# 卡尺测量

如果要测量由圆、椭圆、矩形或直线等简单形状表示的对象，并且对它们的位置、方向和尺寸有大致的了解，则可以使用2D计量来确定确切的形状参数。特别是，初始形状参数的值通过基于所谓测量区域内边缘的精确位置的测量来改进。这些是沿近似已知形状的边界均匀分布的矩形区域。对于单个初始形状，也可以返回多个细化实例。首先，必须使用create\_metrology\_model创建计量模型。在该模型中，将存储与要测量的对象相关的所有所需信息。为了实现有效的测量，应该使用操作符set\_metrology\_model\_image\_size将执行测量的图像的大小添加到模型中。

read\_image (Image, 'pads')  
get\_image\_size (Image, Width, Height)  
create\_metrology\_model (MetrologyHandle)  
set\_metrology\_model\_image\_size (MetrologyHandle, Width, Height)

然后，必须添加图像中物体形状的近似值和控制测量的一些参数。对于每个形状，根据其几何类型，使用以下运算符:

•add\_metrology\_object\_circle\_measure添加一个或多个圆的参数，即中心点和半径的坐标。•add\_metrology\_object\_ellipse\_measure添加一个或多个椭圆的参数，即中心点的坐标，主轴的方向，以及小半轴和大半轴的大小。

•add\_metrology\_object\_line\_measure添加一条或多条线的参数，即起点和终点的坐标。•add\_metrology\_object\_rectangle2\_measure添加一个或多个矩形的参数，即中心点的坐标，主轴的方向，以及小半轴和大半轴的大小。

•add\_metrology\_object\_generic添加圆形、椭圆、直线和/或矩形的参数。注意，可以使用操作符set\_metrology\_object\_param更改控制度量的几个参数。

add\_metrology\_object\_rectangle2\_measure (MetrologyHandle, RectangleInitRow, \  
RectangleInitColumn, \  
RectangleInitPhi, \  
RectangleInitLength1, \  
RectangleInitLength2, \  
RectangleTolerance, 5, .5, 1, [], \  
[], MetrologyRectangleIndices)  
add\_metrology\_object\_circle\_measure (MetrologyHandle, CircleInitRow, \  
CircleInitColumn, CircleInitRadius, \  
CircleRadiusTolerance, 5, 1.5, 2, [], \  
[], MetrologyCircleIndices)

图像中的实际测量是使用apply\_metrology\_model操作符执行的。可以使用操作符get\_metrology\_object\_result从计量模型访问由测量产生的精细形状参数。

apply\_metrology\_model (Image, MetrologyHandle)  
get\_metrology\_object\_result (MetrologyHandle, MetrologyRectangleIndices, \  
'all', 'result\_type', 'all\_param', \  
RectangleParameter)  
get\_metrology\_object\_result (MetrologyHandle, MetrologyCircleIndices, 'all', \  
'result\_type', 'all\_param', CircleParameter)

要检查已添加到计量模型中的轮廓，可以使用get\_metrology\_object\_model\_contour。要访问度量区域(这在调整控制度量的参数时可能很有帮助)，可以调用操作符get\_metrology\_object\_measures。除了基本步骤之外，还可以执行其他几个步骤。物体的位置因图像而异，为了提高计量的精确值，就得对齐计量模型。HALCON提供了三种不同的对齐方法:•使用基于形状的匹配•使用区域处理•使用从点对应确定的刚性转换。

\* AlignmentMode := 'shape-based matching'  
\* AlignmentMode := 'region processing'  
\* AlignmentMode := 'rigid transformation

2.3.1.1基于形状的匹配为了在新图像中找到待测量的物体，需要创建并训练形状模型。

create\_generic\_shape\_model (ShapeModelID)  
train\_generic\_shape\_model (ImageReduced, ShapeModelID)

现在，使用set\_metrology\_model\_param将参考坐标系设置为形状模型区域的原点。形状模型的原点是create\_generic\_shape\_model中使用的输入区域的中心，可以用area\_center来确定。这样，您就可以直接使用find\_generic\_shape\_model的结果来对齐计量模型

area\_center (ModelRegion, Area, RowModel, ColumnModel)  
set\_metrology\_model\_param (MetrologyHandle, 'reference\_system', [RowModel, \  
ColumnModel,0])

