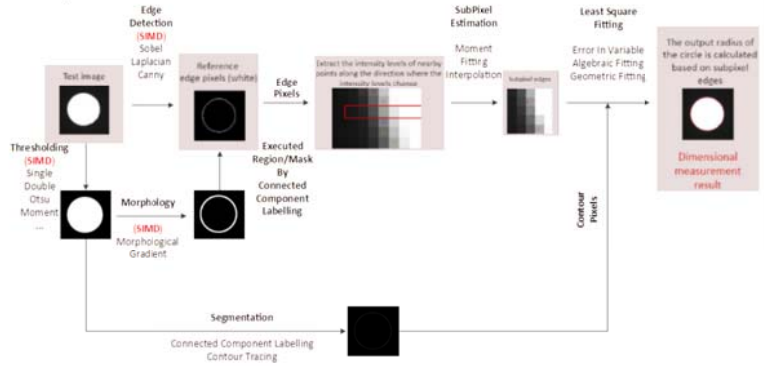
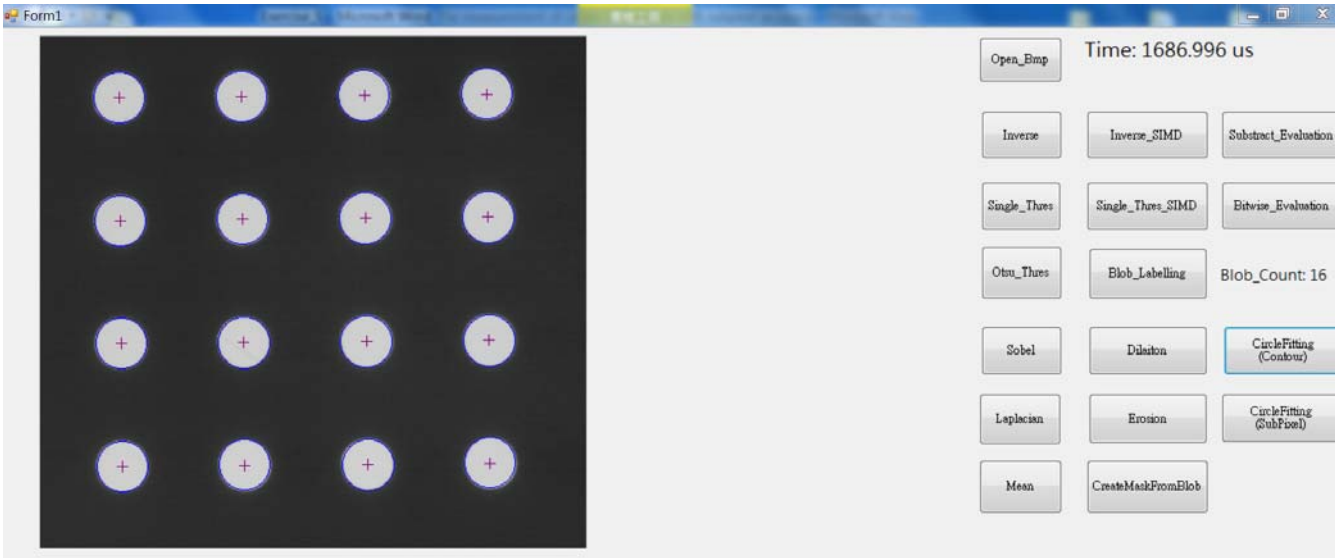


