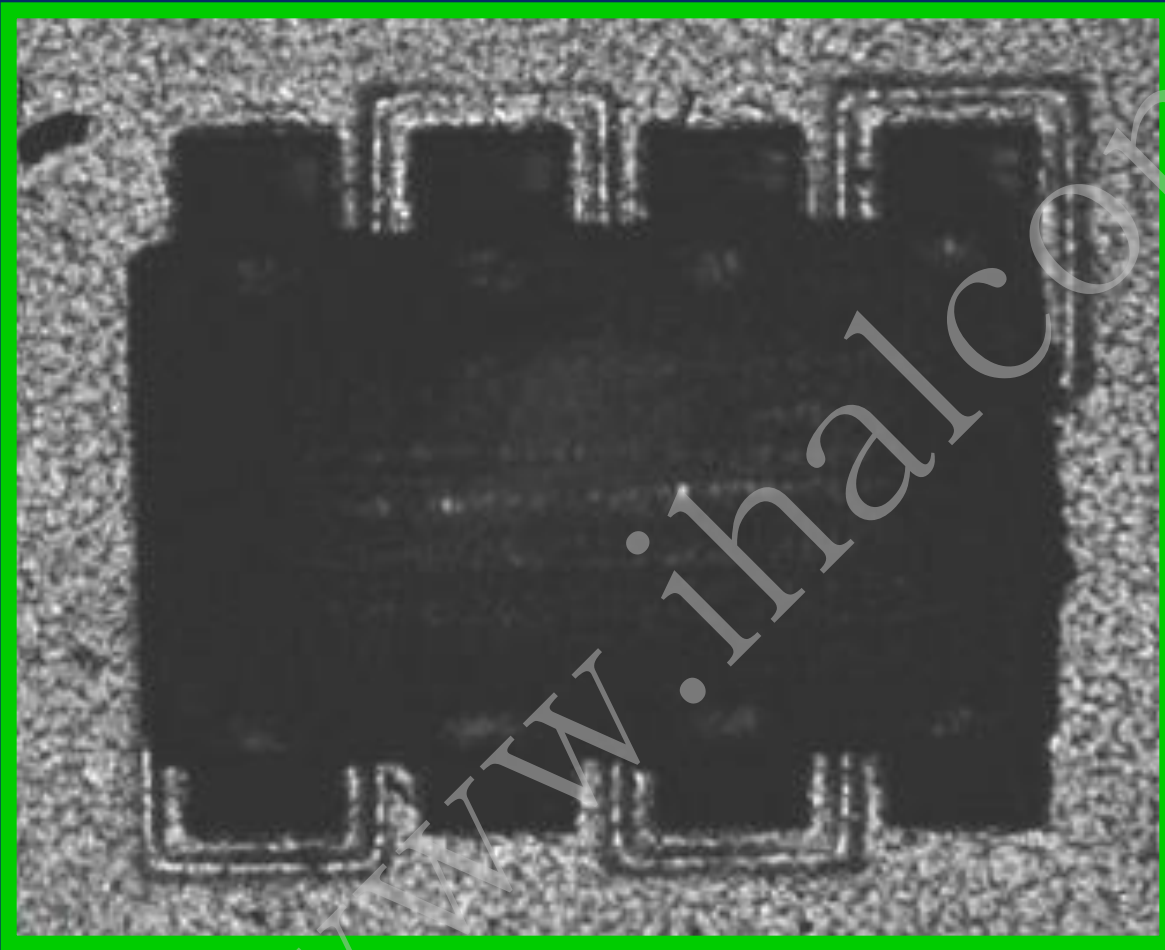
HALCON基于形状的匹配允许形状变化



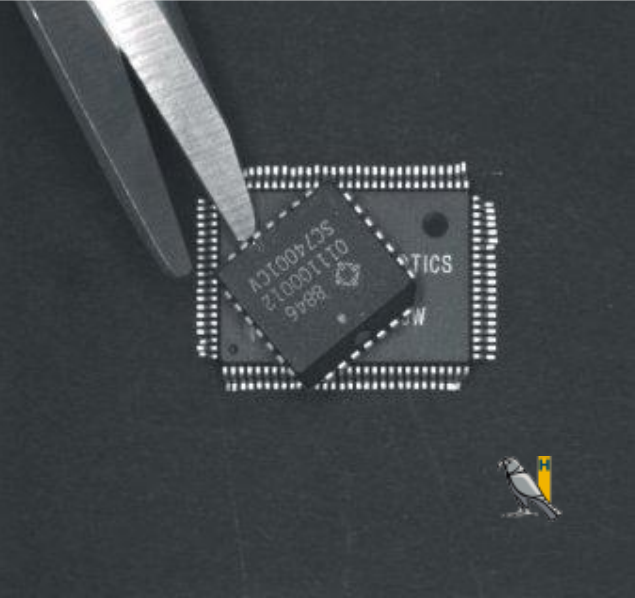
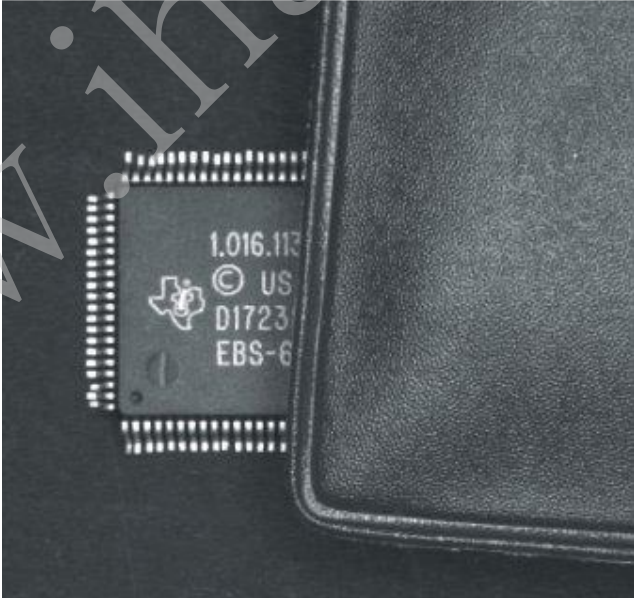
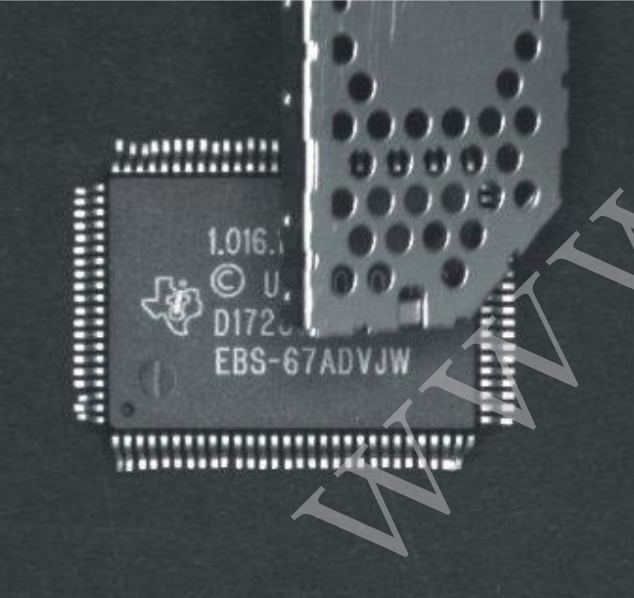
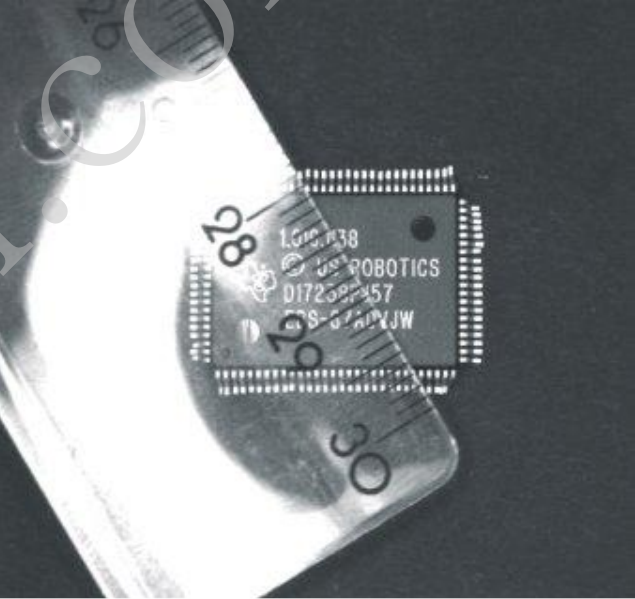
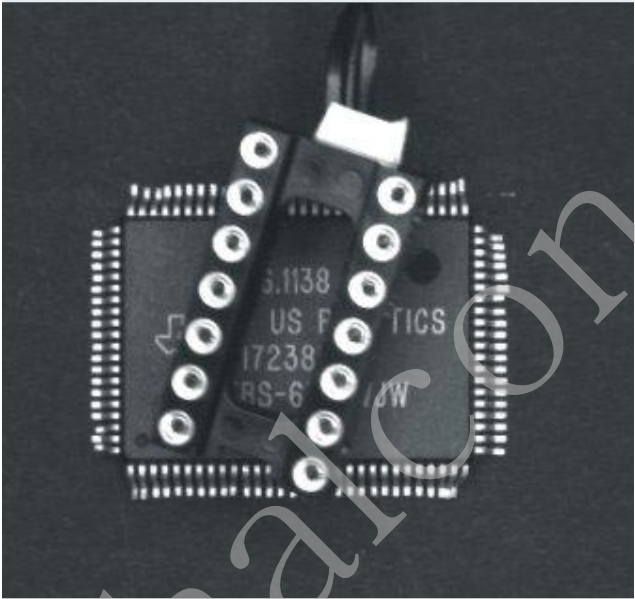
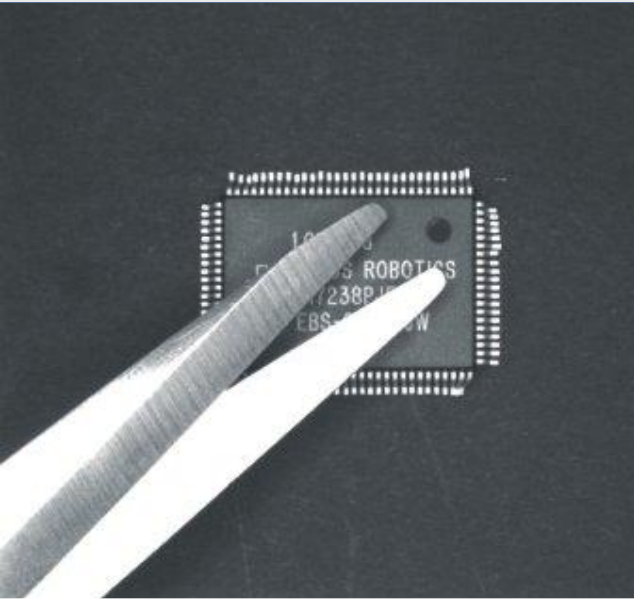
HALCON提供了鲁棒性最强的字符识别算法



HALCON提供了鲁棒性最强的模板匹配算法——NCC



HALCON提供了鲁棒性最强的模板匹配算法

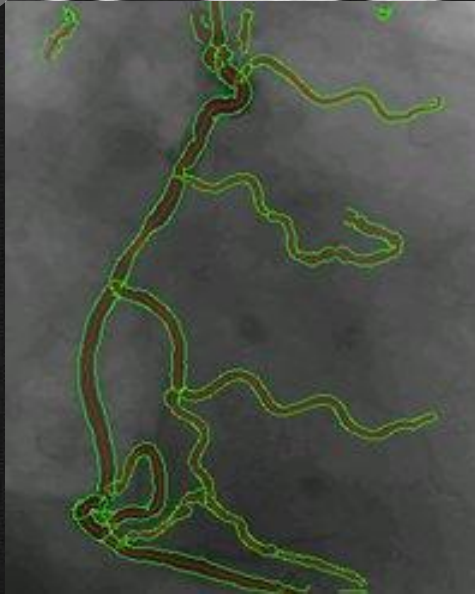
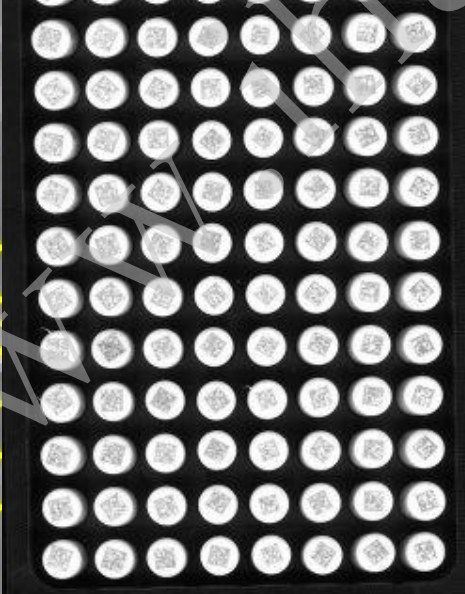
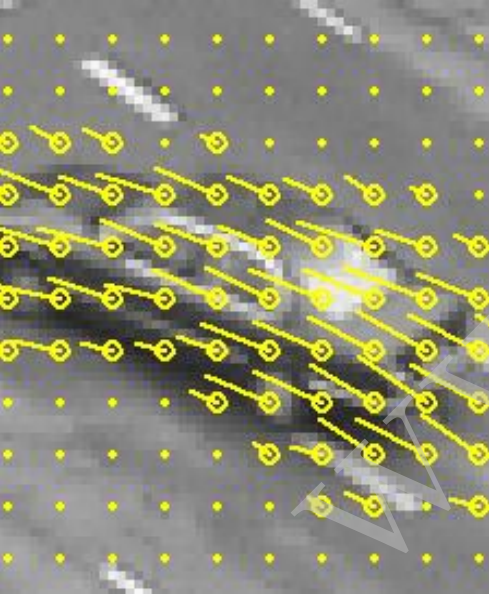
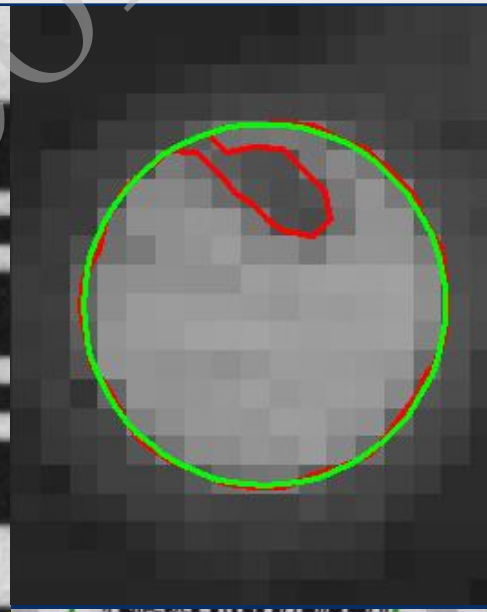
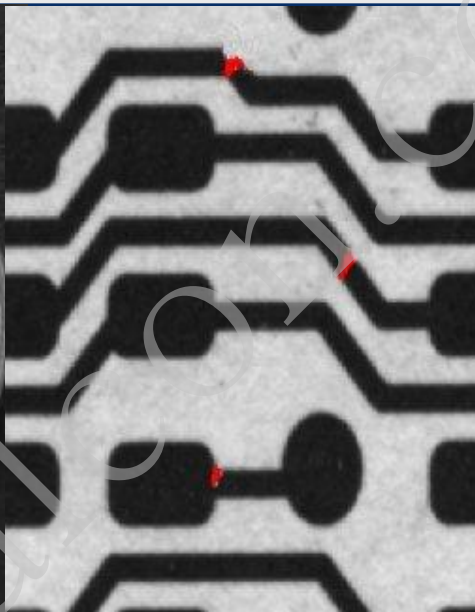
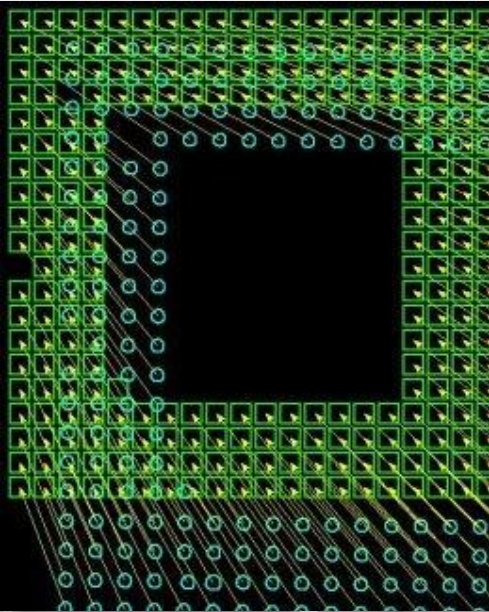


HALCON 特点之四——全面性



全面性

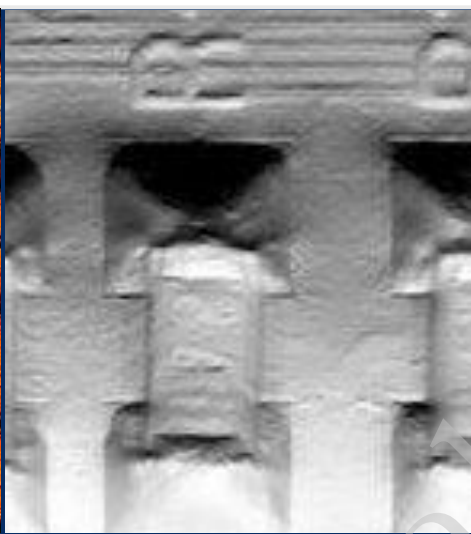
HALCON提供了全面的机器视觉技术



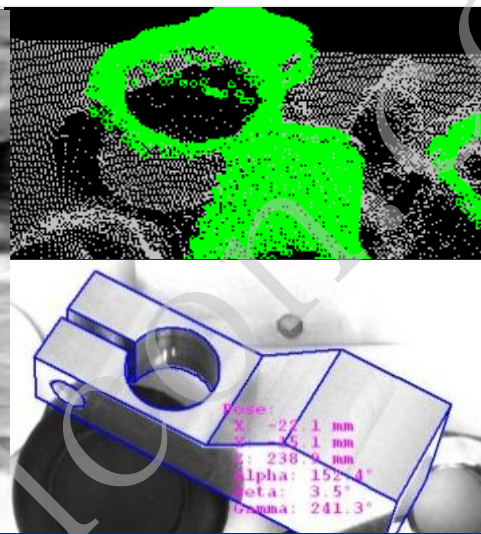
HALCON提供了全面的三维技术



多视角立体视觉



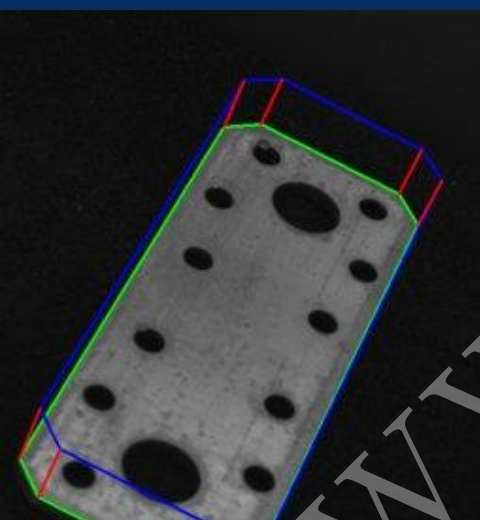
光度学立体视觉



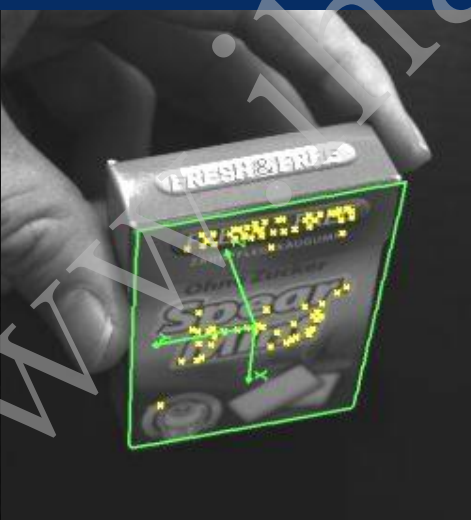
三维匹配



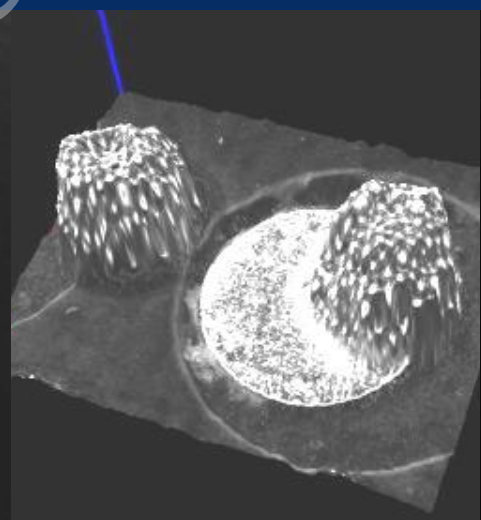
Sheet of light



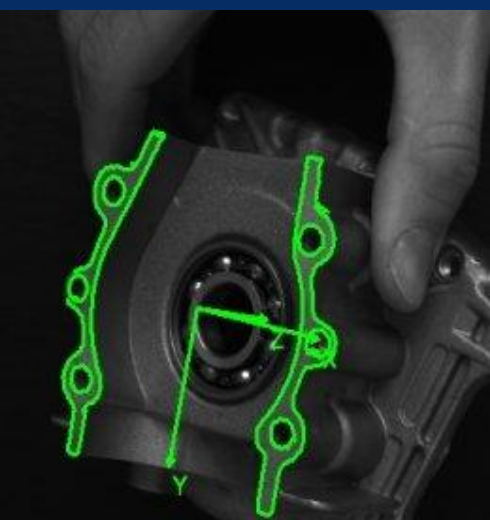
轮廓姿态



相对于点的姿态

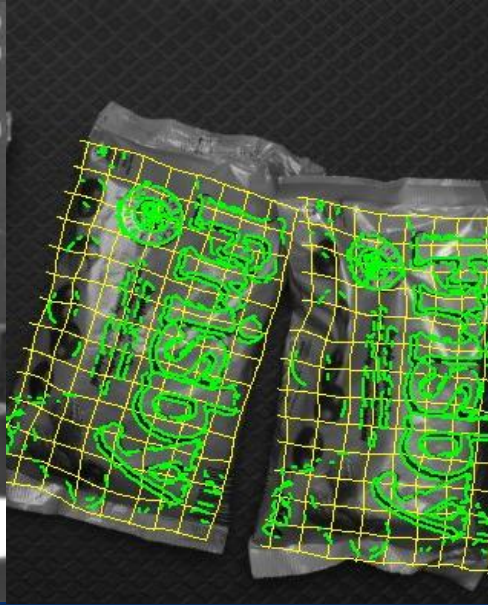
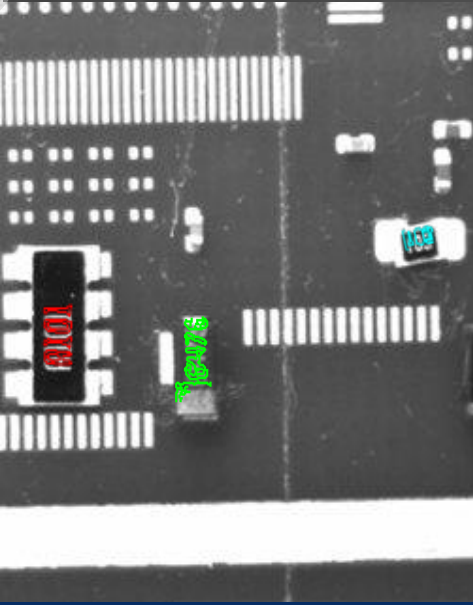
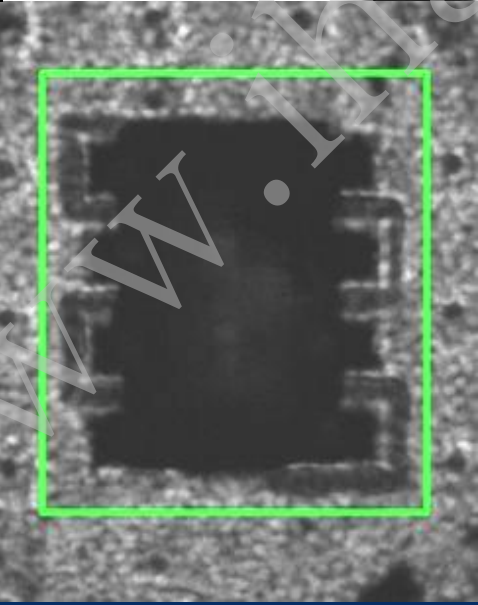
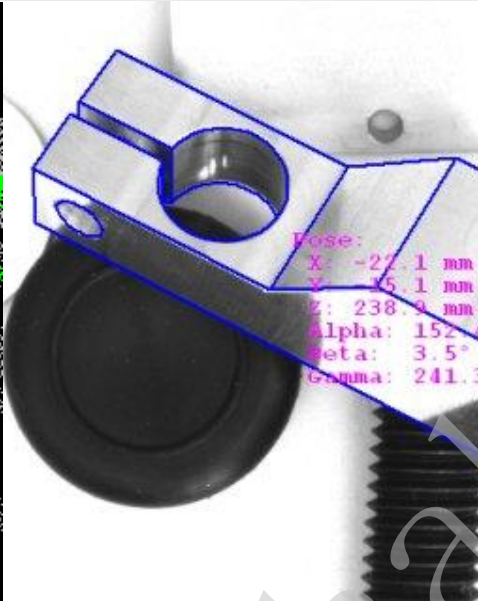
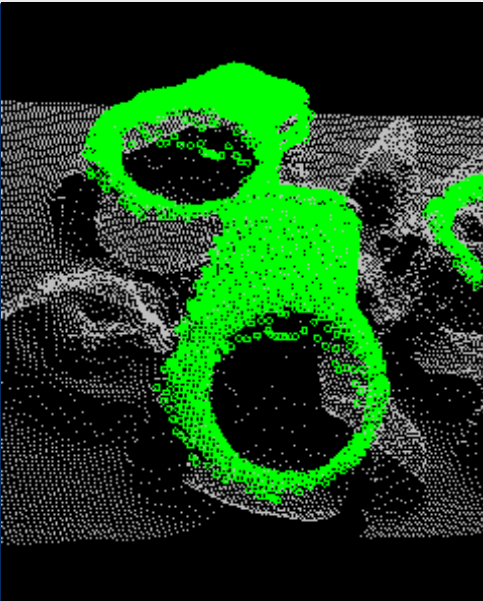