要检查已添加到计量模型中的轮廓，可以使用get\_metrology\_object\_model\_contour。计量模型可以使用align\_metrology\_model进行对齐。该算子使用由算子find\_generic\_shape\_model获得并由算子get\_generic\_shape\_model\_result检索的位置和旋转角度来对齐计量模型。

find\_generic\_shape\_model (CurrentImage, ShapeModelID, MatchResultID, \  
NumMatchResult)  
get\_generic\_shape\_model\_result (MatchResultID, 'all', 'angle', AngleAlign)  
align\_metrology\_model (MetrologyHandle, RowAlign, ColumnAlign, AngleAlign)

最后，使用apply\_metrology\_model执行实际的度量。

apply\_metrology\_model (CurrentImage, MetrologyHandle)

2.3.1.2区域处理对齐也可以通过区域处理来完成。在这种情况下，我们使用area\_center和orientation\_region来确定分割的参考对象的参考位置。

area\_center (OriginalRegion, Area, RowOrig, ColumnOrig)  
orientation\_region (OriginalRegion, AngleOrig)  
set\_metrology\_model\_param (MetrologyHandle, 'reference\_system', [RowOrig, \  
ColumnOrig,AngleOrig])

首先与参考图像相同的方式分割物体并确定其位置和方向。如果已经设置了计量模型的参考系，则结果可以直接用于align\_metrology\_model的对准。

area\_center (CurrentRegion, Area, RowAlign, ColumnAlign)  
orientation\_region (CurrentRegion, AngleAlign)  
align\_metrology\_model (MetrologyHandle, RowAlign, ColumnAlign, AngleAlign)

最后，您可以使用apply\_metrology\_model执行实际的度量

apply\_metrology\_model (CurrentImage, MetrologyHandle)

使用算子vector\_to\_rigid和hom\_mat2d\_to\_affine\_par提取参考点并确定刚性转换参数。注意，必须注意相应的点在RowReference、ColumnReference、rowextract和columnextracts中具有相同的索引。然后将结果用于align\_metrology\_model的对齐。

apply\_metrology\_model (CurrentImage, MetrologyHandle)

2.3.2查询结果

使用get\_metrology\_object\_result可视化。

get\_metrology\_object\_result (MetrologyHandle, 'all', 'all', 'used\_edges', \  
'row', UsedRow)  
get\_metrology\_object\_result (MetrologyHandle, 'all', 'all', 'used\_edges', \  
'column', UsedColumn)  
gen\_cross\_contour\_xld (UsedEdges, UsedRow, UsedColumn, 10, rad(45)

\* 清空屏幕，显式控制图像显示  
dev\_close\_window ()  
dev\_update\_off ()  
read\_image (Image, '1.png')  
  
dev\_open\_window\_fit\_image (Image, 0, 0, -1, -1, WindowHandle)  
dev\_display (Image)  
\* gen\_region\_line (ROI\_0,60.4159 , 69.5854, 60.4159, 243.094)  
\* 创建测量模型  
create\_metrology\_model (MetrologyHandle)  
Row1 := 60.4159  
Column1 := 69.5854  
Row2 := 60.4159  
Column2 := 243.094  
  
\* 添加找直线工具，给定参数，显示过程卡尺的轮廓  
add\_metrology\_object\_line\_measure (MetrologyHandle, Row1, Column1,\  
Row2, Column2, 20, 5, 1, 30, [], [], Index)  
get\_metrology\_object\_model\_contour (Contour, MetrologyHandle, 0, 1.5)  
get\_metrology\_object\_measures (Contours, MetrologyHandle, 'all', 'all', Row, Column)  
dev\_set\_color('cyan')  
dev\_display (Contour)  
dev\_display (Contours)  
  
\* 执行找直线并显示结果  
apply\_metrology\_model (Image, MetrologyHandle)  
get\_metrology\_object\_result (MetrologyHandle, 0, 'all', 'result\_type',\  
'all\_param', Parameter)  
get\_metrology\_object\_result\_contour (Contour1, MetrologyHandle, 0, 'all', 1.5)  
dev\_set\_line\_width (3)  
dev\_set\_color ('red')  
dev\_display (Contour1)  
clear\_metrology\_model (MetrologyHandle)  
  