# Lab 17 Process of circle measurement

練習目的	提供的程式碼	需要的開發環境/安裝套件	執行指令與重點說明
<p><b>Process of circle measurement</b></p> <ol style="list-style-type: none"> <li><b>Subpixel estimation</b></li> <li><b>Circle fitting</b></li> <li><b>Measurement Process</b></li> </ol>	<p><b>VS2017/VS2022_C++:</b></p> <p>NImage.h, NImage.cpp NImgProcess.h NImgProcess.cpp NObject.h, NObject.cpp NGauge.h, NGauge.cpp</p> <p>NImageDLL.h NImageDLL.cpp NImgProcessDLL.h NImgProcessDLL.cpp NObjectDLL.h NObjectDLL.cpp NGaugeDLL.h NGaugeDLL.cpp</p>	<p>Visual Studio 2017 以上</p> <p>The procedures of circle measurement are shown below.</p>  <p>The flowchart illustrates the circle measurement process. It starts with 'Test Image' leading to 'Edge Detection (SMD) Sobel Laplacian Canny'. This leads to 'Reference edge pixels (white)' and 'Edge Pixels'. 'Edge Pixels' leads to 'Extract the intensity levels of nearby points along the direction where the intensity levels change'. This leads to 'Subpixel Estimation' and 'Moment Fitting Interpolation'. 'Subpixel Estimation' leads to 'Least Square Fitting' and 'Error in Variable Algebraic Fitting Geometric Fitting'. 'Moment Fitting Interpolation' leads to 'Isolated edges'. 'Least Square Fitting' leads to 'The output radius of the circle is calculated based on subpixel edges'. 'Isolated edges' leads to 'Contour Pixels'. 'Contour Pixels' leads to 'Segmentation Connected Component Labelling Contour Tracing'. 'Segmentation Connected Component Labelling Contour Tracing' leads to 'Executed Region/Mask By Connected Component Labelling'. 'Executed Region/Mask By Connected Component Labelling' leads to 'Morphology Morphological Gradient'. 'Morphology Morphological Gradient' leads to 'Thresholding (SMD) Single Double Otsu Moment'. 'Thresholding (SMD) Single Double Otsu Moment' leads to 'Test Image'.</p>	<p><b>NImage.h, NImage.cpp</b> <b>NImageDLL.h</b> <b>NImageDLL.cpp</b></p> <p>✓ 新增 CreateImage (wid, hei) 函式。</p> <p><b>NImgProcess.h</b> <b>NImgProcess.cpp</b> <b>NImgProcessDLL.h</b> <b>NImgProcessDLL.cpp</b></p> <p>✓ 新增 Dilation 及 Erosion 函式。</p> <p>✓ 修改 OtsuThresholding 內容。</p>

	<b>VS2017/VS2022_C#:</b> MyApp Project NImage.cs NImgProcess.cs NObject.cs NGauge.cs		<b>NObject.h NObject.cpp</b> <b>NObjectDLL.h</b> <b>NObjectDLL.cpp</b>  ✓ 新 增 CreateMaskFromObject 函 式。 ✓ 用以產生二值化遮罩。  <b>NGauge.h, NGauge.cpp</b> <b>NGaugeDLL.h</b> <b>NGaugeDLL.cpp</b>  ✓ 新 增 SubPixel_EdgeDetector 函 式。 ✓ 請參考專利「 <b>Apparatus          and method for detecting          and sub-pixel location of          edges in a digital image</b> 」 ✓ 請參考論文「 <b>An Isotropic          3 x 3 Image Gradient</b> 」
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			<p><b>Operator】</b>。</p> <ul style="list-style-type: none"> <li>✓ 新增 CircleFitByKasa 函式。</li> <li>✓ 請參考論文 “<b>A circle fitting procedure and its error analysis</b>”。</li> </ul> <p><b>MyApp Project</b></p> <ul style="list-style-type: none"> <li>✓ Circle measure (Contour tracing).</li> <li>✓ Circle measure (SubPixel Edge Detector).</li> </ul>
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練習目的	執行結果
<p><b>Process of circle measurement</b></p> <ol style="list-style-type: none"> <li>1. CircleFitting (Contour Tracing)</li> <li>2. CircleFitting (SubPixel Edge Detector)</li> </ol>	<p><b>CircleFitting (Contour Tracing)</b></p>  <p>The screenshot shows a software application window titled 'Form1'. On the left, there is a 4x4 grid of 16 white circles, each with a small red crosshair in the center. To the right of the grid is a control panel with various buttons and a 'Time: 1686.996 us' display. The buttons include 'Open_Bmp', 'Inverse', 'Inverse_SIMD', 'Subtract_Evaluation', 'Single_Thres', 'Single_Thres_SIMD', 'Bitwise_Evaluation', 'Otsu_Thres', 'Blob_Labelling', 'Blob_Count: 16', 'Sobel', 'Dilation', 'CircleFitting (Contour)', 'Laplacian', 'Erosion', 'CircleFitting (SubPixel)', 'Mean', and 'CreateMaskFromBlob'. The 'CircleFitting (Contour)' button is highlighted with a blue border.</p>

### CircleFitting (SubPixel Edge Detector)



## Comparison of Contour and SubPixel Edge Detector in Circle Fitting