Depth from focus



透视匹配

HALCON提供了全面的匹配工具





HALCON

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HALCON 12的新功能

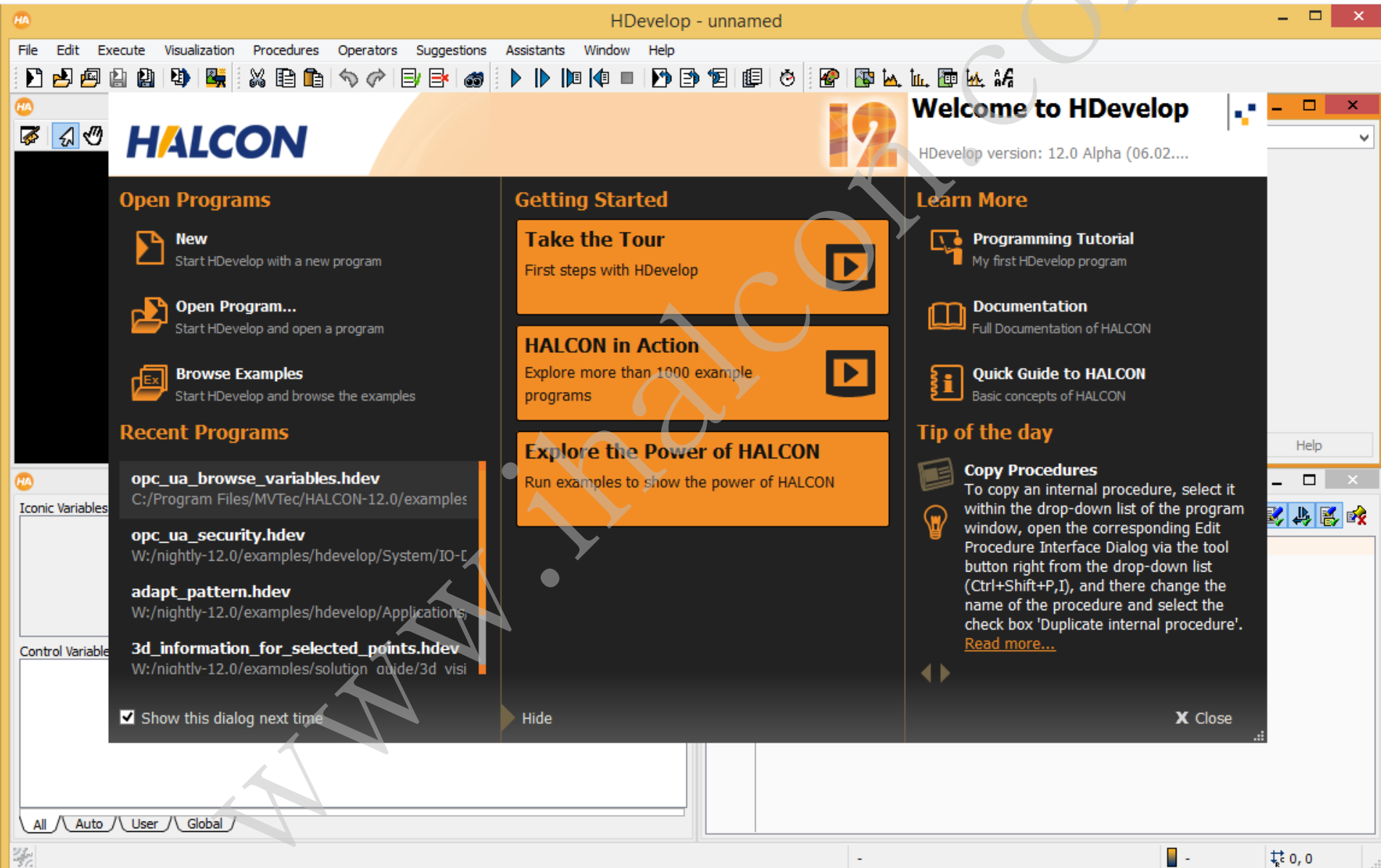


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HDevelop

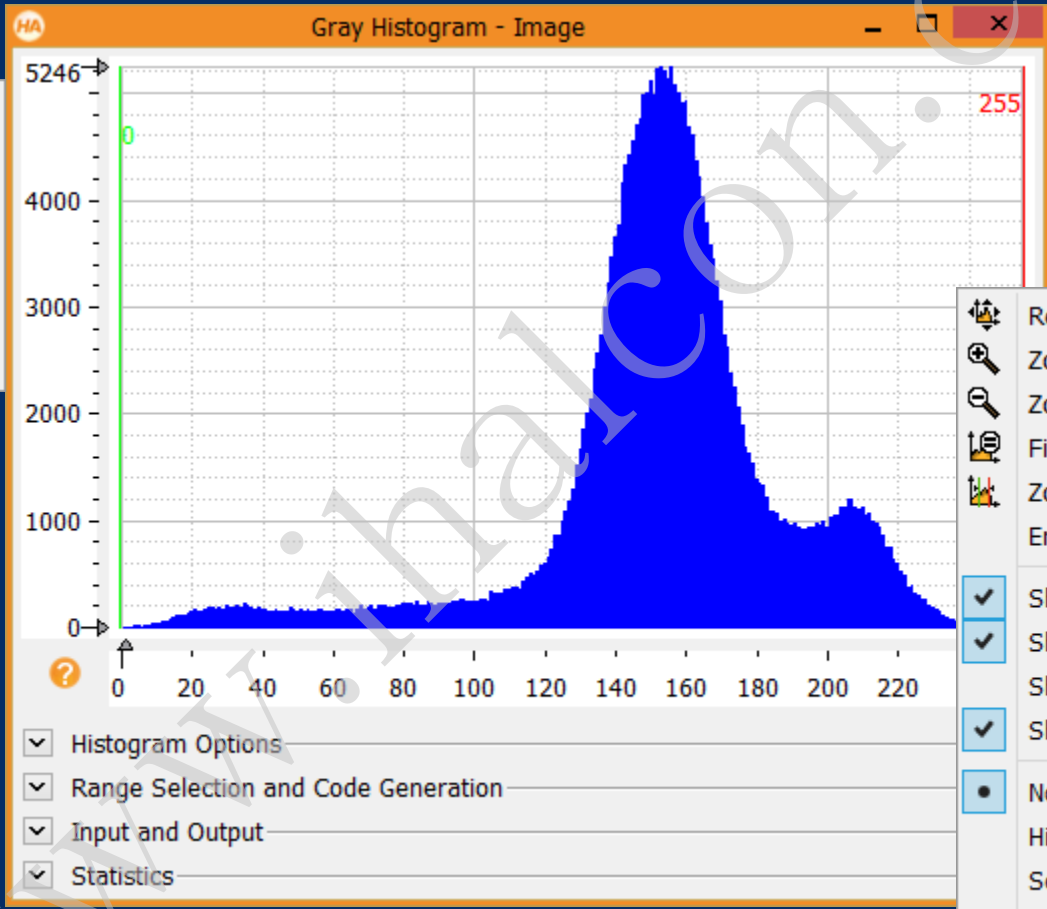
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

HDevelop 提供新的开始对话框



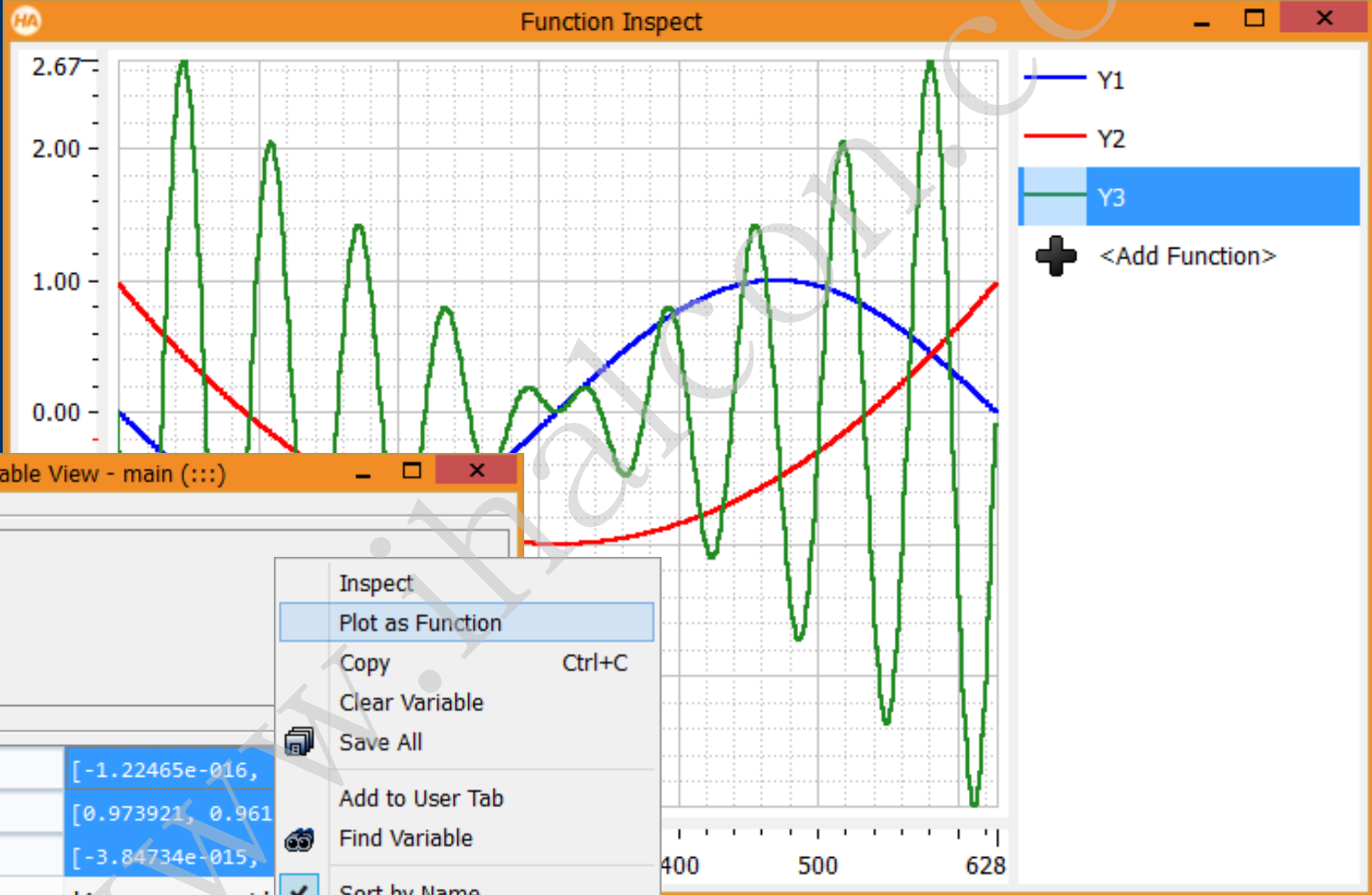
直方图对话框被重新整理

-  Reset Bounds
- Linear Scale
- Logarithmic Scale
- User-defined Range
- Increasing Range
- Adaptive Range



-  Reset Bounds R
-  Zoom In +
-  Zoom Out -
-  Fit Data Range D
-  Zoom To Selection S
-  Enter Bounds... B
- Show Mouse Position P
- Show Function Value At X X
- Show Function Value At Y Y
- Show Background Grid G
- No Output
- Highlight Selection
- Scale Selection
-  Insert Code for Selection

HDevelop可以将 tuples和functions绘制为图表



Variable View - main (:::)

Iconic Variables

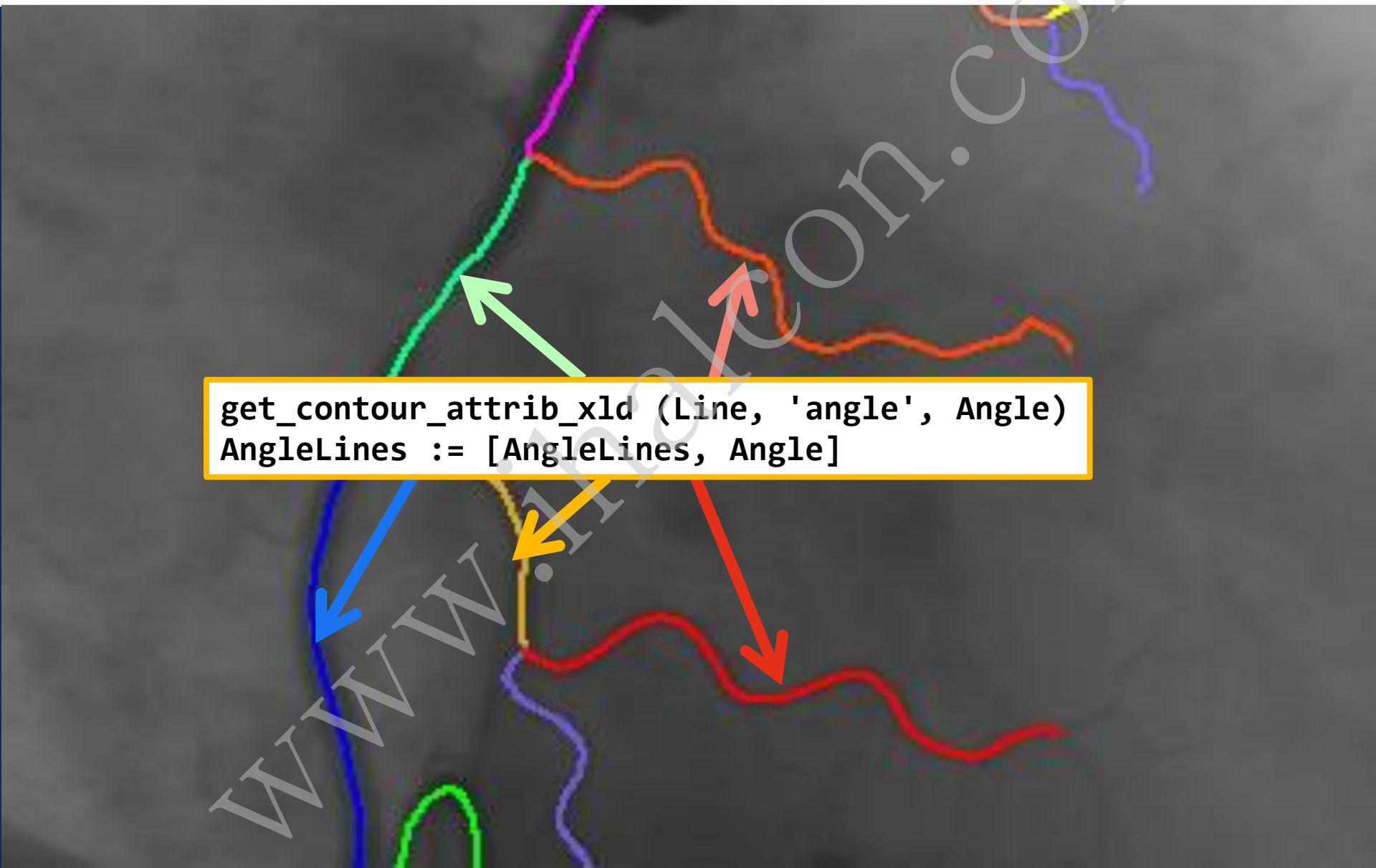
Control Variables

Y1	[-1.22465e-016,
Y2	[0.973921, 0.961
Y3	[-3.84734e-015,

All Auto User Global

- Inspect
- Plot as Function
- Copy Ctrl+C
- Clear Variable
- Save All
- Add to User Tab
- Find Variable
- Sort by Name
- Sort by Occurrence
- Update Variables
- Cleanup

Tuples的管理是繁琐的



```
get_contour_attrb_xld (Line, 'angle', Angle)  
AngleLines := [AngleLines, Angle]
```

Tuples 管理

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Tuples的管理是繁琐的

```
AngleLines := []
StartIndex := [0]
count_obj (Lines, Number)
for I := 0 to Number-1 by 1
  if (I>0)
    StartIndex[I] := StartIndex[I-1]+|Angle|
  endif
  select_obj (Lines, Line, I+1)
  get_contour_attrib_xld (Line, 'angle', Angle)
  AngleLines := [AngleLines, Angle]
endifor
for I := 0 to Number-1 by 1
  if (I<Number-1)
    AngleCurrentLine:=AngleLines[StartIndex[I]:StartIndex[I+1]-1]
  else
    AngleCurrentLine:=AngleLines[StartIndex[I]:|AngleLines|-1]
  endif
endifor
```


Vectors 简化了对于tuples的tuples的管理

```
count_obj (Lines, Number)
for I := 0 to Number-1 by 1
    select_obj (Lines, Line, I+1)
    get_contour_attrib_xld (Line, 'angle', Angle)
    AngleLinesV.at(I) := Angle
endfor

for I := 0 to Number-1 by 1
    AngleCurrentLine := AngleLinesV.at(I)
endfor
```

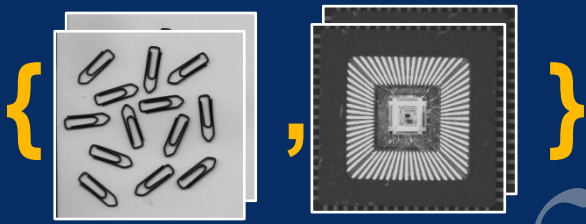
Vectors 可以包含 objects, tuples, 或者 vectors



Iconic

[1,2,3,'four']

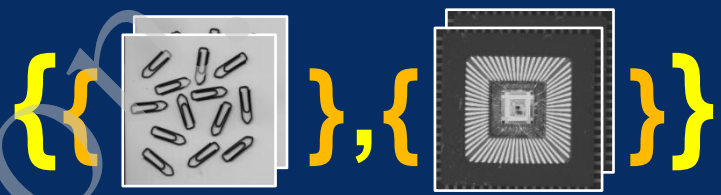
Control



1-dimensional Object Vector

{ [1,2,3,'four'], [5,6,7] }

1-dimensional Tuple Vector



2-dimensional Object Vector

{ { [1,2,3,'four'] }, { [5,6,7] } }

2-dimensional Tuple Vector

Vector 语法

■ Expressions

- `Vector := {[1],[2]}`
- `Vector.at(Index)`
- `Vector.length()`
- `Vector1 == Vector2`

■ Executable expressions:

- `Vector.remove (Index)`
- `Vector.insert (Index, Element)`
- `Vector.clear ()`
- `Vector.concat (Vector2)`

■ Operators:

- `convert_tuple_to_vector_1d (Tuple,Vector)`
- `convert_vector_to_tuple (Vector,Tuple)`

Vectors 可以是多维的

```
Vector3Dim := {{{[1],[2]},{[3],[4]}},{{[5,6]},{[7,['eight']]}}
```

VV3	
0	▾ {{{[1],[2]},{[3],[4]}}
	▾ {[1],[2]}
	▸ [1]
	▸ [2]
	▾ {[3],[4]}
	▸ [3]
	▸ [4]
1	▾ {{{[5, 6]},{[7,['eight']]}}
	▾ {[5, 6]}
	▸ [5, 6]
	▾ {[7,['eight']]}
	▸ [7]
	▸ ['eight']
+	
Types	7 integers 1 string
Dimension	3

只有相同维度的 **vectors** 是类型兼容的

```
Vector2Dim := {{1},{2}}  
Vector1Dim := Vector2Dim.at(0)
```



Correct

```
Vector2Dim := Vector1Dim
```

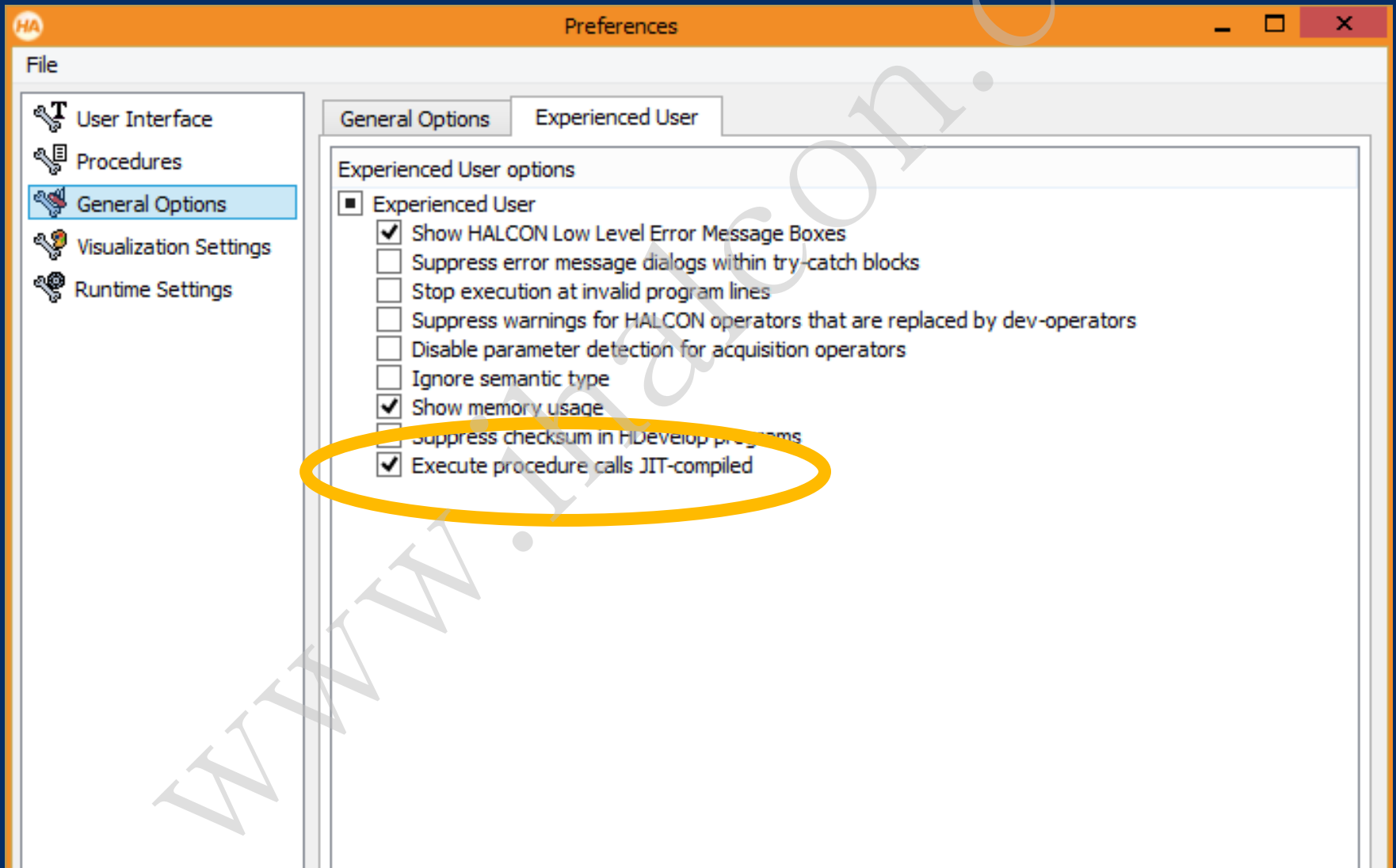


Error

Just-In-Time Compiler

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Procedures can be just-in-time compiled



加速能力取决于procedure的内容

大量的循环计算

uncompiled

compiled

利用HDevelop语言执行的运算

uncompiled

compiled

仅仅调用halcon算子

uncompiled

compiled

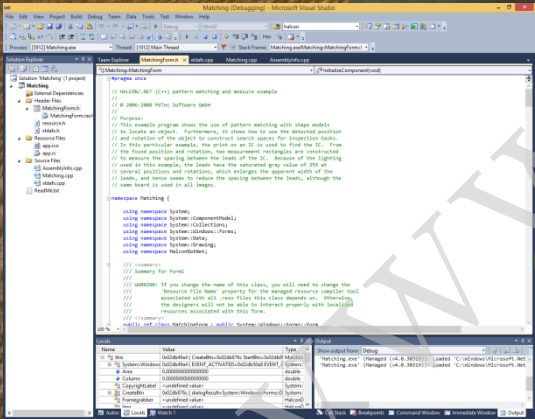
Parallel Programming

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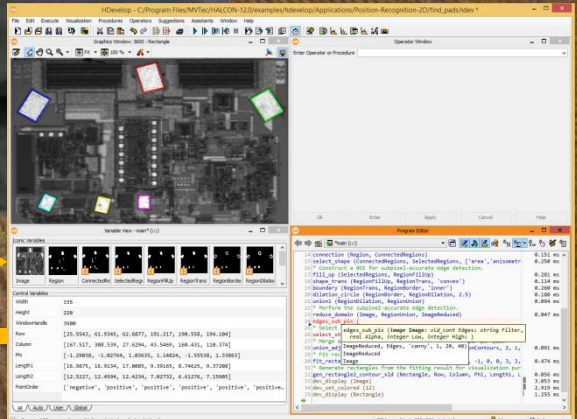
多线程