\* 清空屏幕，显式控制图像显示  
dev\_close\_window ()  
dev\_update\_off ()  
read\_image (Image, '1.png')  
dev\_open\_window\_fit\_image (Image, 0, 0, -1, -1, WindowHandle)  
dev\_display (Image)  
\* gen\_circle (ROI\_0, 130.086, 143.525, 20.9306)  
\* 创建测量模型  
create\_metrology\_model (MetrologyHandle)  
Row1 := 130.086  
Column1 := 143.525  
Radius := 20.9306  
  
\* 添加找圆工具，给定参数，显示过程卡尺  
add\_metrology\_object\_circle\_measure (MetrologyHandle, Row1, Column1,\  
Radius, 12, 3, 1, 30, [], [], Index)  
get\_metrology\_object\_model\_contour (Contour, MetrologyHandle, 0, 1.5)  
get\_metrology\_object\_measures (Contours, MetrologyHandle, 'all', 'all', Row, Column)  
dev\_set\_color('cyan')  
dev\_display (Contour)  
dev\_display (Contours)  
  
\* 执行找圆并显示结果  
apply\_metrology\_model (Image, MetrologyHandle)  
get\_metrology\_object\_result (MetrologyHandle, 0, 'all', 'result\_type',\  
'all\_param', Parameter)  
get\_metrology\_object\_result\_contour (Contour1, MetrologyHandle, 0, 'all', 1.5)  
dev\_set\_line\_width (3)  
dev\_set\_color ('red')  
dev\_display (Contour1)  
clear\_metrology\_model (MetrologyHandle)  
  
  
\* 清空屏幕，显式控制图像显示  
dev\_close\_window ()  
dev\_update\_off ()  
dev\_open\_window\_fit\_image (Image, 0, 0, -1, -1, WindowHandle)  
read\_image (Image, '2.png')  
dev\_display (Image)  
\* gen\_ellipse (ROI\_0, 127.999, 64.0592, rad(90), 104.787, 31.8445)  
\* 创建测量模型  
create\_metrology\_model (MetrologyHandle)  
Row1 := 127.999  
Column1 := 64.0592  
Phi := rad(90)  
Radius1 := 104.787  
Radius2 := 31.8445  
\* 添加找椭圆工具，给定参数，显示过程卡尺  
add\_metrology\_object\_ellipse\_measure (MetrologyHandle, Row1,\  
Column1, Phi, Radius1, Radius2, 12, 3, 1, 30, [], [], Index)  
get\_metrology\_object\_model\_contour (Contour, MetrologyHandle, 0, 1.5)  
get\_metrology\_object\_measures (Contours, MetrologyHandle, 'all', 'all', Row, Column)  
dev\_set\_color('cyan')  
dev\_display (Contour)  
dev\_display (Contours)  
  
\* 执行找椭圆并显示结果  
apply\_metrology\_model (Image, MetrologyHandle)  
get\_metrology\_object\_result (MetrologyHandle, 0, 'all',\  
'result\_type', 'all\_param', Parameter)  
get\_metrology\_object\_result\_contour (Contour1, MetrologyHandle, 0, 'all', 1.5)  
dev\_set\_line\_width (3)  
dev\_set\_color ('red')  
dev\_display (Contour1)  
clear\_metrology\_model (MetrologyHandle)  
  
  
\* 清空屏幕，显式控制图像显示  
dev\_close\_window ()  
dev\_update\_off ()  
read\_image (Image, '1.png')  
dev\_open\_window\_fit\_image (Image, 0, 0, -1, -1, WindowHandle)  
dev\_display (Image)  
\* gen\_rectangle2 (ROI\_0, 180.346, 261.975, rad(-0.264078), 194.727, 120.459)  
\* 创建测量模型  
create\_metrology\_model (MetrologyHandle)  
Row1 := 180.346  
Column1 := 261.975  
Length1 := 194.727  
Length2 := 120.459  
Phi := rad(-0.264078)  
  
  
\* 添加找矩形工具，给定参数，显示过程卡尺  
add\_metrology\_object\_rectangle2\_measure (MetrologyHandle, Row1,\  
Column1, Phi, Length1, Length2, 12, 3, 1, 30, [], [], Index)  
get\_metrology\_object\_model\_contour (Contour, MetrologyHandle, 0, 1.5)  
get\_metrology\_object\_measures (Contours, MetrologyHandle, 'all', 'all', Row, Column)  
dev\_set\_color('cyan')  
dev\_display (Contour)  
dev\_display (Contours)  
  