开发多线程程序是困难的



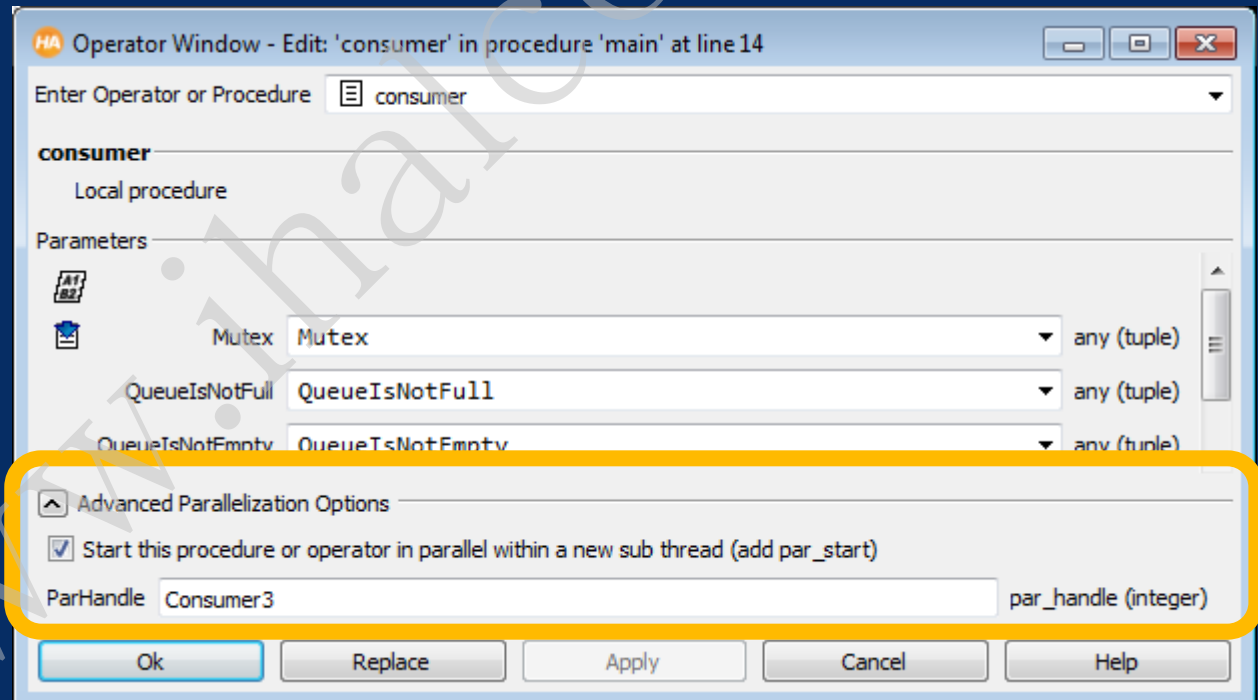
Visual Studio



HDevelop

HDevelop 支持多线程编程

```
par_start<Consumer3> : consumer(...)
```



HDevelop 支持多线程编程

线程运行

```
par_start : acquire(...)
```

```
par_start : process(...)
```

```
par_start : process(...)
```

```
par_start : process(...)
```

```
par_start : process(...)
```

par_join 等待线程运行结束

```
par_start<Thread1>: process(...)
```

```
par_start<Thread2>: process(...)
```

```
par_join ([Thread1, Thread2])
```


HDevelop提供多线程调试工具

The screenshot shows the HDevelop interface with a 'Call Stack' window open. The 'Call Stack' window contains a table with the following data:

Thread ID	References	State	Run Mode	Stop Mode	Caller
main (3380)		Stopped	Single step	User action	
4264	1	Stopped	Single step	Run action completed	main : 34 : processing_thread
2508	2	Stopped	Run continuously	User action	main : 34 : processing_thread
4560	1	Stopped	Run continuously	User action	main : 37 : acquisition_thread

Below the table, the 'Procedure' column shows:

- main (::) Line 34
- processing_thread (: : QueueImage=78962776, QueueResults=78962920, ThreadIndex=1 :) Line 17

The code editor at the bottom shows the following code snippet:

```

15 * this is an indicator from the acquisition
16 * no more input is coming.
17 get_message_param (MessageData, 'key_exists' 0.099 ms
18 if (StopProcInfo[0]) 0.025 ms
19     break
    
```

The status bar at the bottom indicates: dequeue_message (0.0 ms) | [0] ImgProcessedCrate (#=1: 640x512x3xbyte) | 54,54,54 | 0, 0

HALCON 支持线程同步

lock_mutex
try_lock_mutex
unlock_mutex

Mutex

wait_condition
timed_wait_condition
signal_condition
broadcast_condition

Condition

wait_barrier

Barrier

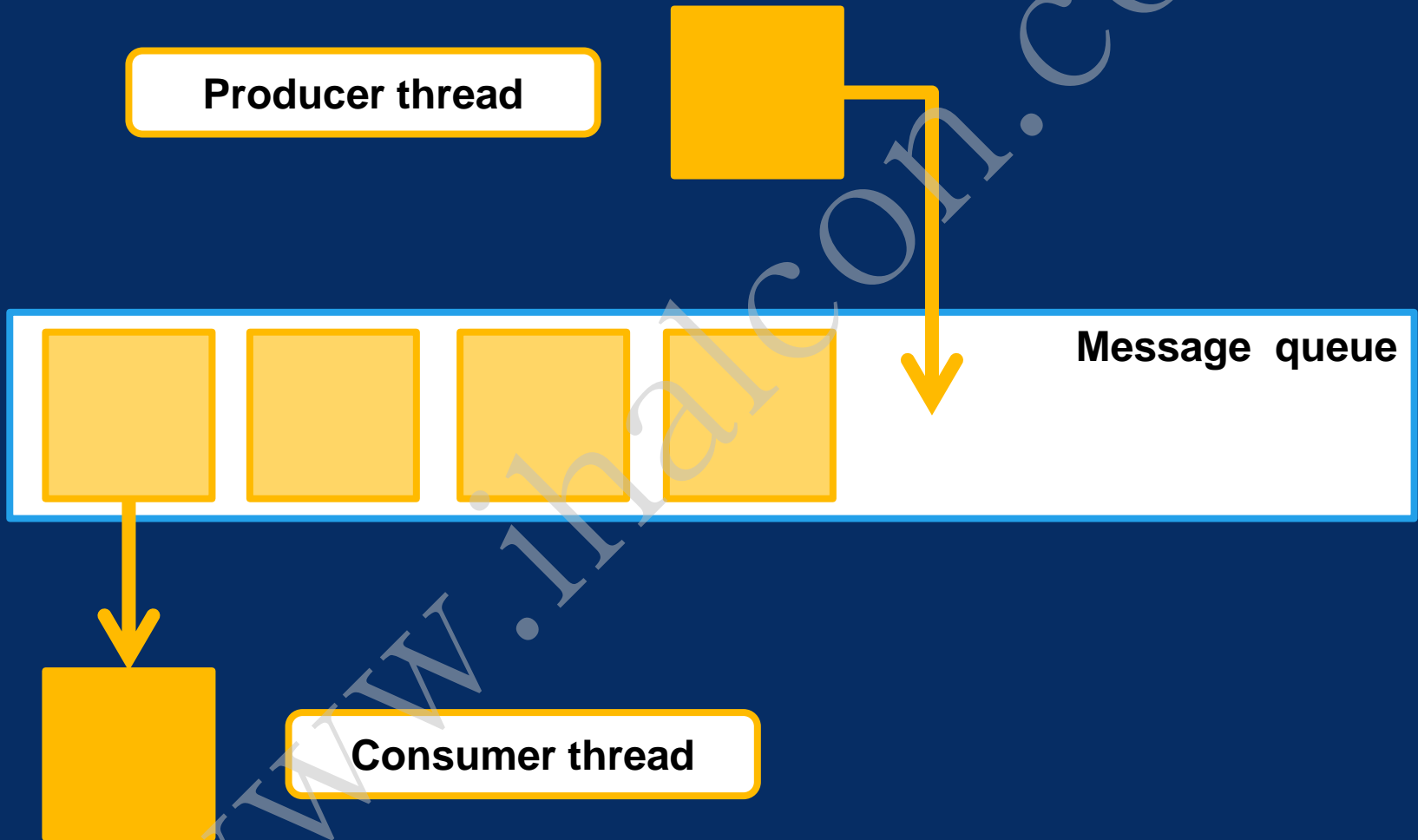
wait_event
try_wait_event
signal_event

Event

create_*
clear_*
get_threading_attrib

*

使用消息队列，无需同步机制



消息队列简化了线程同步

Message queue

Message

Key	Data
'key1'	Tuple
'key2'	Image
...	

Message

Message

dequeue_message

enqueue_message



如何使用消息队列

`create_message_queue`

`set_message_queue_param (max_message_num)`

`create_message`

`set_message_tuple`

`set_message_obj`

`set_message_param (Remove keys)`

`enqueue_message`

`dequeue_message`

`get_message_param (Key exists? Key type?)`

`get_message_tuple`

`get_message_obj`

`get_message_queue_param (MessageNum, MaxMessageNum)`

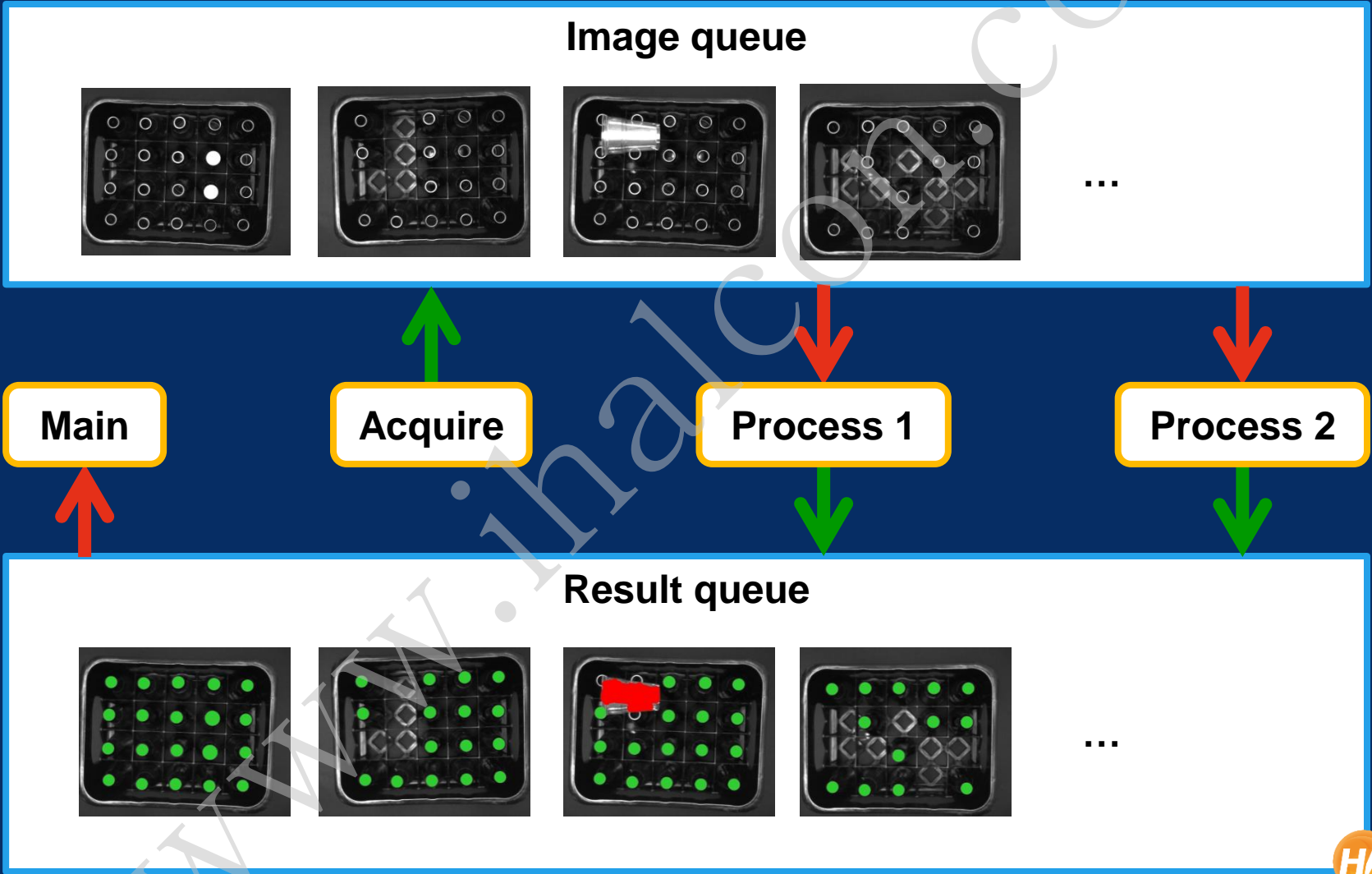
`set_message_queue_param`

`(Flush, Abort waiting dequeue, restart waiting)`

`clear_message`

`clear_message_queue`

例子



Plugin for VisualStudio

www.inhalcon.com

HALCON 为 Visual Studio 提供了一个插件

The screenshot shows the HALCON Variable Inspect plugin integrated into Visual Studio. The main editor displays C++ code for image processing, including functions for generating measurement rectangles and creating a model. A context menu is open over the code, and a separate window shows a grayscale image of a circuit board with green bounding boxes and labels like 'U203' and 'S023'. The Locals window shows variables like height, mrow, rect_width, etc.

```

// Compute the coordinates of the measured model.
// center of the model.
double center_row, center_column;
Hlong area = rectangle.AreaCenter;
double rect1_row = center_row-102;
double rect1_col = center_column+5;
double rect2_row = center_row+107;
double rect2_col = center_column+5;
double rectPhi = 0;
double rect_length = 170.0;
double rect_width = 5.0;

// Generate the two measurement rectangles.
HRegion rectangle1, rectangle2;
rectangle1.GenRectangle2(rect1_row, rect1_col,
rect_length, rect_width);
rectangle2.GenRectangle2(rect2_row, rect2_col,
rect_length, rect_width);

// Create an iconic representation of the model. This region will be
// transformed by the measured position of the model for visualization
// purposes later on.
HImage image_reduced = image.ReduceDomain(rectangle);
HRegion shape_model_contours;
HImage shape_model_image;

// Create the model.
HShapeModel shape_model("none", "use");

// Display the model and window. SetColor("green")
window.DispObj(shape_model_image, "shape_model_image");
    
```

Locals

Name	Value
height	492
mrow	297
rect_width	5.00000
shape_model_image	{...}
mbutton	5767872
center_row	243.000
rect2_row	350.000
shape_model_contours	{...}
mcolumn	1
center_column	297.000
window	{...}
rect2_col	302.000

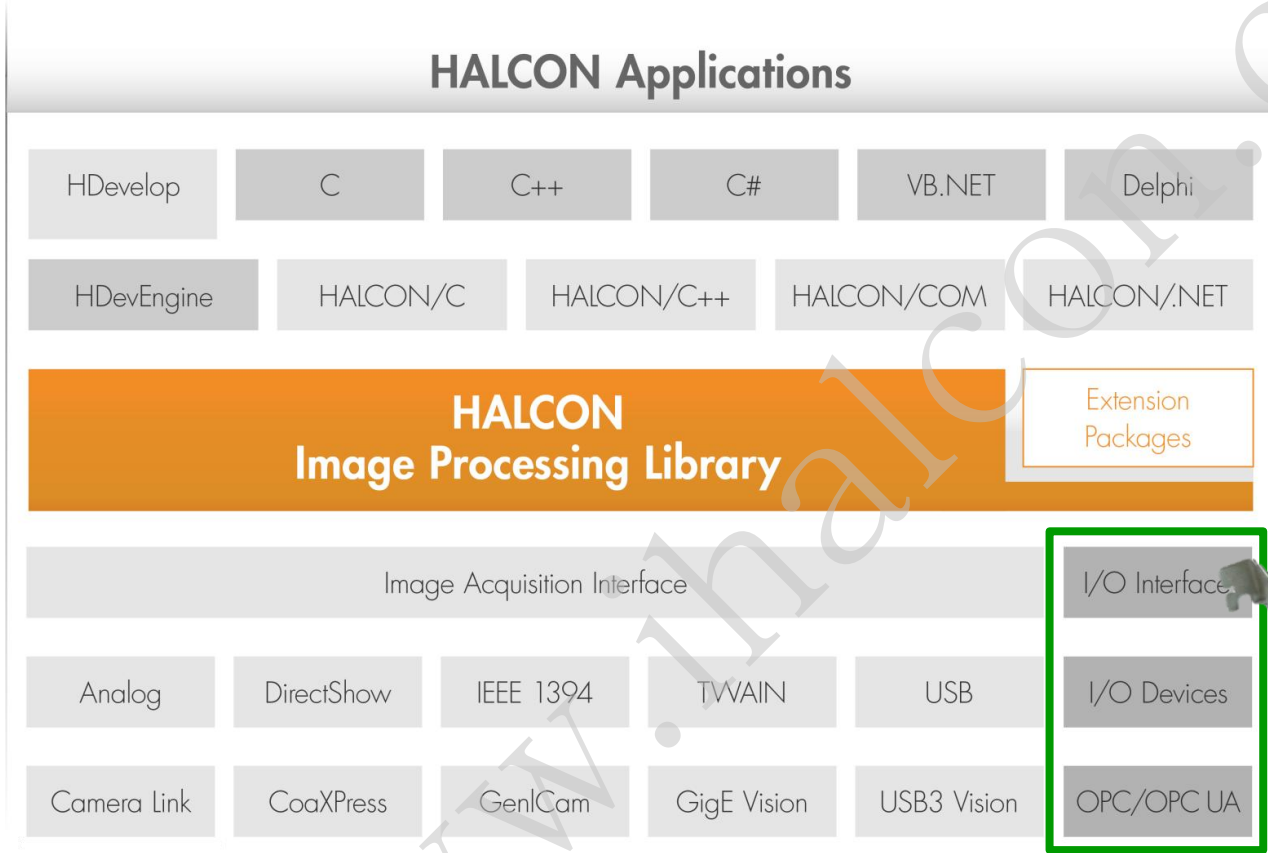
HALCON Variable Inspect

shape_model_contours
Type: Region
Region width: 231
Region height: 101
val:100 n:23 c:25

I/O Interfaces

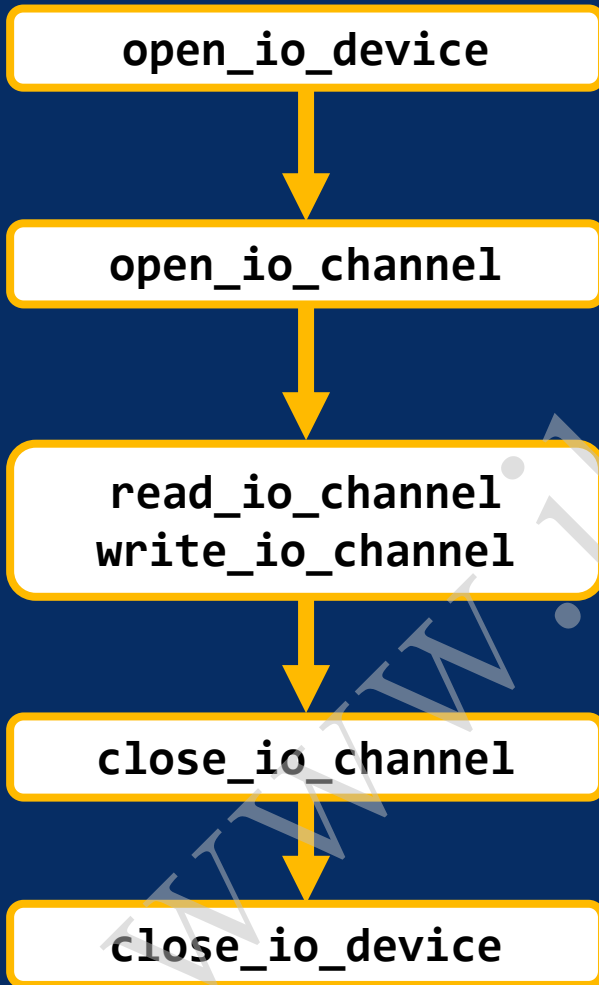
www.ihalcon.com

HALCON 支持数字IO接口



**Advantech, National Instruments, Contec, Interface, ...
+ OPC, OPC UA**

基本的IO操作流程

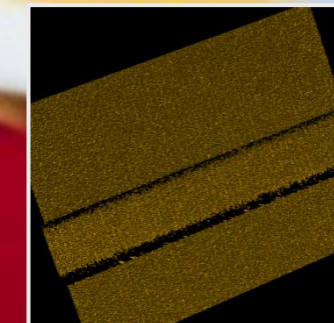
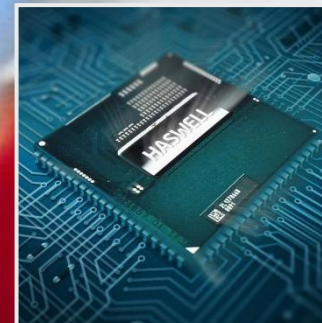
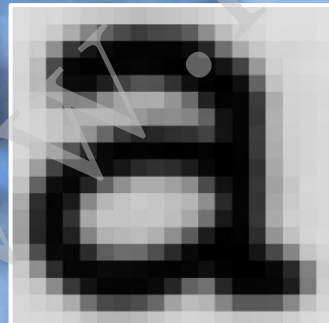
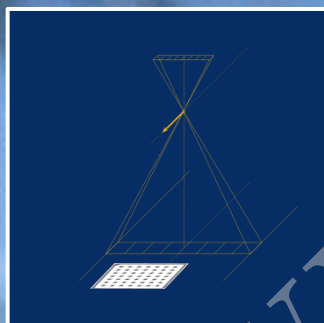
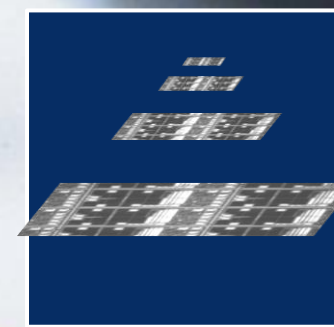
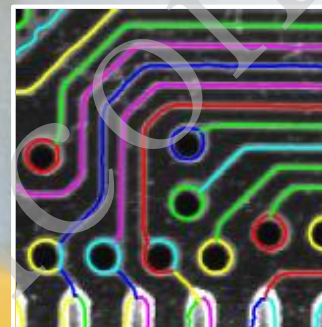


Speedup

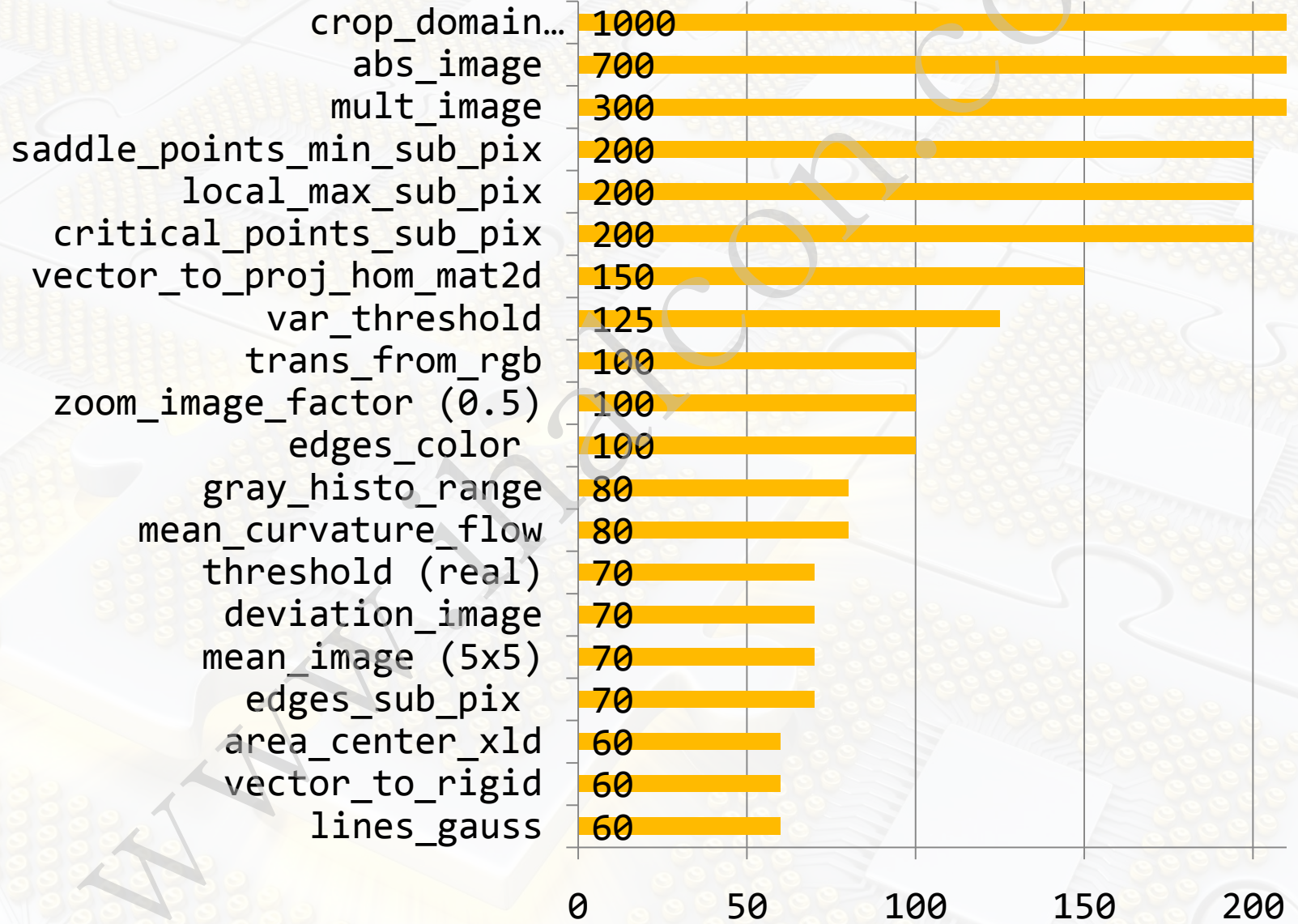
www.ihacon.com

HALCON 更快了

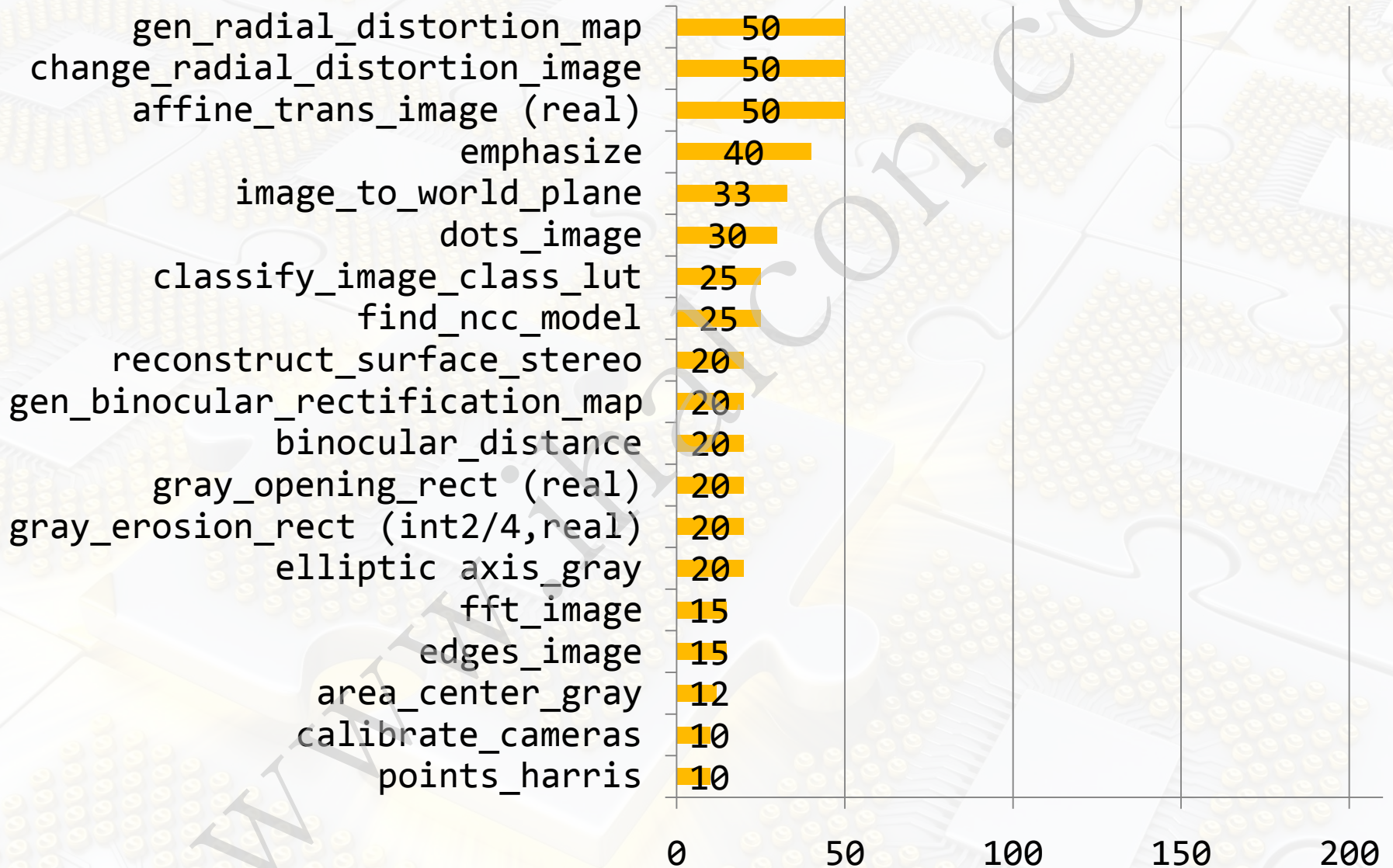
- Edge/line/point extraction
- Zooming/image pyramids
- Line scan calibration
- MLP training
- AVX2
- 3D visualization



HALCON 更快了



HALCON 更快了



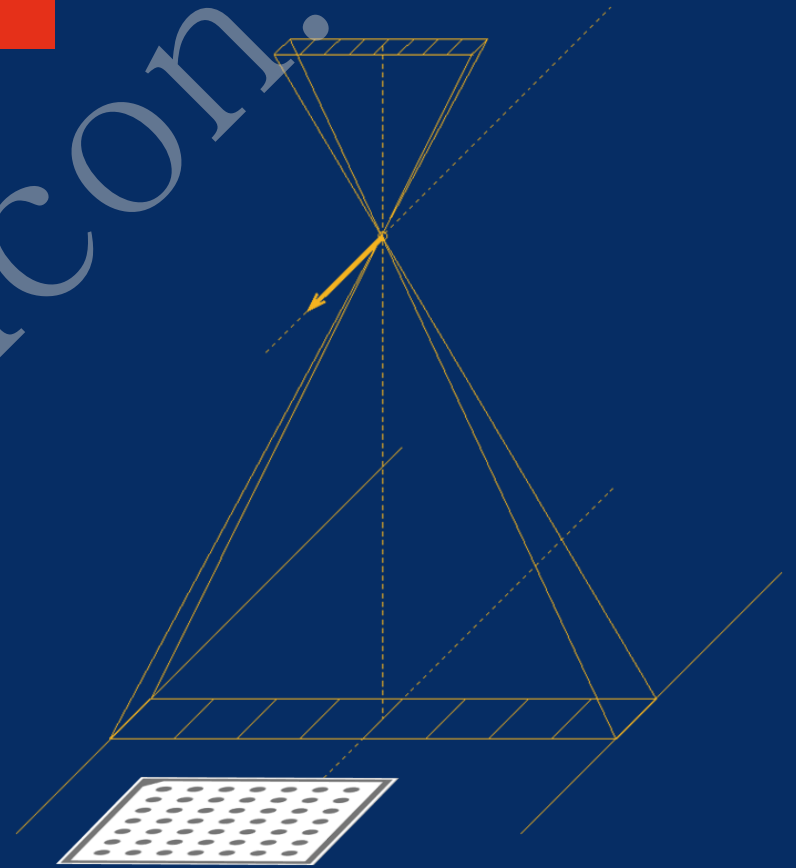
线扫相机的标定现在非常快

执行时间

HALCON 11

HALCON 12

```
calibrate_cameras  
camera_calibration  
(both for line scan cameras)
```

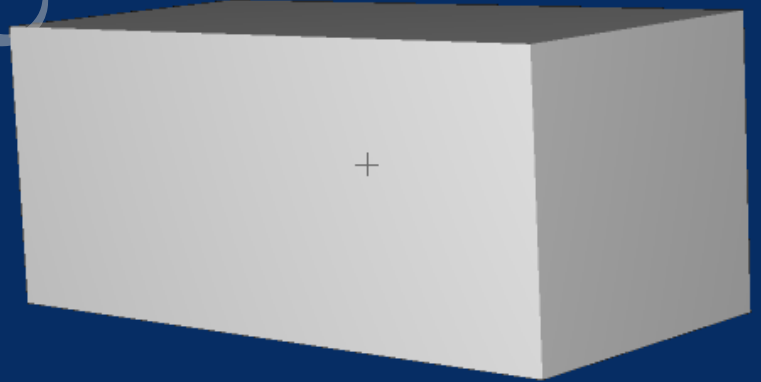


对于依靠于外接立方体的参数，
`get_object_model_3d_params` 的计算更快了

执行时间

HALCON 11

HALCON 12



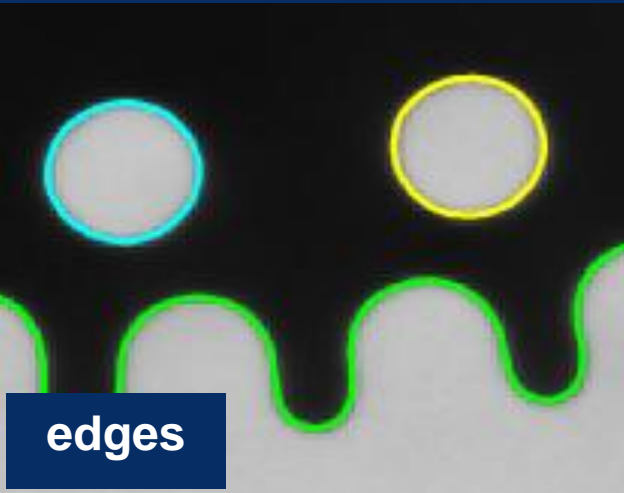
```
get_object_model_3d_params(..., 'bounding_box1', ...)  
get_object_model_3d_params(..., 'center', ...)  
get_object_model_3d_params(..., 'diameter_axis_aligned_bounding_box', ...)
```

很多edge, line和point filters变的更快了

执行时间

HALCON 11

HALCON 12



edges_sub_pix
edges_color_sub_pix
edges_color

lines_gauss
lines_color
lines_facet

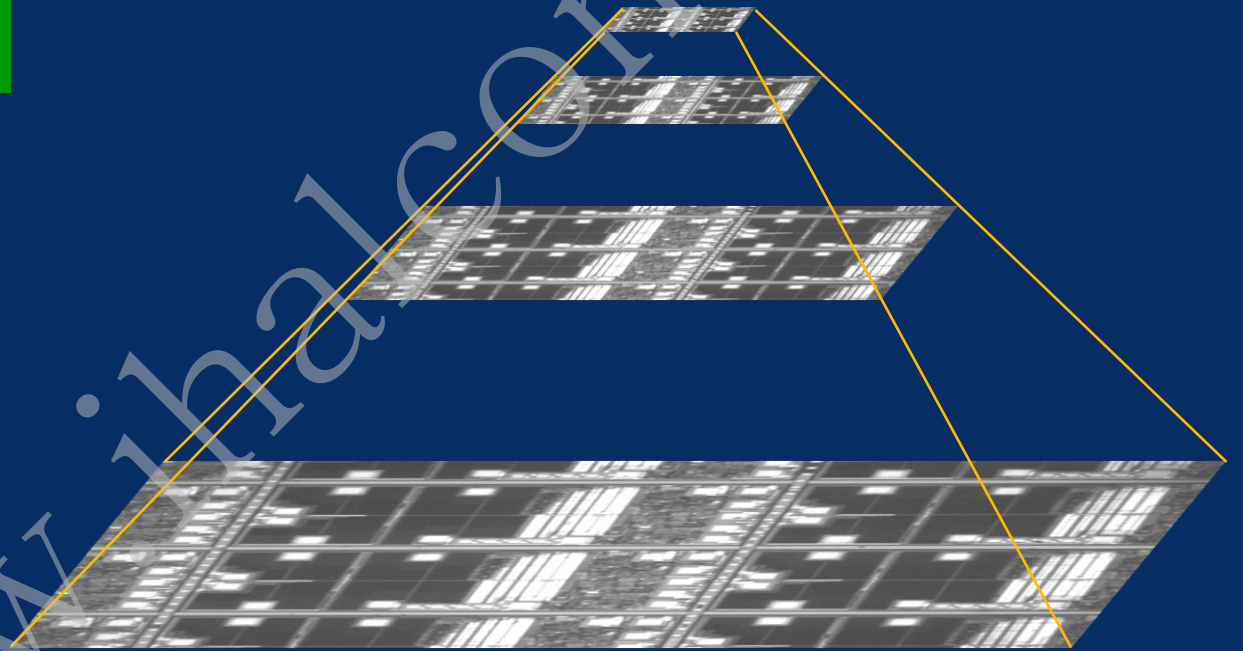
saddle_points_sub_pix
critical_points_sub_pix
local_max_sub_pix
local_min_sub_pix

图像金字塔的产生和图像缩放更快了

执行时间

HALCON 11

HALCON 12

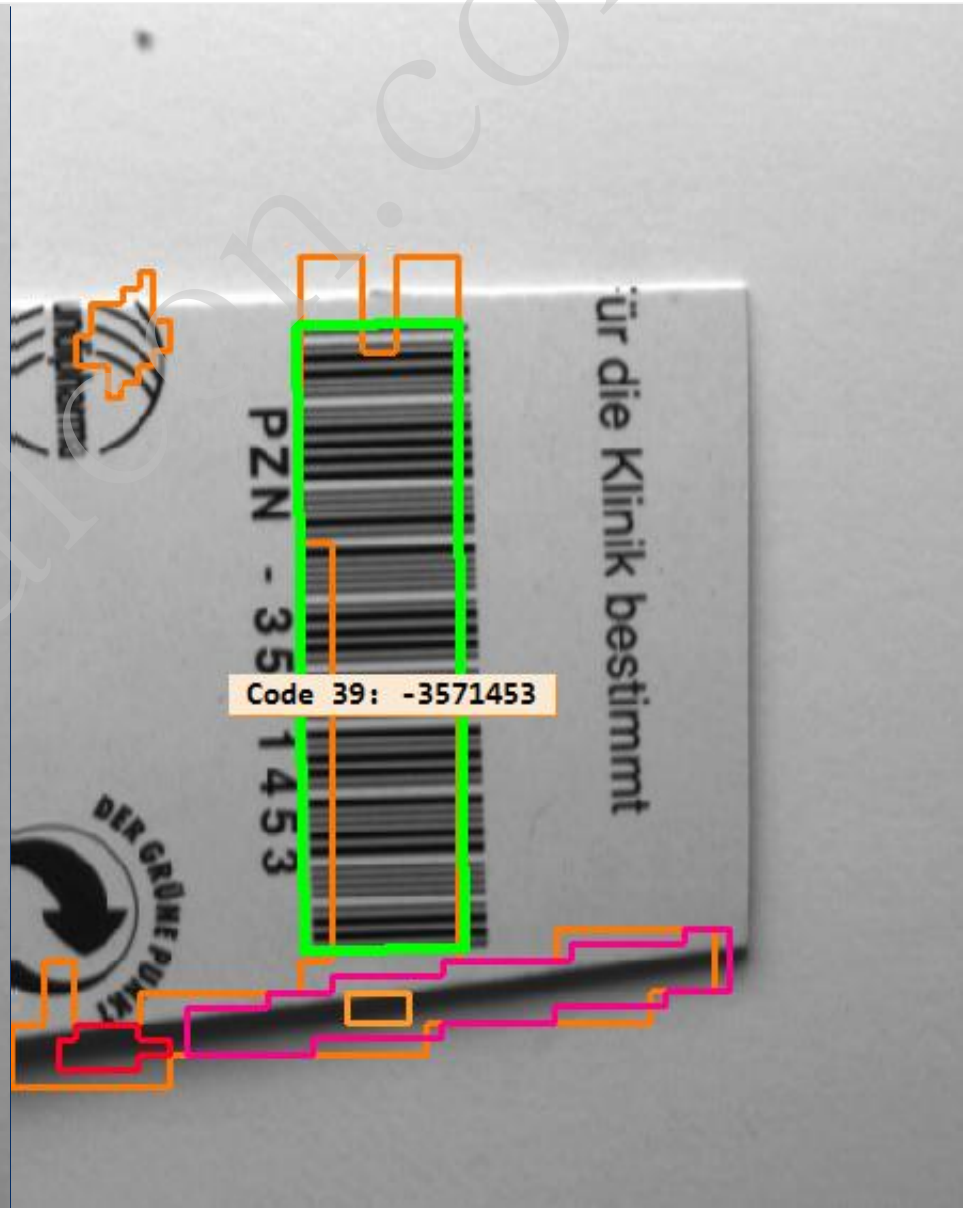
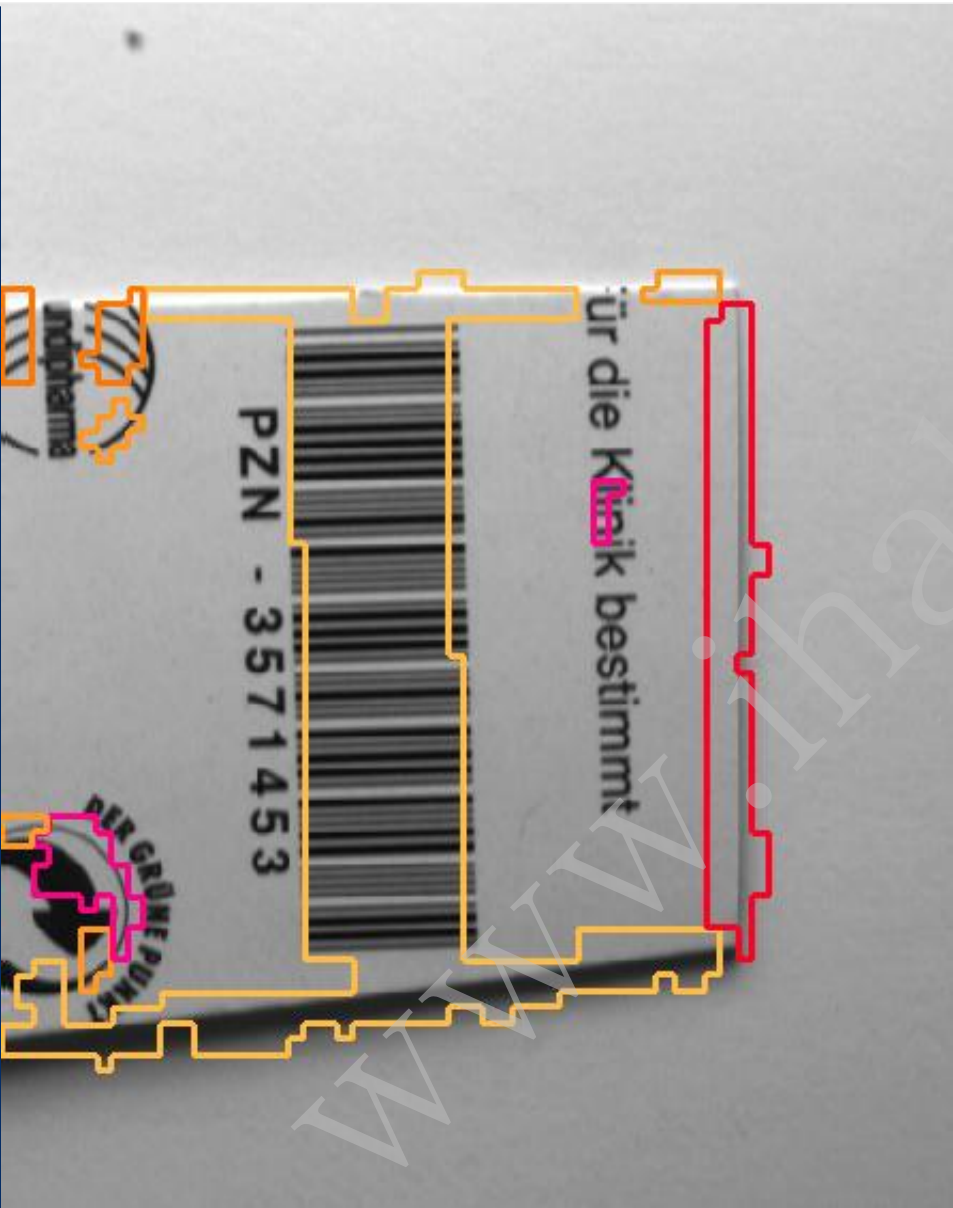


```
gen_gauss_pyramid  
zoom_image_factor  
zoom_image_size
```

Bar code

www.ihalcon.com

条码识别能力变得更加强大



条码识别能力变得更加强大

HALCON 12

Code 128: THS7319IZSVR

Code 128: D1310

Code 128: Q2500

Code 128: L3285558TW3

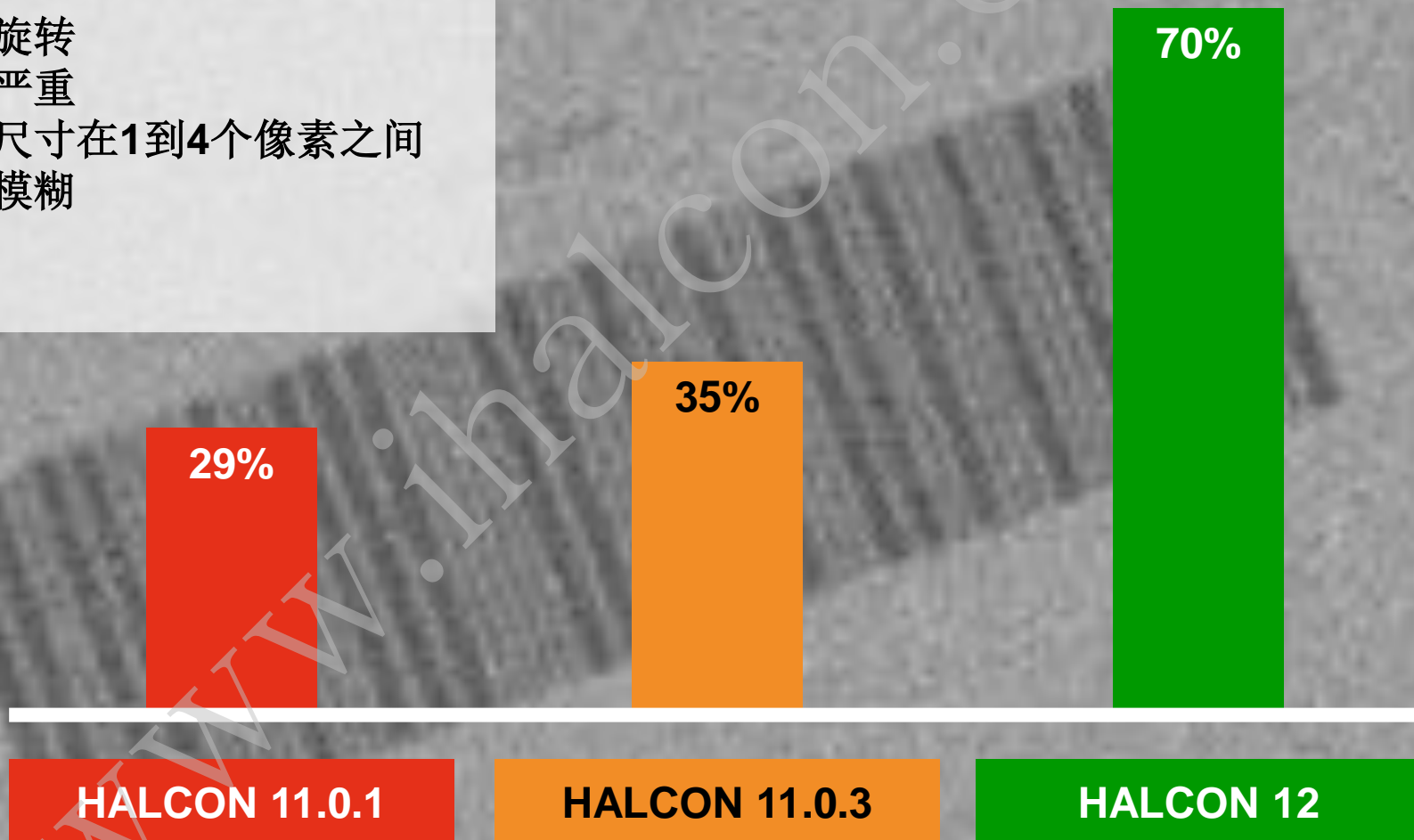
Code 128: TAIWAN



我们通常需要限制更多

挑战:

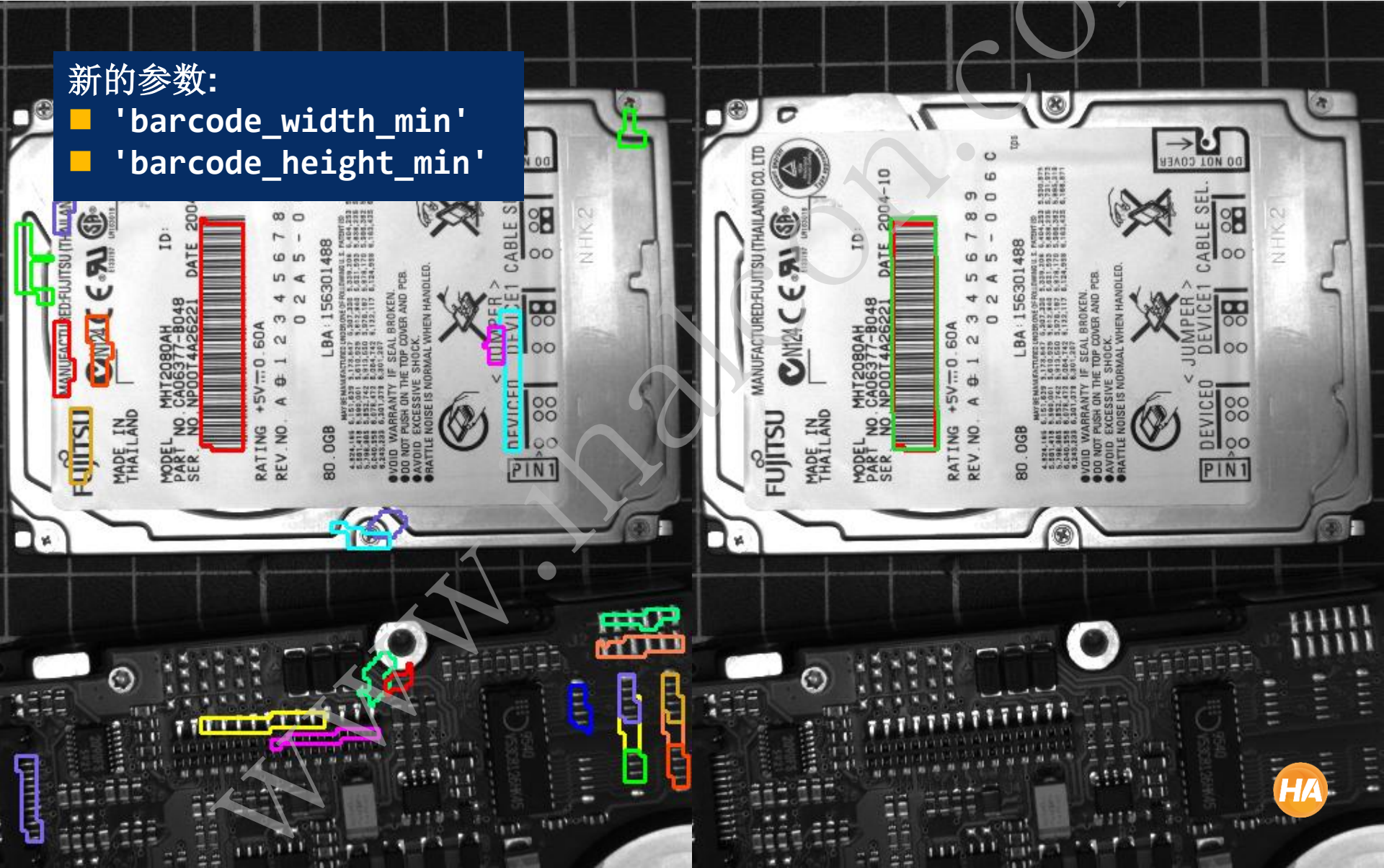
- 任意旋转
- 噪声严重
- 元素尺寸在1到4个像素之间
- 图像模糊



尺寸可以被设置

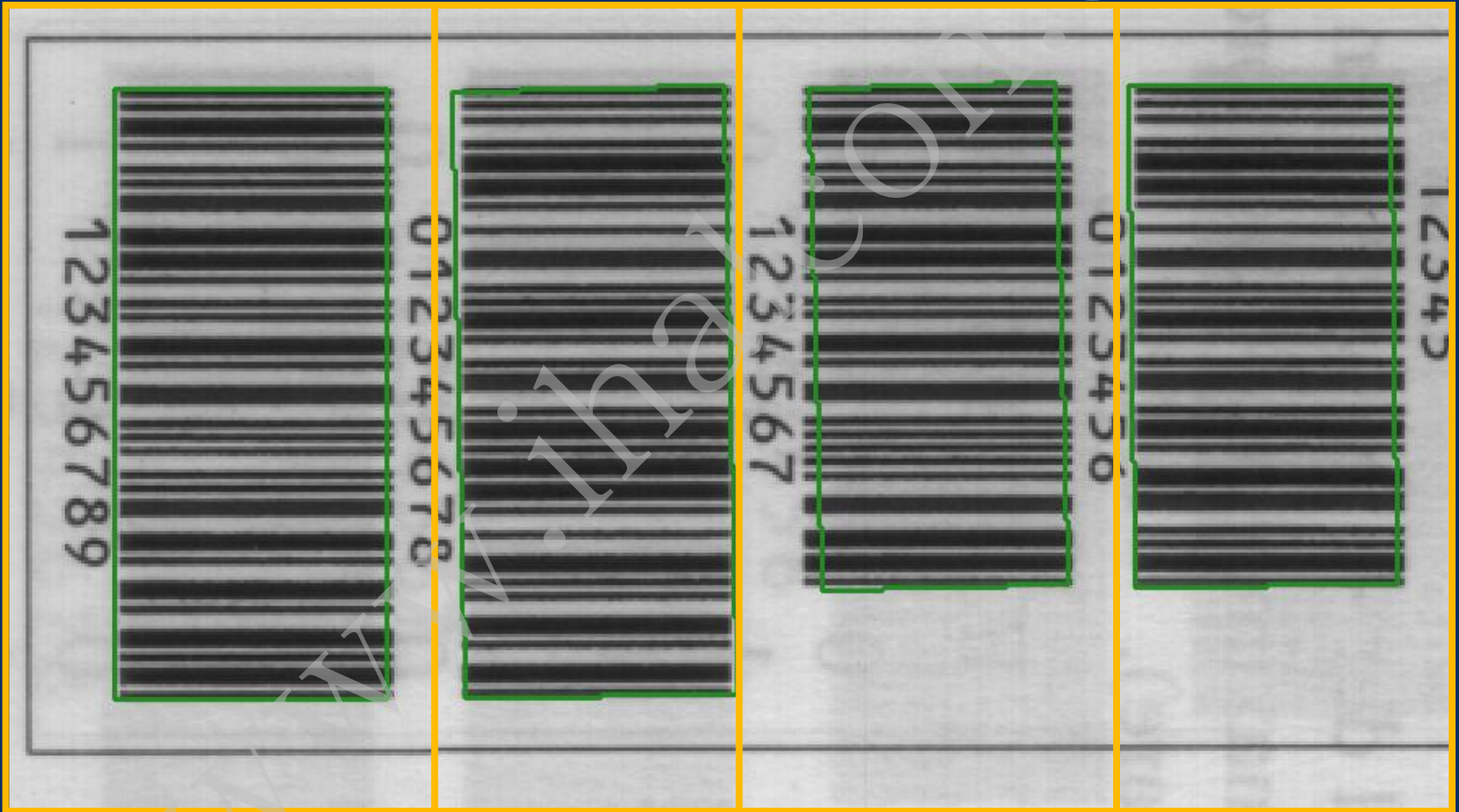
新的参数:

- 'barcode_width_min'
- 'barcode_height_min'



训练更快了，同时对于同一个图像支持多种类型的条码

```
create_bar_code_model ('train', 'all', BarCodeHandle)
```



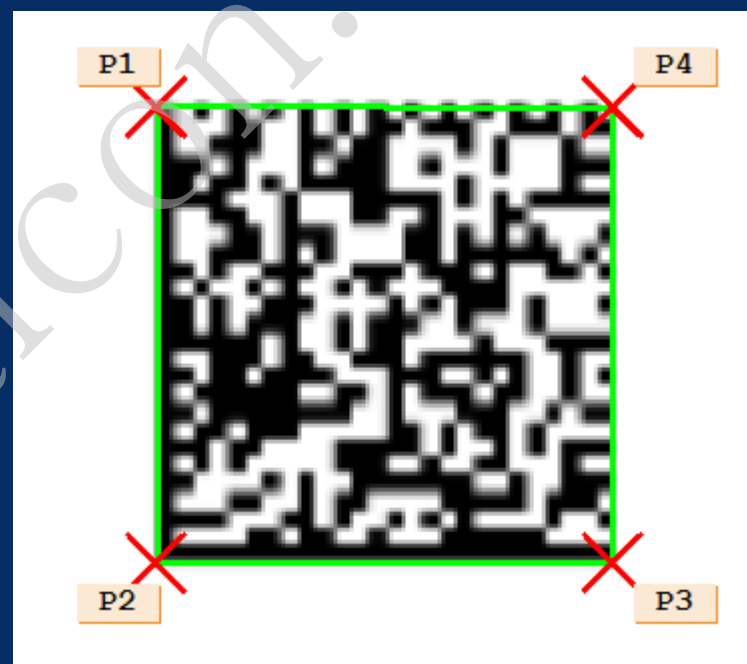
Data code

www.ihalcon.com

二维码识别提供了ECC 200质量的评估

根据SEMI T10-0701标准，对二维码质量进行评估：

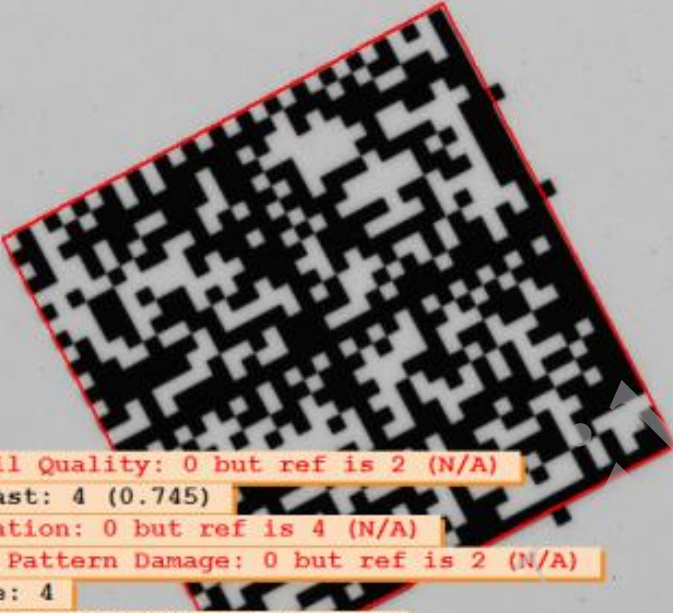
P1 Row, P1 Column,
P2 Row, P2 Column,
P3 Row, P3 Column,
P4 Row, P4 Column,
Rows, Columns,
Symbol Contrast,
Symbol Contrast SNR,
Horizontal Mark Growth,
Vertical Mark Growth,
Data Matrix Cell Width,
Data Matrix Cell Height,
Horizontal Mark Misplacement,
Vertical Mark Misplacement,
Cell Defects,
Finder Pattern Defects,
Unused Error Correction



二维码质量评估能力更加强大

HALCON 11

Symbol Number: 7 Scan Position: 5



Overall Quality: 0 but ref is 2 (N/A)
 Contrast: 4 (0.745)
 Modulation: 0 but ref is 4 (N/A)
 Fixed Pattern Damage: 0 but ref is 2 (N/A)
 Decode: 4
 Axial Nonuniformity: 4 (0.022)
 Grid Nonuniformity: 4 (0.038)
 Unused Error Correction: 0 (0.000) but ref is 4 (1.000)

HALCON 12

Symbol Number: 7 Scan Position: 5



Overall Quality: 2
 Contrast: 4 (0.741)
 Modulation: 4
 Fixed Pattern Damage: 2
 Decode: 4
 Axial Nonuniformity: 4 (0.001)
 Grid Nonuniformity: 4 (0.009)
 Unused Error Correction: 4 (1.000)



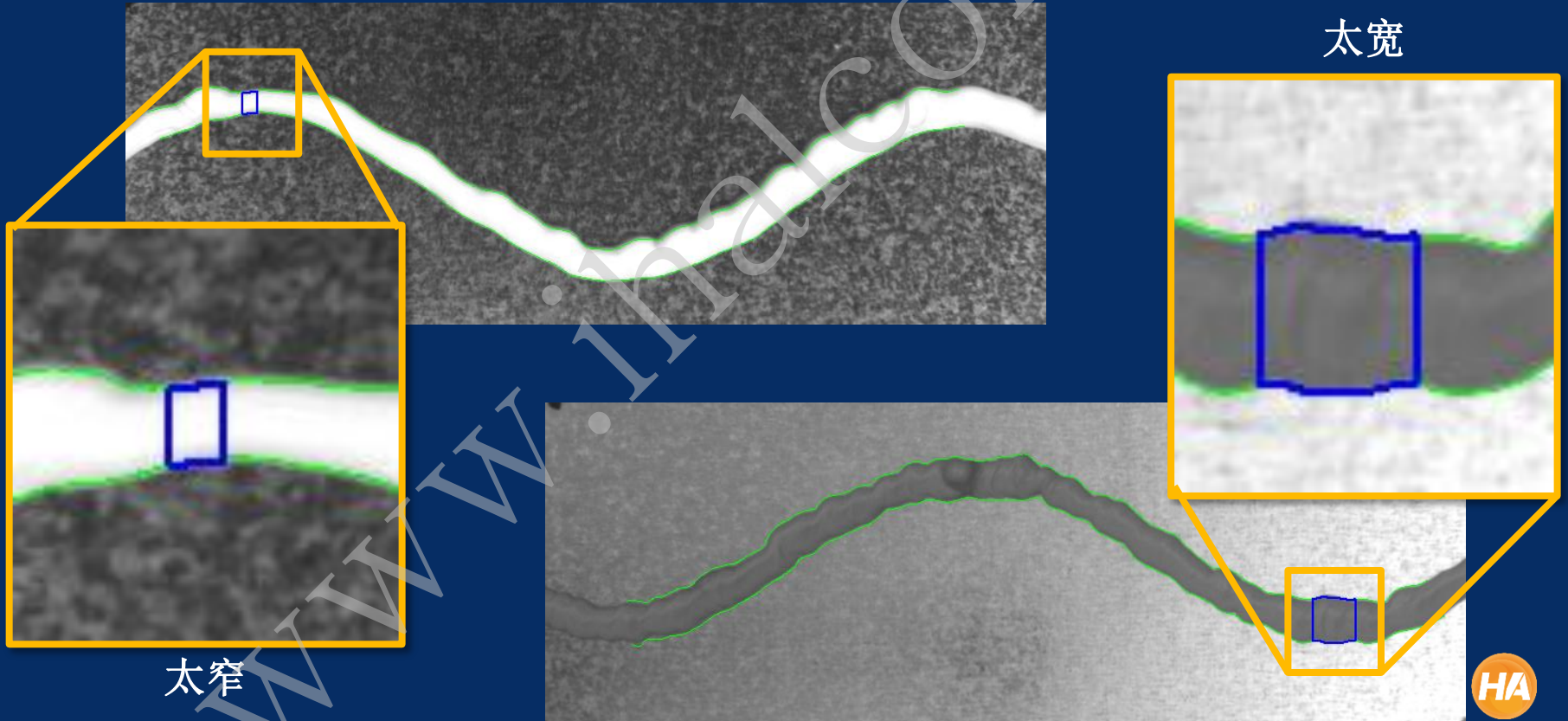
Bead Inspection

www.ihalcon.com

HALCON提供了新的算子用于bead inspection

设置项:

- 标准位置的轮廓
- 标准厚度
- 位置和厚度的容差范围



XLD Distance transform

www.halcon.com

计算两条轮廓的点距离

Inspect frame of phone camera (image 2/2)

Frame not OK

新的算子:
distance_contours_xld
segment_contour_attrib_xld
create_distance_transform_xld
apply_distance_transform_xld

Legend:
Extracted contours
Frame too narrow
Frame too wide
Contour defect

```
distance_contours_xld ( ::
```

- ▶ **ContourFrom**,
- ▶ **ContourTo** :
- ◀ **ContourOut** :
- ▶ **Mode** :)



ContourFrom



ContourTo



ContourOut

在拷贝ContourFrom的基础上
增加'distance'属性

‘point_to_point’ 更快,
‘point_to_segment’ 更精确

```
distance_contours_xld ( ::
```

```
▶ ContourFrom,
```

```
▶ ContourTo :
```

```
◀ ContourOut :
```

```
▶ Mode : )
```

‘point_to_point’
‘point_to_segment’



ContourFrom

ContourTo

Calibration

www.ihalcon.com

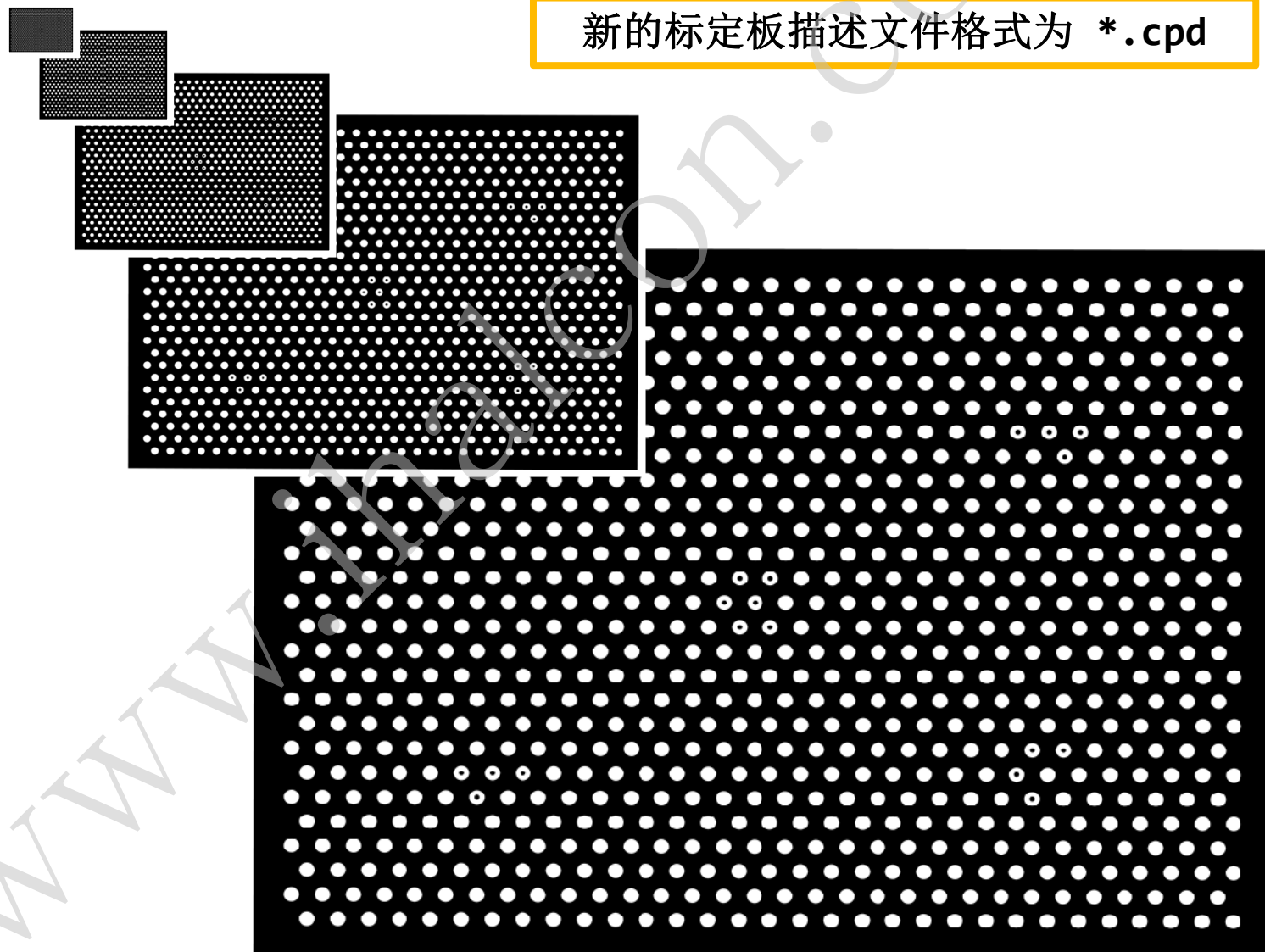
使用新的标定板，标定更加简单了

- ✓ 标定点更多 → 更准确的畸变计算结果
- ✓ 多个特征标识 → 标定板范围可以大于视场范围
- ✓ 视场被完整覆盖 → 只需要更少的标定图像

标准标定板尺寸为5mm 到 1200mm

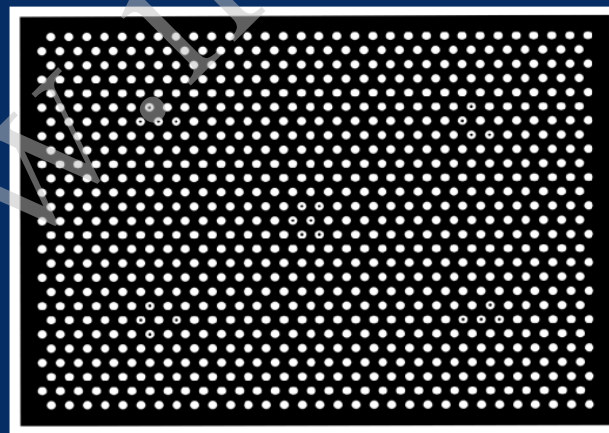
新的标定板描述文件格式为 *.cpd

20 mm
40 mm
80 mm
160 mm
320 mm



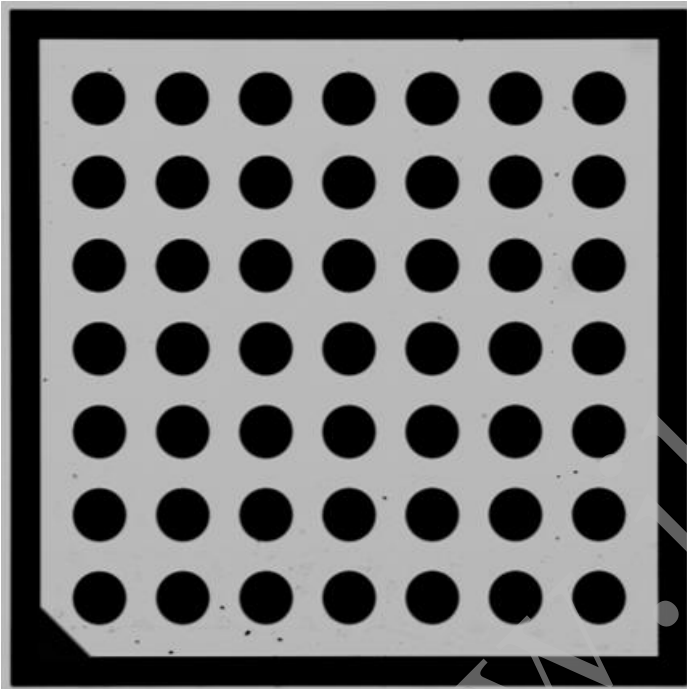
标定板信息

尺寸	材质			精度
	陶瓷	玻璃	塑料/铝	
20 x 15 mm	■	■	□	± 150 nm
40 x 30 mm	■	■	□	± 150 nm
80 x 80 mm	■	■	□	± 150 nm
160 x 120 mm	□	□	■	± 30 μm
320 x 240 mm	□	□	■	± 30 μm