\* 执行找矩形并显示结果  
apply\_metrology\_model (Image, MetrologyHandle)  
get\_metrology\_object\_result (MetrologyHandle, 0, 'all', 'result\_type',\  
'all\_param', Parameter)  
get\_metrology\_object\_result\_contour (Contour1, MetrologyHandle, 0, 'all', 1.5)  
dev\_set\_line\_width (3)  
dev\_set\_color ('red')  
dev\_display (Contour1)  
clear\_metrology\_model (MetrologyHandle)  
  
  
  
\* 清空屏幕，显式控制图像显示  
dev\_close\_window ()  
dev\_update\_off ()  
read\_image (Image, '1.png')  
dev\_open\_window\_fit\_image (Image, 0, 0, -1, -1, WindowHandle)  
dev\_display (Image)  
\* gen\_rectangle2 (ROI\_0, 138.007, 291.483, rad(-0), 21.4609, 21.0581)  
\* 创建测量模型  
create\_metrology\_model (MetrologyHandle)  
Row1 := 138.007  
Column1 := 291.483  
Length1 := 21.4609  
Length2 := 21.0581  
Phi := rad(-0)  
  
  
\* 添加找矩形工具，给定参数，显示过程卡尺  
add\_metrology\_object\_generic (MetrologyHandle, 'rectangle2', \  
[Row1, Column1, Phi, Length1, Length2], 12, 3, 1, 30, [], [], Index)  
get\_metrology\_object\_model\_contour (Contour, MetrologyHandle, 0, 1.5)  
get\_metrology\_object\_measures (Contours, MetrologyHandle, 0, 'all', Row, Column)  
dev\_set\_color('cyan')  
dev\_display (Contour)  
dev\_display (Contours)  
  
\* 添加找圆工具，给定参数，显示过程卡尺  
Row2 := 130.086  
Column2 := 143.525  
Radius := 20.9306  
add\_metrology\_object\_generic (MetrologyHandle, 'circle', \  
[Row2, Column2, Radius], 12, 3, 1, 30, [], [], Index1)  
get\_metrology\_object\_model\_contour(Contour2, MetrologyHandle, 1, 1.5)  
get\_metrology\_object\_measures (Contours3, MetrologyHandle, 1, 'all', Row3, Column3)  
dev\_set\_color ('green')  
dev\_display (Contour2)  
dev\_display (Contours3)  
  
dev\_set\_line\_width (3)  
\* 执行找矩形并显示结果  
apply\_metrology\_model (Image, MetrologyHandle)  
get\_metrology\_object\_result (MetrologyHandle, 0, 'all', 'result\_type',\  
'all\_param', Parameter1)  
get\_metrology\_object\_result\_contour (Contour1, MetrologyHandle, 0, 'all', 1.5)  
get\_metrology\_object\_result (MetrologyHandle, 1, 'all', 'result\_type',\  
'all\_param', Parameter2)  
get\_metrology\_object\_result\_contour (Contour3, MetrologyHandle, 1, 'all', 1.5)  
dev\_set\_color ('red')  
dev\_display (Contour1)  
dev\_display (Contour3)  
clear\_metrology\_model (MetrologyHandle)  
  
  
  
  
\* 清空屏幕，显式控制图像显示  
dev\_close\_window ()  
dev\_update\_off ()  
read\_image (Image, '1.png')  
dev\_open\_window\_fit\_image (Image, 0, 0, -1, -1, WindowHandle)  
dev\_display (Image)  
  
\*   
\* Matching 01: \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*  
\* Matching 01: 模型初始化  
\* Matching 01: \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*  
set\_system ('border\_shape\_models', 'false')  
  