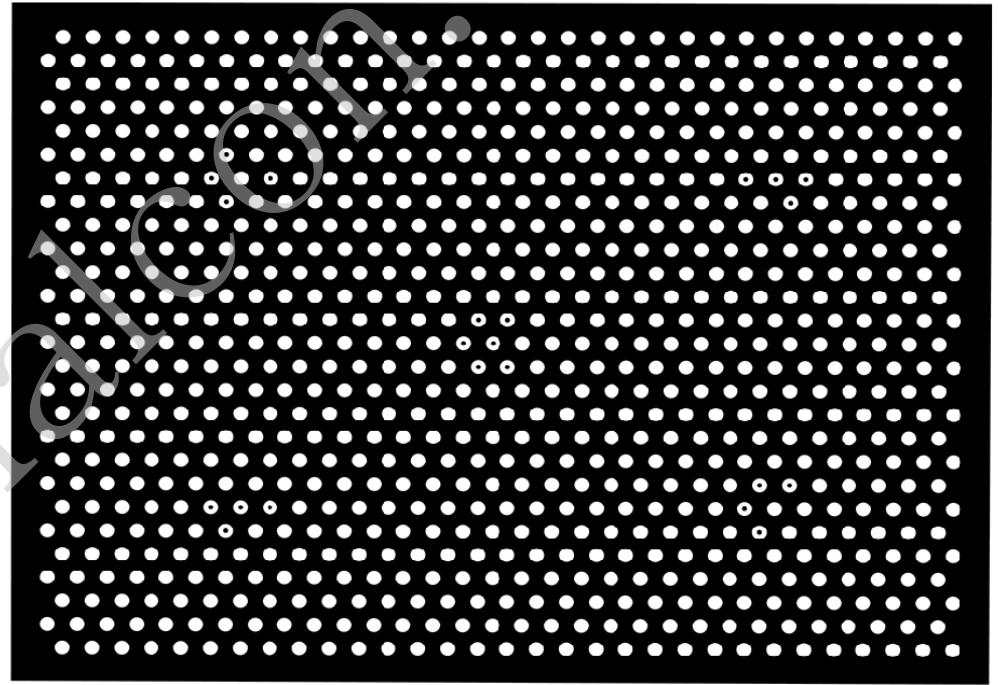


创建你自己的标定板

gen_caltab

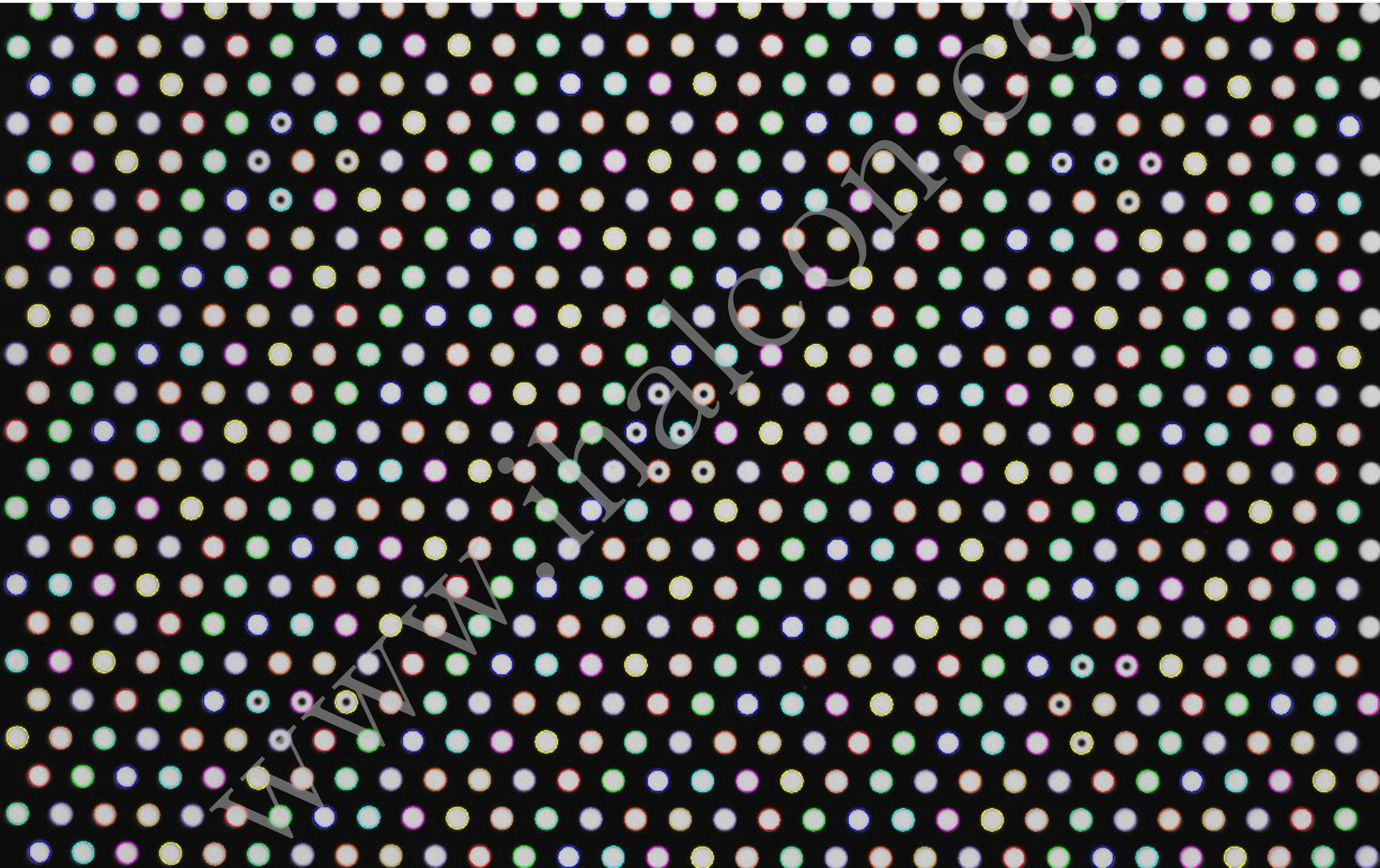


create_caltab

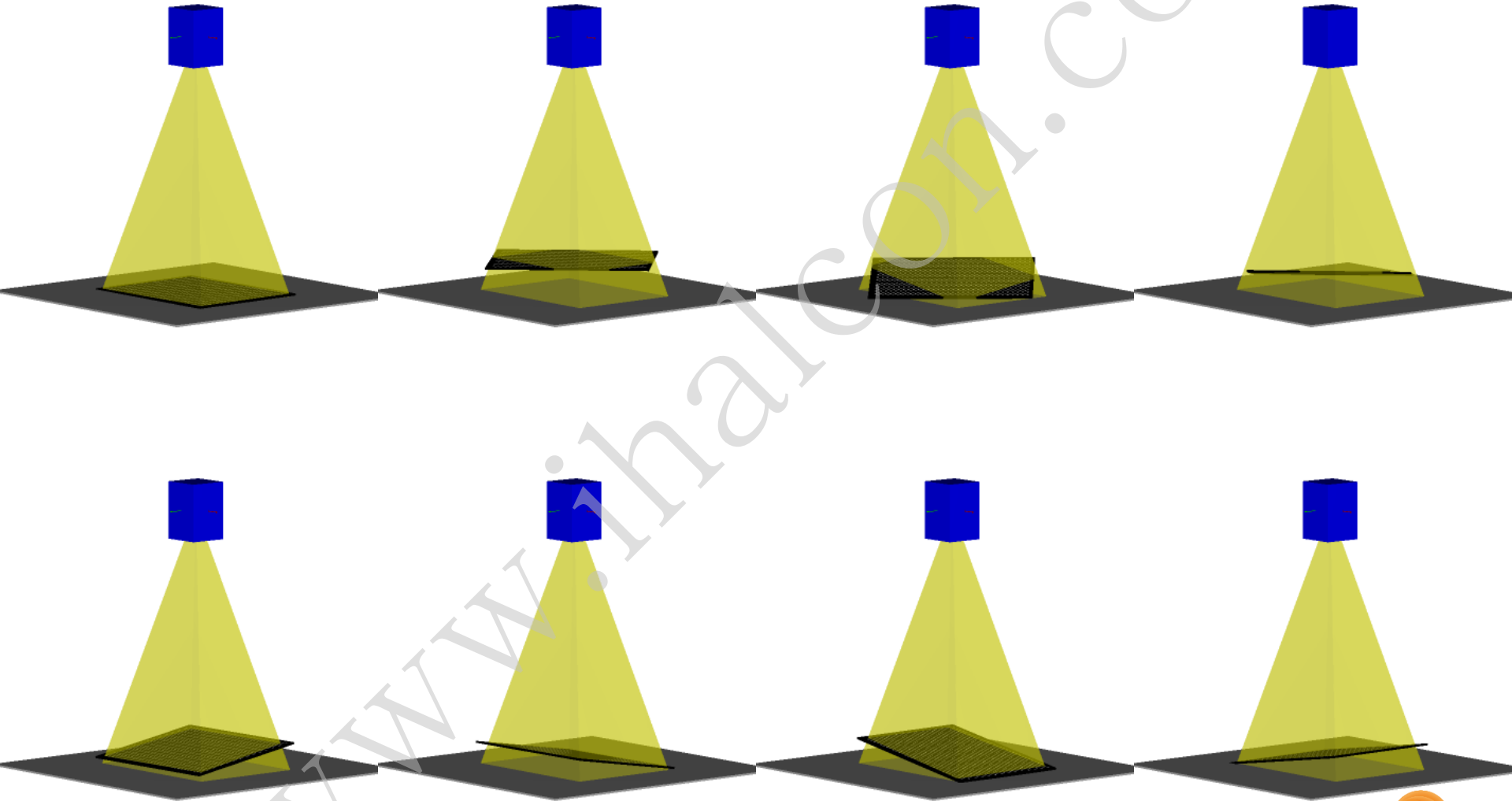


测试为目的!
自制的标定板精度很难保证!

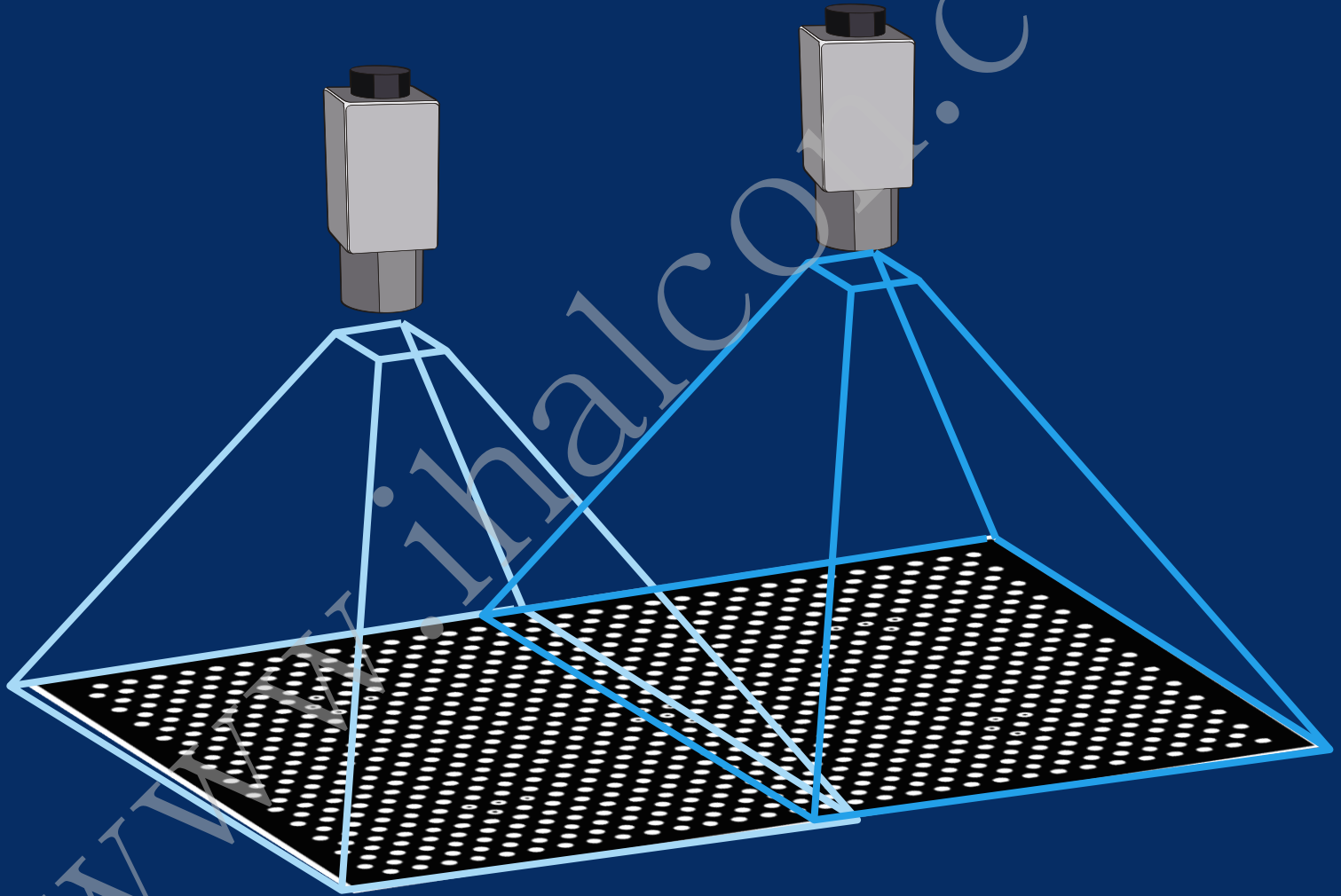
标定允许只使用标定板的一部分



使用新的标定板，更少的图像被使用



拼接标定可以使用一部分重复或者无重复



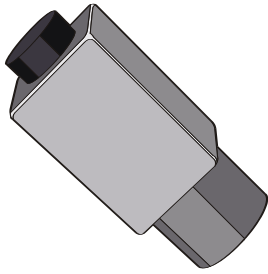
Sheet-of-Light Calibration

www.halcon.com

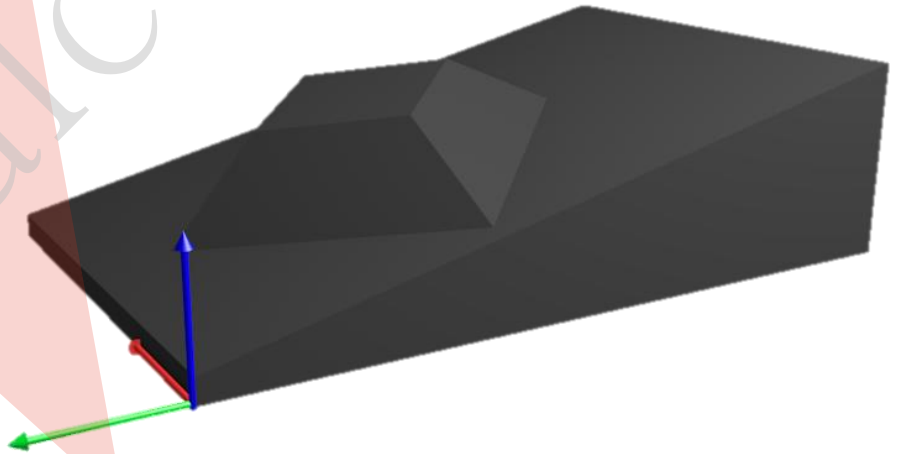
结构光标定是困难的



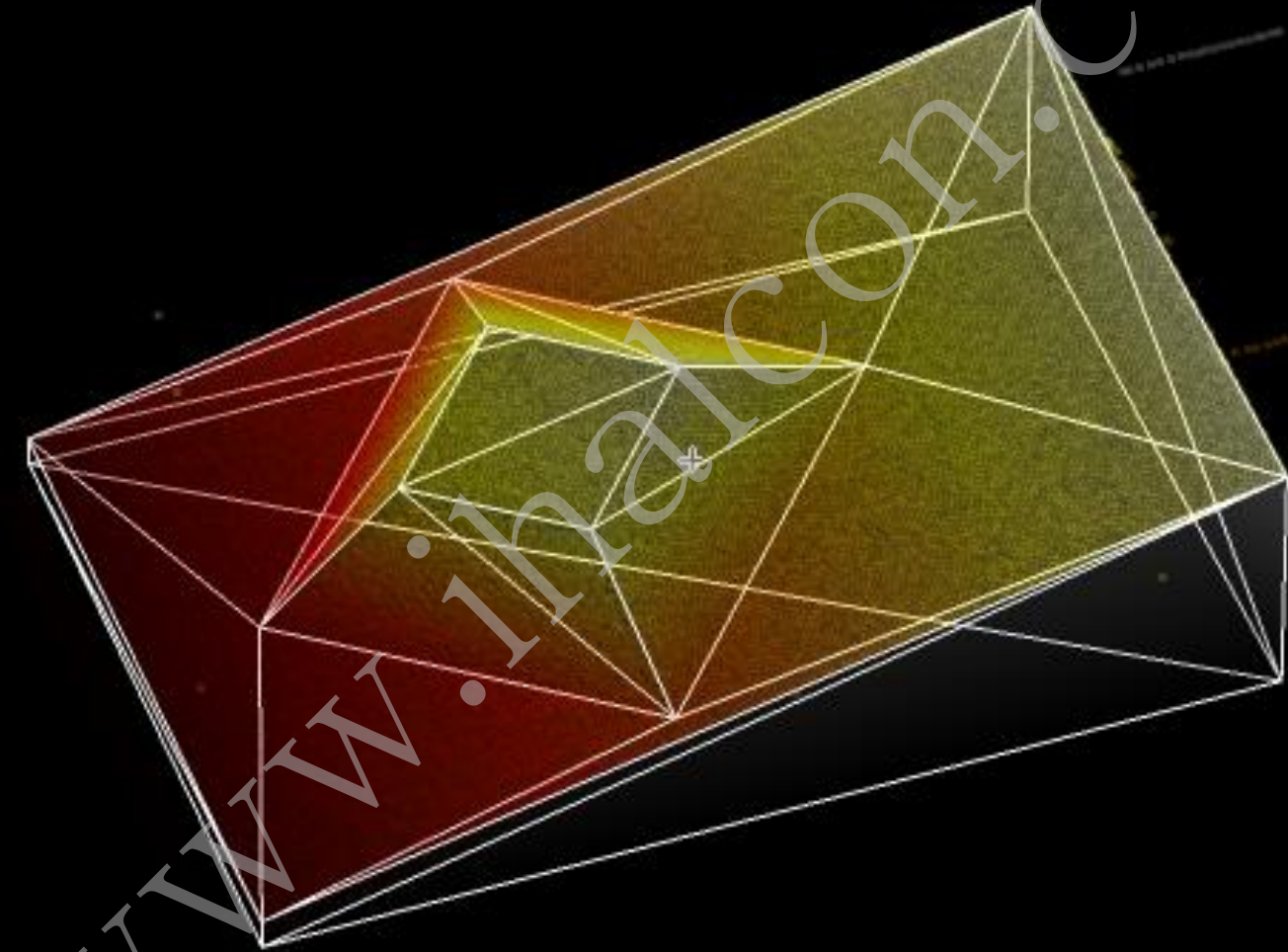
结构光标定变的简单了



1. 构建3D标定块
2. 扫描
3. 完成



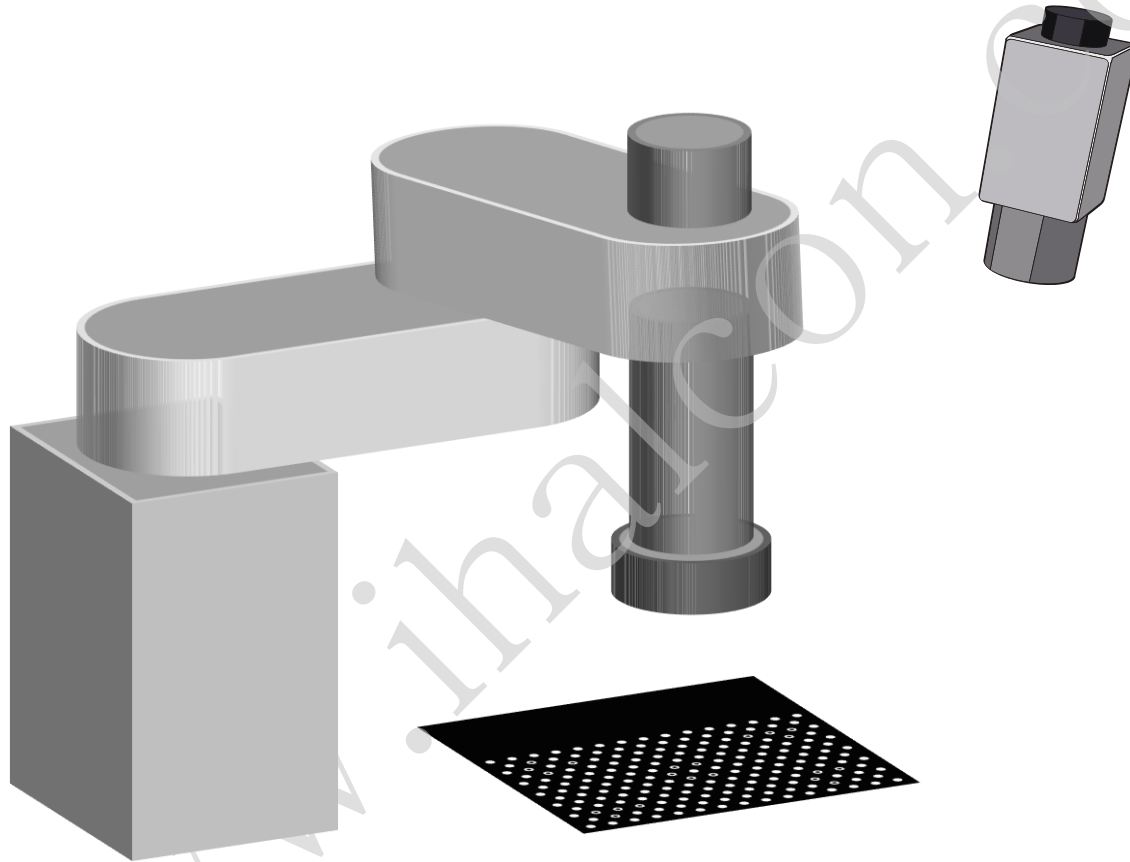
标定块



SCARA Calibration

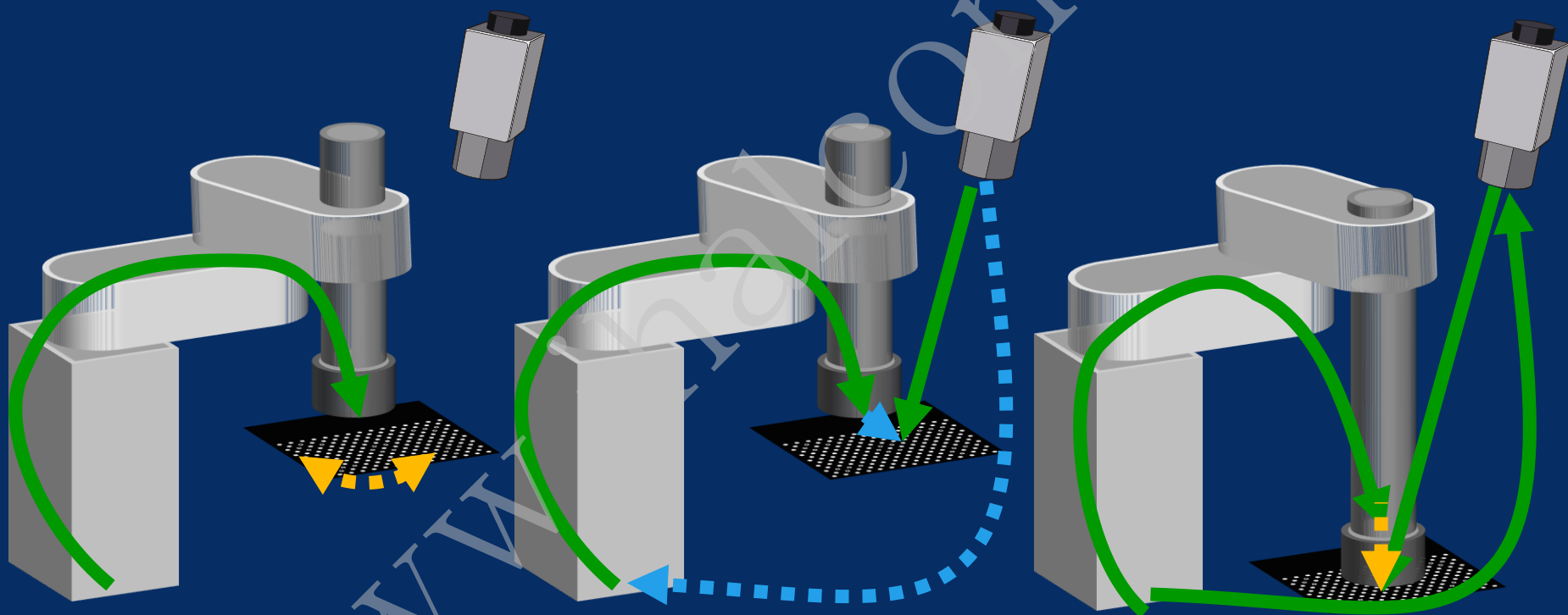
www.ihalcon.com

HALCON支持SCARA机器人的手眼标定



SCARA手眼标定由三部分完成

(0. 标定相机)



1. 准备标定数据模型

2. 标定手眼系统

3. 修正Z方向位置

SCARA 标定类似于普通的手眼标定

单独标定相机

初始化标定模型

```
create_calib_data(..., 'hand_eye_scara...',...)  
set_calib_data_cam_param  
set_calib_data_calib_object
```

获得标定图像和机械手
姿态

```
set_calib_data (..., 'tool_in_base_pose',...)  
find_calib_object (...)
```

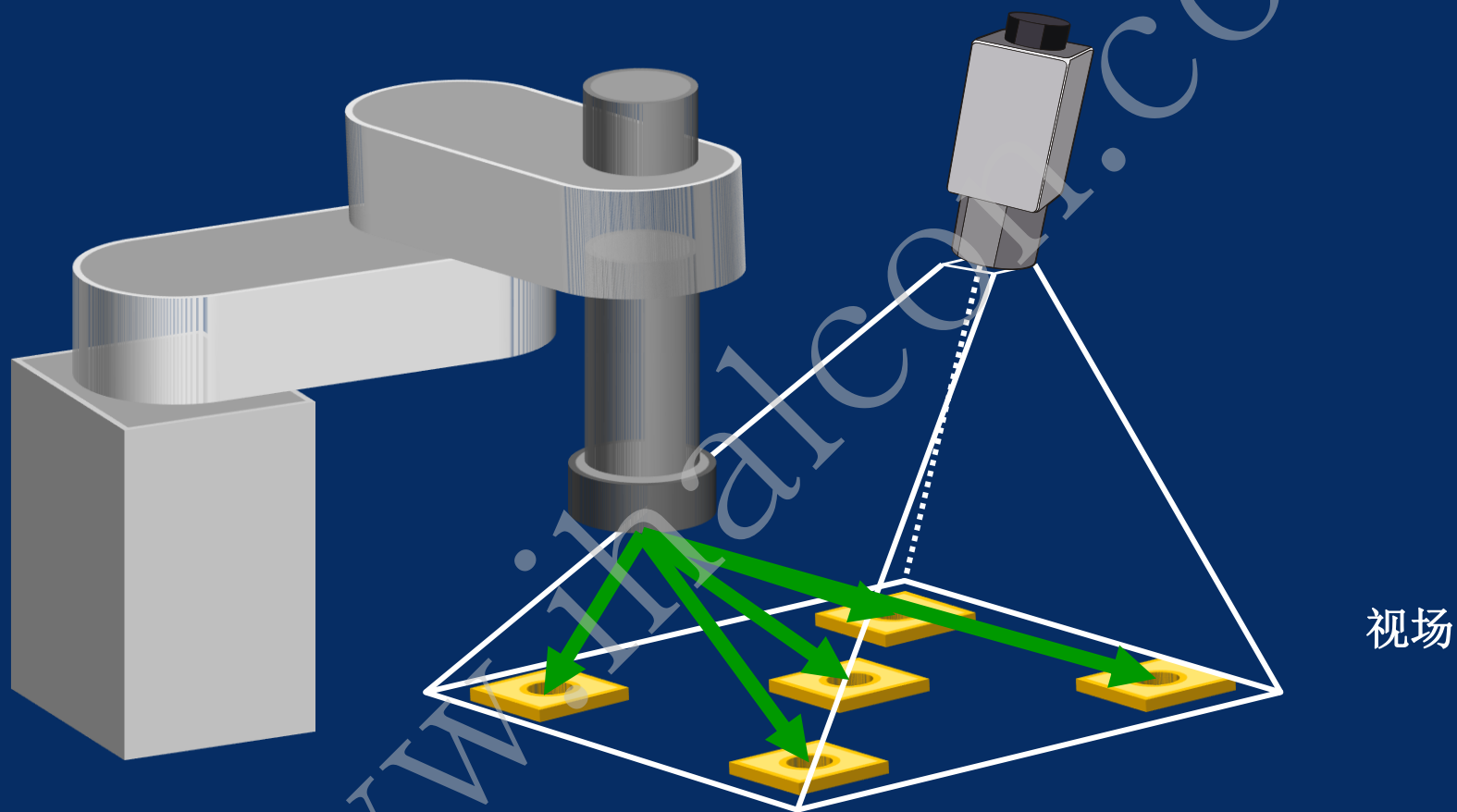
执行手眼标定

```
calibrate_hand_eye ()  
get_calib_data (..., 'base_in_cam_pose',...)
```