\*   
\* Matching 01: 从基本区域构建ROI  
gen\_rectangle1 (ModelRegion, 41.9811, 50.1341, 322.331, 481.792)  
\*   
\* Matching 01: 从原图提取模型模板  
reduce\_domain (Image, ModelRegion, TemplateImage)  
\*   
\* Matching 01: 创建形状模板  
create\_shape\_model (TemplateImage, 5, rad(0), rad(360), rad(1),\  
['none','no\_pregeneration'], 'use\_polarity', [30,30,0], 10, ModelID)  
\*   
\* Matching 01: 获取模型轮廓，以便稍后将其转换为图像  
get\_shape\_model\_contours (ModelContours, ModelID, 1)  
\*   
\* Matching 01: 获取参考位置  
area\_center (ModelRegion, ModelRegionArea, RefRow, RefColumn)  
vector\_angle\_to\_rigid (0, 0, 0, RefRow, RefColumn, 0, HomMat2D)  
affine\_trans\_contour\_xld (ModelContours, TransContours, HomMat2D)  
\*   
\* Matching 01: 显示模型轮廓  
dev\_display (Image)  
dev\_set\_color ('green')  
dev\_set\_draw ('margin')  
dev\_display (ModelRegion)  
dev\_display (TransContours)  
stop ()  
\*   
\* Matching 01: 匹配形状模板  
find\_shape\_model (Image, ModelID, rad(0), rad(360), 0.5, 0, 0.5,\  
'least\_squares', [5,1], 0.75, Row, Column, Angle, Score)  
\*   
dev\_display (Image)  
for I := 0 to |Score| - 1 by 1  
 hom\_mat2d\_identity (HomMat2D)  
 hom\_mat2d\_rotate (HomMat2D, Angle[I], 0, 0, HomMat2D)  
 hom\_mat2d\_translate (HomMat2D, Row[I], Column[I], HomMat2D)  
 affine\_trans\_contour\_xld (ModelContours, TransContours, HomMat2D)  
 dev\_set\_color ('green')  
 dev\_display (TransContours)  
 stop ()  
endfor  
\* 创建测量模型  
create\_metrology\_model (MetrologyHandle)  
Row1 := 130.086  
Column1 := 143.525  
Radius := 20.9306  
  
\* 添加找圆工具，给定参数，显示过程卡尺  
add\_metrology\_object\_circle\_measure (MetrologyHandle, Row1, Column1,\  
Radius, 12, 3, 1, 30, [], [], Index)  
get\_metrology\_object\_model\_contour (Contour, MetrologyHandle, 0, 1.5)  
get\_metrology\_object\_measures (Contours, MetrologyHandle, 'all', 'all', Row3, Column3)  
dev\_set\_color('cyan')  
dev\_display (Contour)  
dev\_display (Contours)  
  
\* 执行找圆并显示结果  
apply\_metrology\_model (Image, MetrologyHandle)  
get\_metrology\_object\_result (MetrologyHandle, 0, 'all', 'result\_type',\  
'all\_param', Parameter)  
get\_metrology\_object\_result\_contour (Contour1, MetrologyHandle, 0, 'all', 1.5)  
dev\_set\_line\_width (3)  
dev\_set\_color ('red')  
dev\_display (Contour1)  
  
stop()  
  
\* 绑定测量卡尺到形状模板上  
set\_metrology\_model\_param (MetrologyHandle, 'reference\_system', [Row, Column, 0])  
  
\* 读取另一幅图片  
threshold (Image, Region, 0, 255)  
area\_center (Region, Area, Row5, Column5)  
hom\_mat2d\_identity (HomMat2D)  
hom\_mat2d\_rotate (HomMat2D, 0.2, Row5, Column5, HomMat2D)  
affine\_trans\_image (Image, ImageAffineTrans, HomMat2D, 'constant', 'false')  
\* read\_image (Image1, '3.png')  
find\_shape\_model (ImageAffineTrans, ModelID, rad(0), rad(360), 0.5,\  
0, 0.5, 'least\_squares', [5,1], 0.75, Row2, Column2, Angle1, Score1)  
align\_metrology\_model (MetrologyHandle, Row2, Column2, Angle1)  
get\_metrology\_object\_measures (Contours1, MetrologyHandle, 'all', 'all', Row4, Column4)  
dev\_clear\_window ()  
dev\_display (ImageAffineTrans)  
dev\_set\_line\_width (1)  
dev\_set\_color ('cyan')  
dev\_display (Contours1)  
\*模板匹配的同时测量圆的相关参数  
apply\_metrology\_model (ImageAffineTrans, MetrologyHandle)  
get\_metrology\_object\_result (MetrologyHandle, 0, 'all', 'result\_type',\  
'all\_param', Parameter1)  
get\_metrology\_object\_result\_contour (Contour2, MetrologyHandle, 0, 'all', 1.5)  
dev\_set\_line\_width (3)  
dev\_set\_color ('red')  
dev\_display (Contour2)  
clear\_metrology\_model (MetrologyHandle)  
clear\_shape\_model (ModelID)