确定Z方向变换

```
find_calib_object  
Move robot to plate origin  
pose_invert  
pose_compose  
set_origin_pose
```

移动机械手到5个已知的位置，不使用标定板完成近似的标定



移动机械手到5个已知的位置，不使用标定板完成近似的标定

`vector_to_pose (X,Y,Z,Row,Column,..., BaseInCamPose)`

x
P2

x
P3

x
P4

x
P5

SCARA机械手的拾取和放置

ObjInBasePose:

Tx: 0.328 m

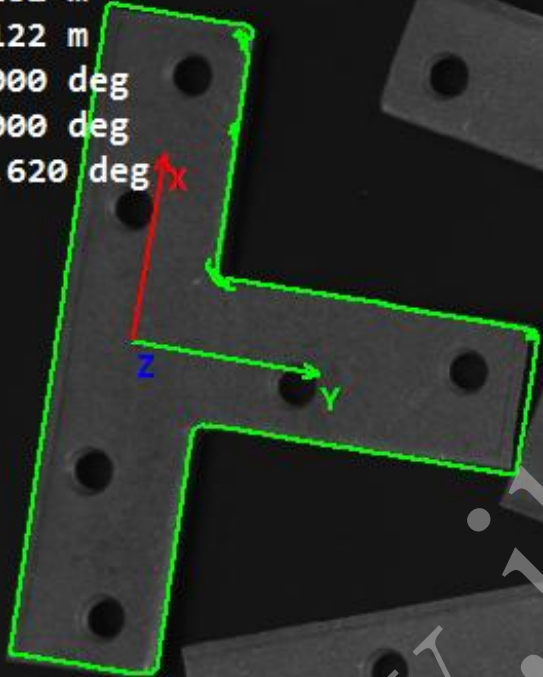
Ty: 0.181 m

Tz: 0.122 m

Alpha: 0.000 deg

Beta: 0.000 deg

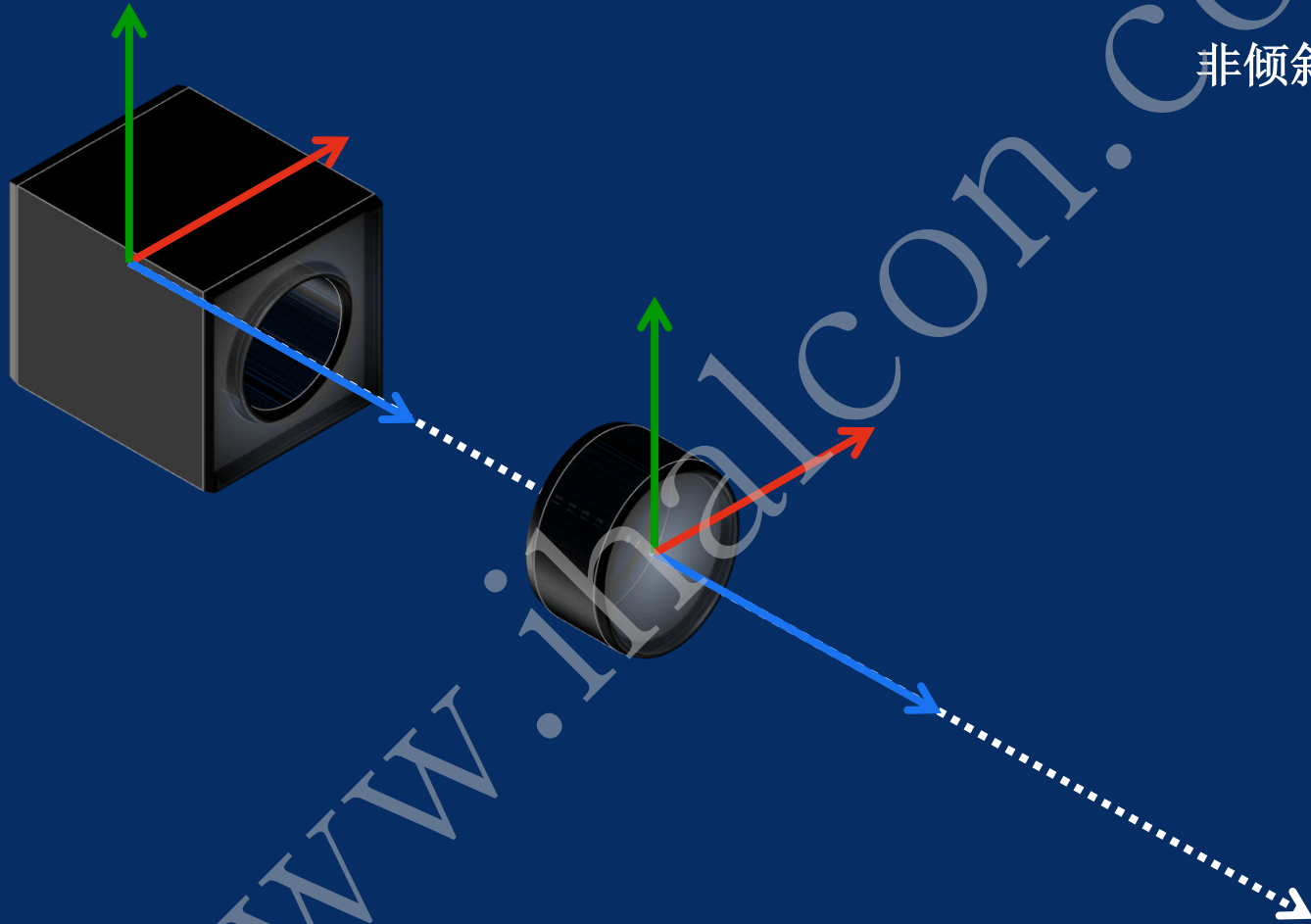
Gamma: 82.620 deg



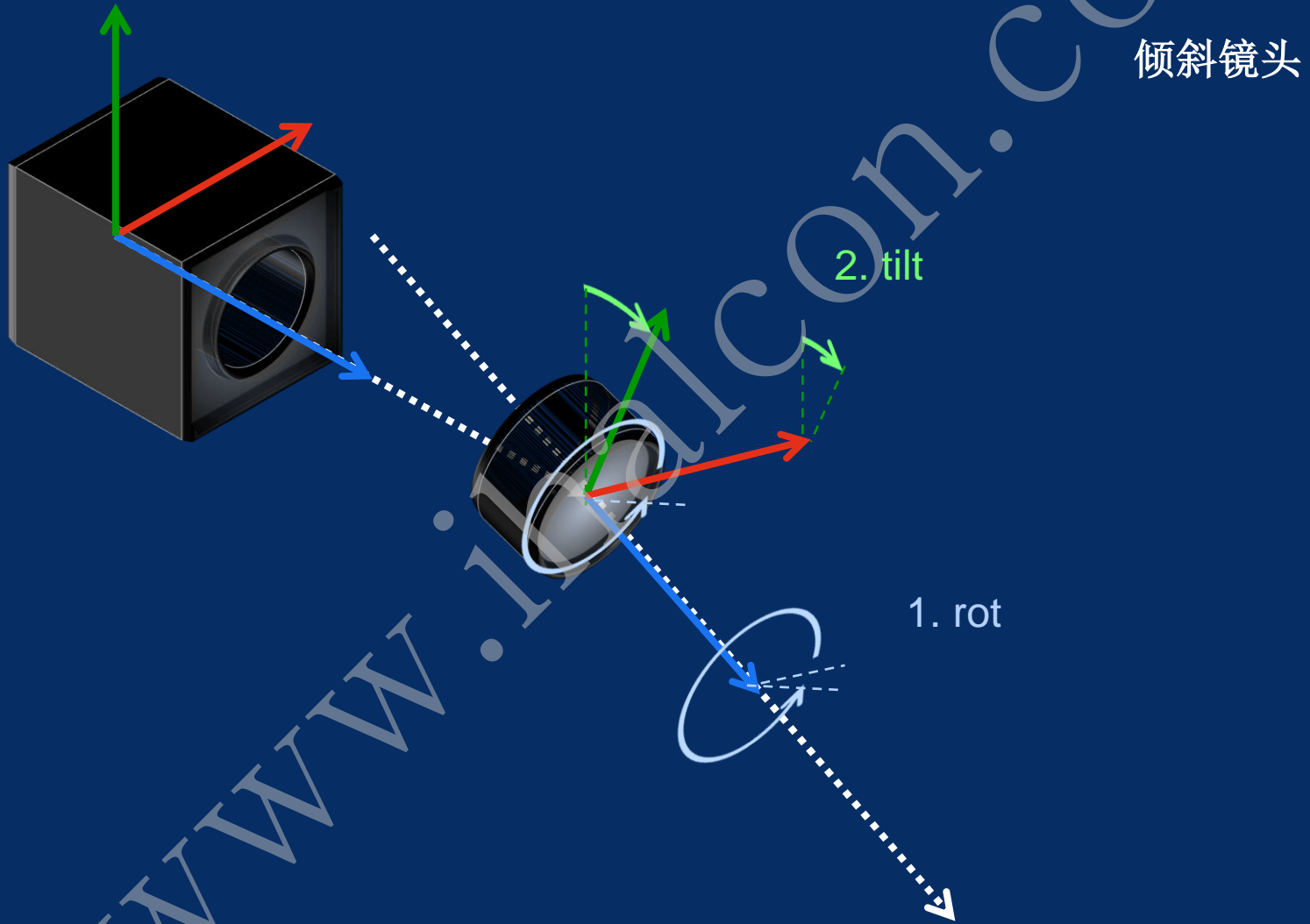
Tilt Lenses

www.halcon.com

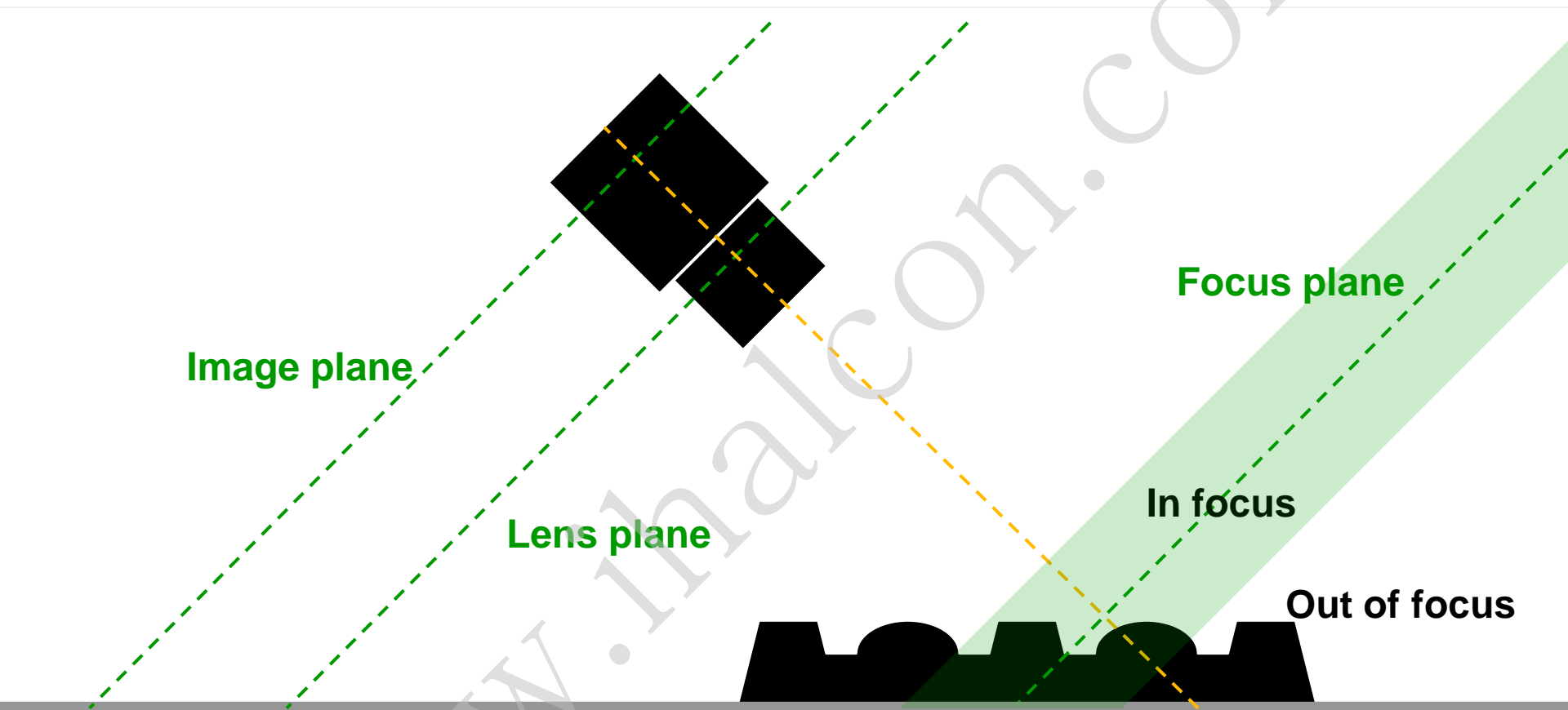
倾斜镜头的标定



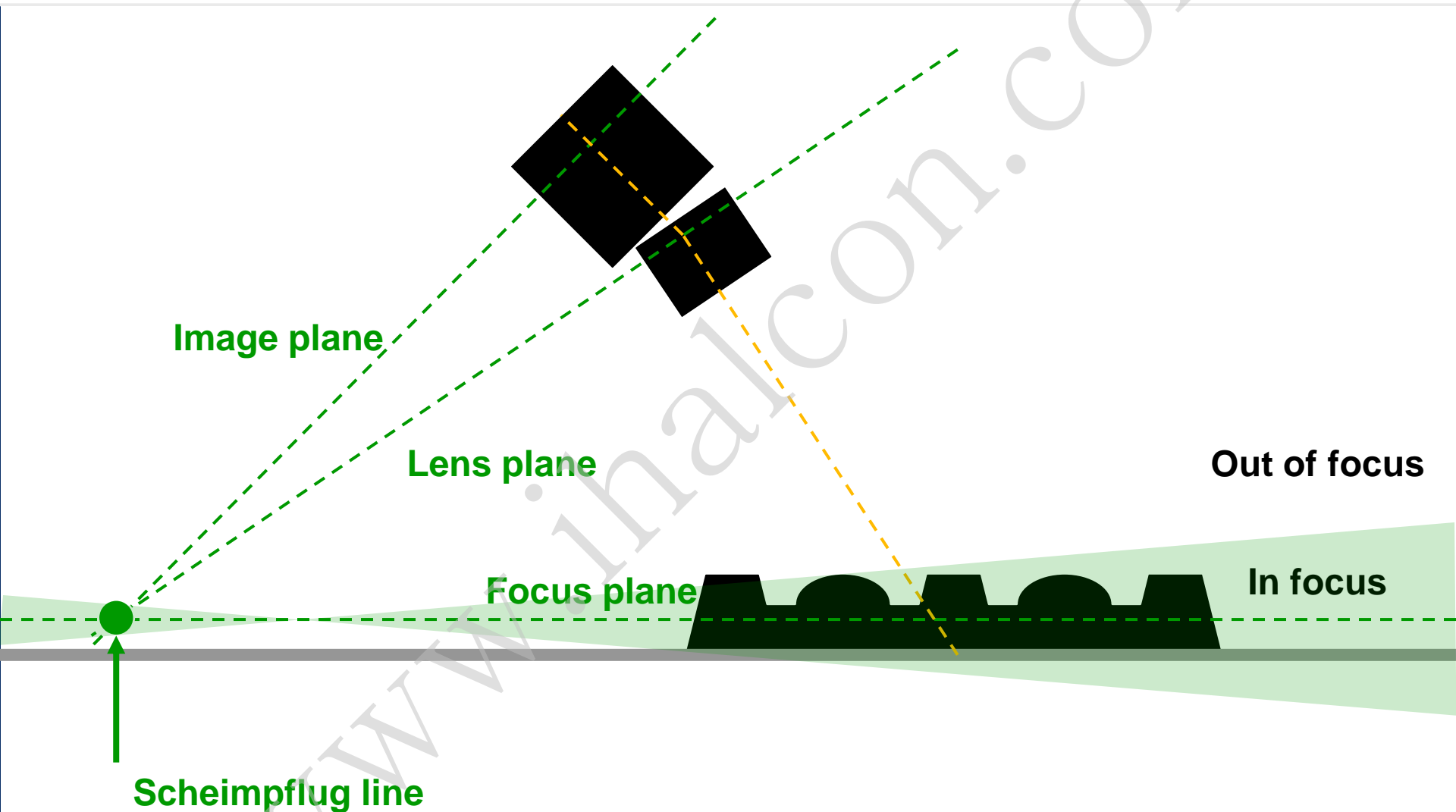
支持倾斜镜头的标定



当相机架设有一定角度时，视场的一部分可能很容易虚焦



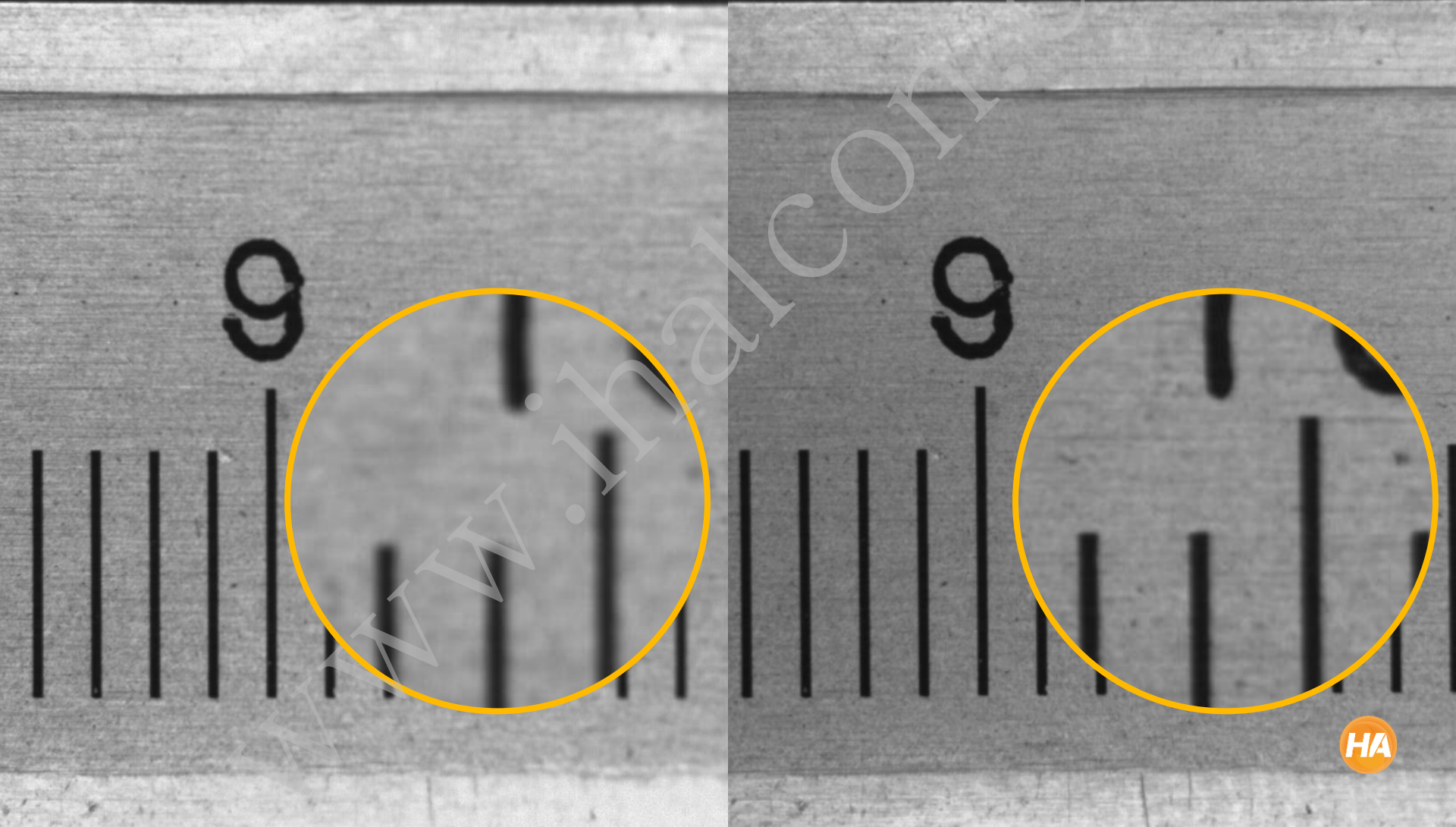
当使用倾斜镜头时，完整的视场可以被聚焦



当使用倾斜镜头，完整的视场可以被聚焦

非倾斜

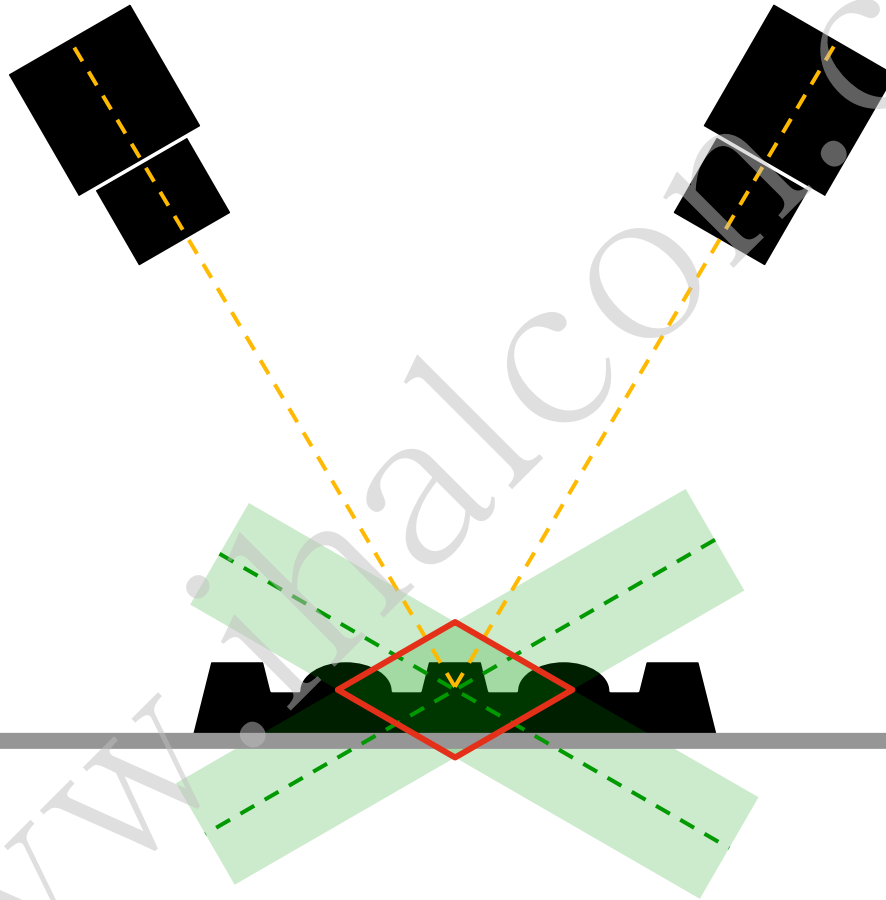
倾斜



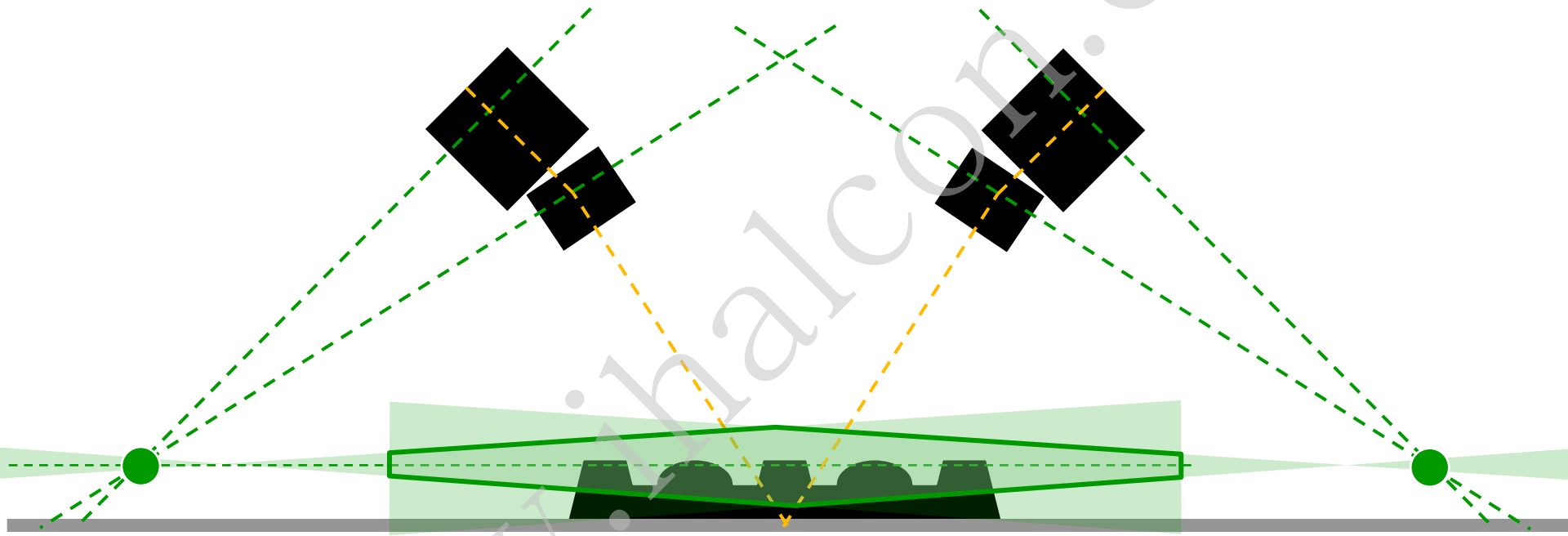
不同模式的相机参数

Parameter	Division model	Polynomial model	Line scan camera
Focal length	f	f	f
Radial distortion parameters	K	K_1 K_2 K_3	K
Decentering distortion parameters		P_1 P_2	
Tilt and rotation (optional)	Tilt Rot	Tilt Rot	
Pixel size	S_x, S_y	S_x, S_y	S_x, S_y
Principal point	C_x, C_y	C_x, C_y	C_x, C_y
Image size	Width Height	Width Height	Width Height
Movement vector			V_x, V_y, V_z

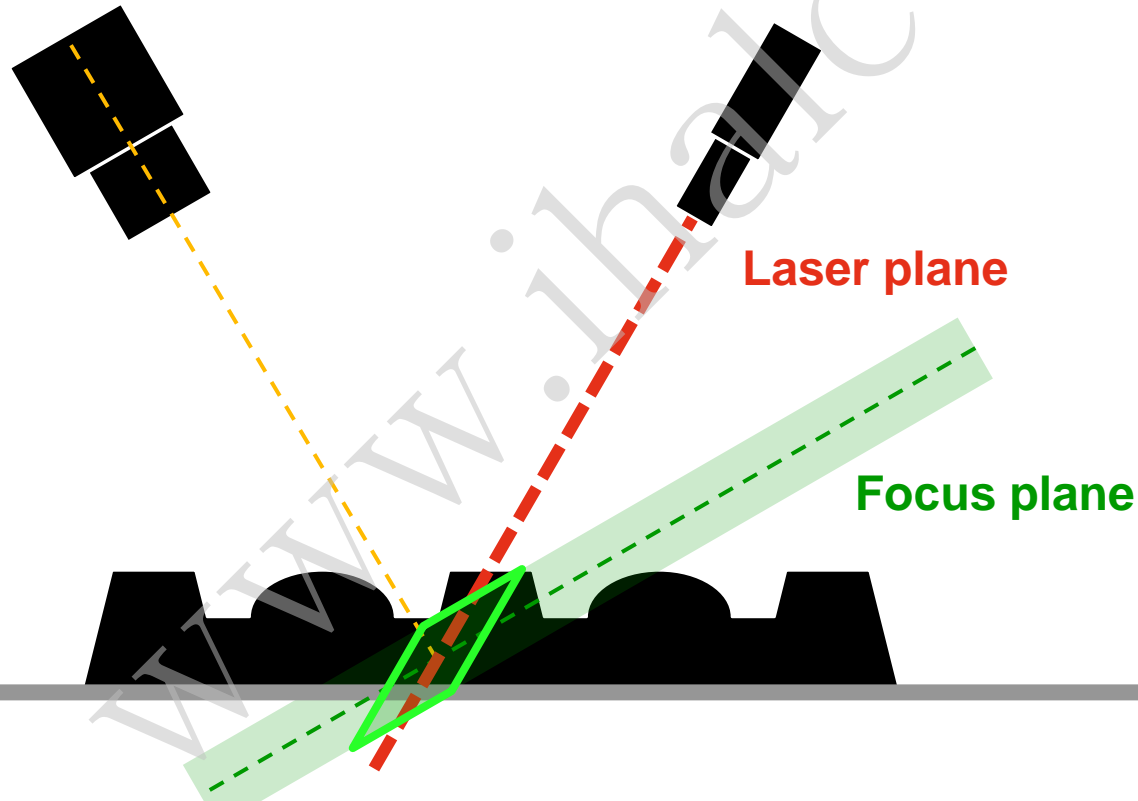
在立体视觉架设时，完整视场位于所有相机聚焦范围内是很困难的



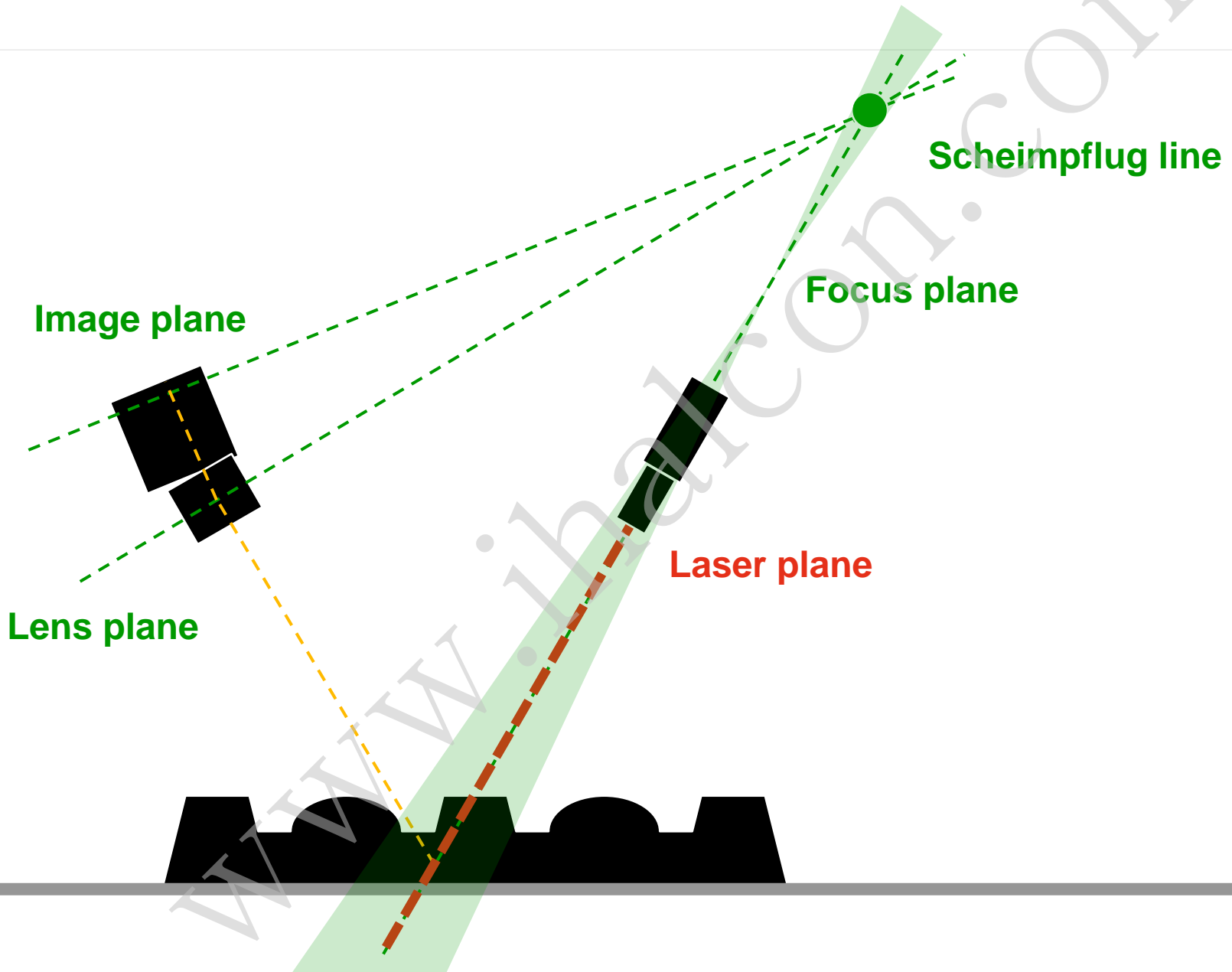
当使用倾斜镜头，完整的视场可以被聚焦



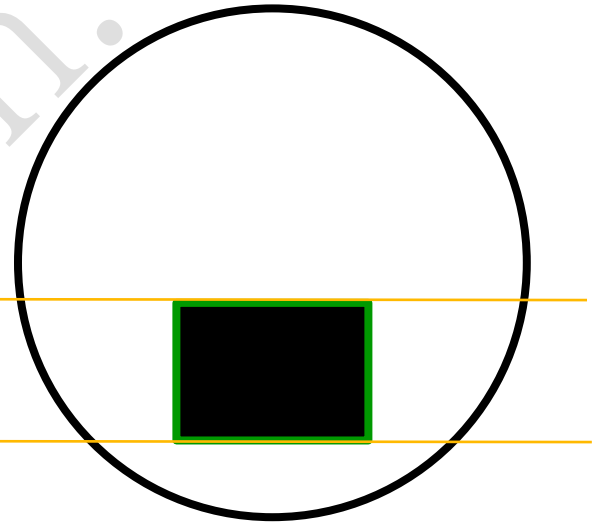
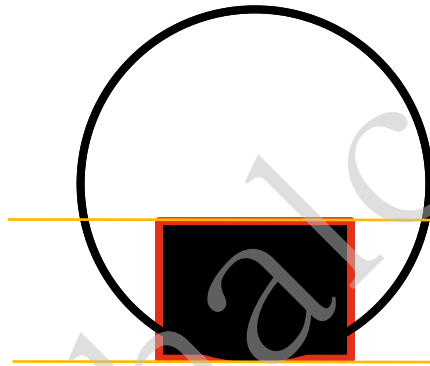
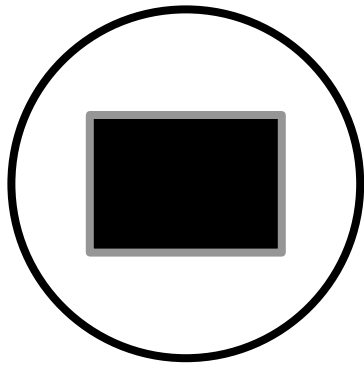
通常情况下，结构光不能被完整聚焦



利用倾斜镜头，结构光能被完整聚焦



倾斜镜头需要一个大的对角线尺寸



Standard lens



Tilted standard lens



Tilt lens

OCR

www.halcon.com

现状

1. 分割

2. 识别

HALCON 提供了文字分割的算子



```
find_text (Image, TextModel, TextResult)
```

缺点: 大量的参数需要设置

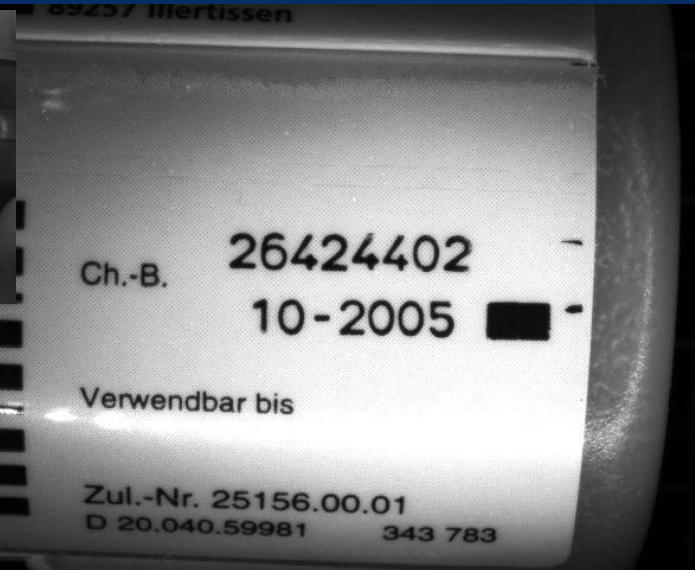
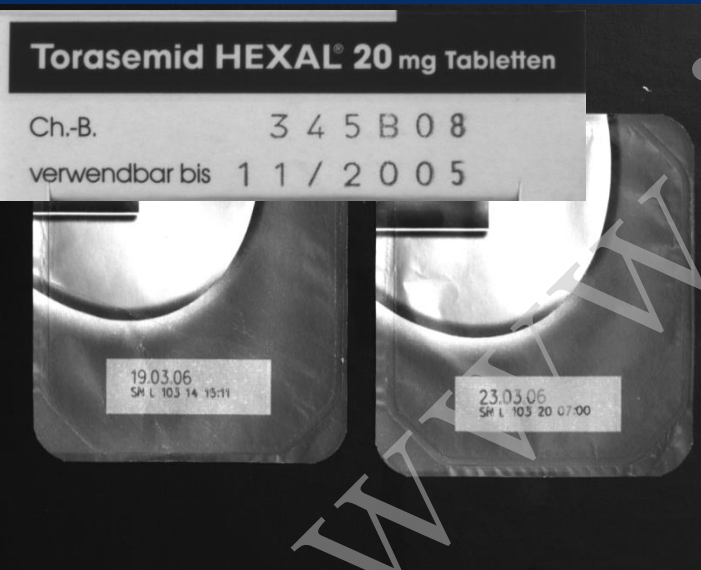


DALE RH-50 30W 240Ω 1%
RE75G2400 K8708

'char_height'	40	'char_width'	25
'is_dotprint'	0	'is_imprinted'	1
'max_line_num'	2	'polarity'	1
'stroke_width'	5	'uppercase_only'	1

OCR需要改进

- 首先关注于主要的视觉应用，并进行了如下假设：
 - 接近水平的字符排列
 - 非孤立的字符
 - 标准字体



获得了令人满意的结果



mindestens haltbar bis:
18.02.05 18s
24.02.05
1 03 2117 (C)

mindestens haltbar bis:
18.02.05 18s
24.02.05
1 03 2117 (C)

8 °C mindestens
ar bis:
2 02

0°C mindestens haltbar bis:
21.03.05
12:54 28

8 °C mindestens
ar bis:
2 02

0°C mindestens haltbar bis:
21.03.05
12:54 28

D
BY 303
FAV
e Markenbu

D
BY 303
FAV
e Markenbu

Auftrag-Nr.: 374767
Filial-Nr.: 42242

Auftrag-Nr.: 374767
Filial-Nr.: 42242

01

Traumeel S
50,0 Salbe

540
10,15

01

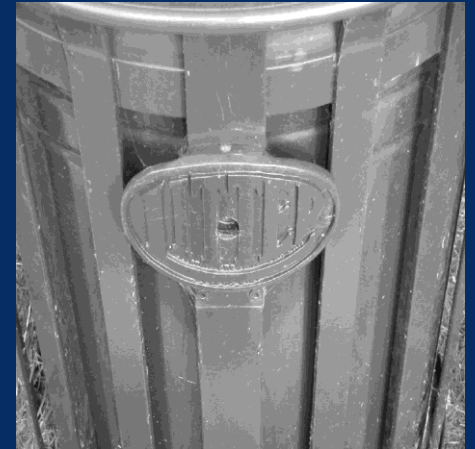
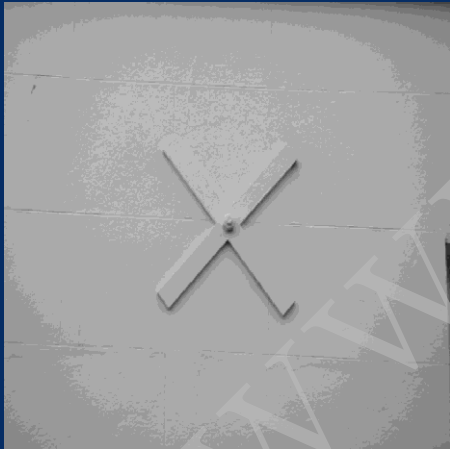
Traumeel S
50,0 Salbe

540
10,15

对于ICDAR 2003 的文字集，得到了很好的结果



一些图像违背了前提假设



读取医药包装上的过期时间



自动字符读取不需要参数设置

Specify classifier beforehand

`create_text_model_reader (... , 'auto' , Font , ...)`

Create text reader

`set_text_model_params`

Set optional parameters

`find_text (Image, ...)`

Find text

`get_text_result (... , Text)`

Query final result



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HDevelop介绍



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HDevelop介绍

- HDevelop是开始视觉处理算法的一个很好的工具，类似于VC、VB、Delphi等编译环境。
- 它有自己的交互式界面，可以编译和测试视觉处理算法，可以方便查看处理结果。
- 可以导出算法代码
- 可以作为算法开发、研究、教学等工具。

HDevelop介绍

- 每个程序包含一个Halcon算子序列
- 程序能够分为一些过程
- 还可以使用if, for, repeat 或者 while等控制语句 组织这些算子序列
- 各个算子的结果通过变量来传递
- 不传递隐含数据
- 算子的输入参数可以是变量，也可以是表达式
- 输出参数是变量
- HDevelop 不能用于设计用户界面
- HDevelop 程序只是作为应用软件视觉部分算法原型
- HDevelop 不能作为最终的应用软件

快速原型化: HDevelop

HDevelop 擅长什么?

- 直接连接采集卡和相机
- 从采集卡、相机或者文件中载入图像
- 检查图像数据
- 可行性研究
- 开发一个视觉检测方案
- 测试不同算子或者参数值的计算效果
- 保存程序
- 可以导出以 C++, C#, C, Visual Basic, 或者VB.NET程序

HDevelop编程

在HDevelop中可以编写完整的程序

适用于无编程经验的程序员

优点

- 很好的支持所有 HALCON算子
- 方便查看可视数据
- 方便选择、调试和编辑参数
- 方便技术支持 (发送HDevelop 程序)

缺点

- 不能直接生成一个正常的应用程序 (例如, 创建用户界面)

基于类的编程

使用C++, Visual Basic, 或者 Delphi可以编写完成的应用程序
适用于有经验的程序员

优点

- 有更好的编程结构
- 统一的编程风格

缺点

- 较难调试和查看可视化数据
- 需要花时间编写显示部分
- 较难的技术支持
 - 需要提取出于HALCON相关的部分程序
 - 需要区分是正常程序的错误还是HALCON程序的错误

推荐的编程方法

在HDevelop编写算法部分

使用C++ 或 Visual Basic开发应用程序

从HDevelop导出算法代码并集成到应用程序中

优点

- 很好的支持所有HALCON 算子
- 方便检查可视数据
- 方便选择、调试和编辑参数
- 方便技术支持 (发送HDevelop 程序)
- 充分利用两种环境

缺点

- 一个改变了的算法代码不能重新载入到 HDevelop中

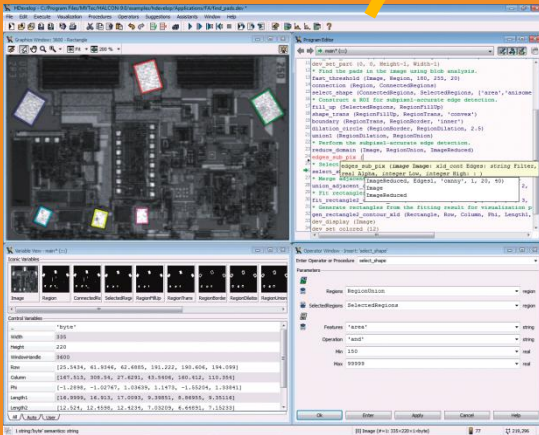
HDevelop 可以提供快速的解决方案

1. 开发视觉检测程序

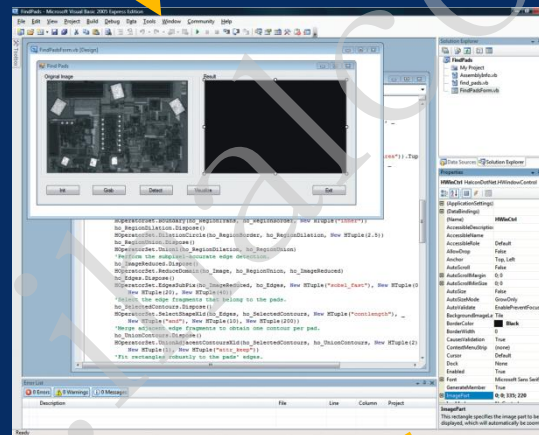
2. 添加用户界面

3. 执行应用程序

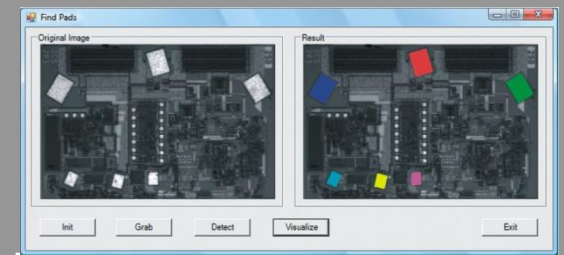
Export code



HDevelop



Visual Studio



HALCON library

Compile

机器



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HALCON数据结构



Halcon数据类型大致分为:

- **Iconic** 图标
 - **Image** 图像
 - **Region** 区域
 - **Extended Line Description(XLD)**
- **Control** 控制
 - **String** 字符
 - **Integer** 整型
 - **Real** 实型
 - **Handle** 句柄
- **Tuple**

Iconic 图标数据结构

Images 图像

- 多通道
- 任意的感兴趣区域
- 多像素类型
(byte, (u)int1/2/4, real, complex, direction, cyclic, vector_field)

Regions 区域

- 效率高的数据结构 (行程编码)
- 很多算子都会使用
- 市场上最快的形态学方法

XLD

- 亚像素精度直线和边缘轮廓
- 基于一定数据结构的点的列表
- 处理后的轮廓、多边形、直线、平行线, 等.

Handles 句柄

一种控制复杂数据结构的机制
用唯一的整型值标识这个数据
例如

- Window, file, socket, frame grabber, gnuplot
- OCR, 3D object model, measure, matching, calibration model, classifiers, matrices, ...

典型的算子

- `create/open_*(... Handle)`
- `close_*(Handle)`
- `write_*(Handle, FileName)`
- `read_*(FileName, Handle)`
- `do_something_*(...Handle...)`

Tuple:

Iconic Tuple (Object Tuple) 图标数组（物体数组）

Iconic tuple 变量

- 一个变量中包含一组数目不定的图标变量
- 最小索引是1
- 最大索引是元素个数

Operations 操作

- Display 显示
- Number of elements 元素个数
- Selection 选择
- Concatenation 串联
- Type checking 类型校验
- Comparison 比较

Tuple:

Control Tuple 控制数组

变量类型

- Integer
- Real
- String

变量长度

- 如果长度为1，可以作为正常变量使用
- 第一个索引为0
- 最大的索引为变量长度-1

使用

- 自动转换变量类型
- 自动内存管理
- 很多算子都会使用

结束语

谢谢！



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基于HALCON的机器 视觉教学实验系统



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大恒机器视觉教学实验系统

- 机器视觉基础教学方案
- 三维视觉视觉技术教学方案
- 机器人视觉技术及教学方案
- 大数据量存储解决方案

机器视觉基础教学方案



机器视觉基础教学方案

- 平移式机器视觉教学实验系统
- 旋转式机器视觉教学实验系统
- 线阵检测教学实验系统

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机器视觉基础教学方案-实验案例

基础型实验



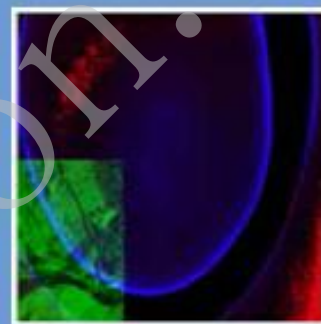
摄像机的安装和使用



光源的选择和使用



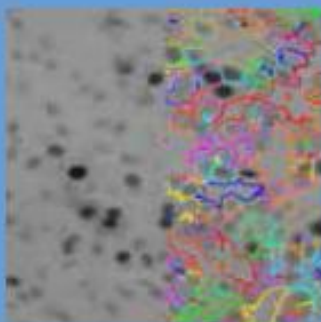
时域滤波



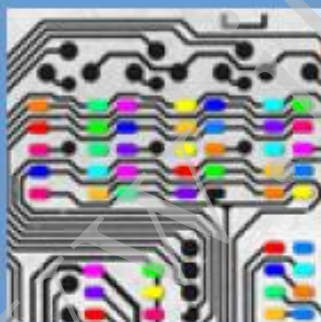
频域滤波



动态阈值分割



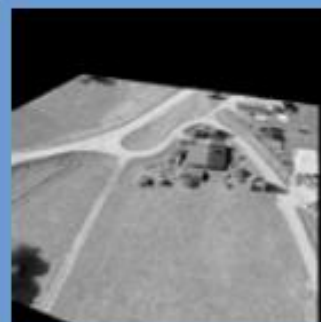
分水岭分割



形态学处理与特征提取



亚像素边缘提取



几何变换



模板匹配

机器视觉基础教学方案-实验案例

实战型实验



一维测量



二维测量



OCR 检测



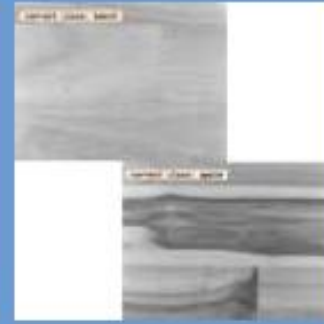
一维码识别



二维码识别



3D 形状匹配



分类器使用 - 木材分类

机器视觉基础教学方案-实验软件平台

每个实验系统包含两套软件：


- HALCON 交互式的编程环境——HDevelop
中算法程序
- 把HDevelop 的代码导入到一个基于MFC 的
程序框架界面

机器视觉基础教学方案-实验软件平台

大恒图像

机器视觉教学实验系统——实战篇

- 二维码识别
- 一维码识别
- 一维测量
- OCR测量
- 二维测量
- 3D形状匹配
- 木材分类



大恒图像

结束语

谢谢！