# **Code reproduction documentation**

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# Catalogue

#### 1. Software and library requirements

The following software needs to be installed before running Demo\_WSWTNN\_PnP:

Matlab 2018a Matconvnet Visual Studio 2015 CUDA 9.0 CUDNN v7.6.5 Computer system: Windows 10, Intel Core i7-10870H CPU (2.20 GHz), RTX 2060

(Note: For computers with different performance and different versions of matlab, the CUDA version should be different. You need to select the version of CUDA and CUDNN according to your computer.)

#### 2. Download software

### 2.1. MATLAB

MATLAB 2018a: <u>https://pan.baidu.com/s/1Rl2pv0cGv27skG\_02Dtjgw</u> [key]: z6so

#### 2.2. Matconvnet

Matconvnet: <u>https://www.vlfeat.org/matconvnet/</u> Place the matconvnet-1.0-beta25 file under MATLAB/R2018a/toobox in the MATLAB 2018a installation location as shown in Fig. 2.1 below:

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	📜 matconvnet-1.0-beta25	2021/5/1 10:29	文件夹	
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) (F.)	📕 nnet	2021/4/15 22:54	文件夹	

Figure 2.1

### 2.3. Visual Studio

Visual Studio 2015: <u>https://pan.baidu.com/s/1bkEexqA8rMiEaTcYkcQdfg</u> [key]: 5pd5

## **2.4. CUDA**

CUDA 9.0 https://docs.nvidia.com/cuda/cuda-quick-start-guide/index.html The steps for configuring CUDA are as follows: https://docs.nvidia.com/cuda/cuda-quick-start-guide/index.html

## **2.5. CUDNN**

CUDNN v7.6.5: <u>https://developer.nvidia.com/rdp/cudnn-archive</u> The steps for configuring CUDNN are as follows: <u>https://docs.nvidia.com/deeplearning/cudnn/install-guide/index.html#install-windows</u>

# **3.** Experimental environment construction process

#### **3.1 CPU compilation**

(1) Add matconvnet-1.0-beta25 and its sub files to D:\Program Files (x86)\MATLAB\R2018a\toolbox

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Figure 3.1

(2) Enter mex-setup in the MATLAB command line window to see if mex-setup C++ appears. If no mex-setup C++ appears, Visual Studio 2015 is not successfully installed

```
>> clear all
>> mex -setup
MEX 配置为使用 'Microsoft Visual C++ 2015 (C)' 以进行 C 语言编译。
警告: MATLAB C 和 Fortran API 已更改,现可支持
    包含 2<sup>32-1</sup> 个以上元素的 MATLAB 变量。您需要
    更新代码以利用新的 API。
    您可以在以下网址找到更多的相关信息:
    https://www.mathworks.com/help/matlab/matlab_external/upgrading-mex-files-to-use-64-bit-api.html.
要选择不同的语言,请从以下选项中选择一种命令:
 mex -setup C++
 mex -setup FORTRAN
MEX 配置为使用 'Microsoft Visual C++ 2015' 以进行 C++ 语言编译。
警告: MATLAB C 和 Fortran API 已更改,现可支持
    包含 2<sup>32-1</sup> 个以上元素的 MATLAB 变量。您需要
    更新代码以利用新的 API。
    您可以在以下网址找到更多的相关信息:
    https://www.mathworks.com/help/matlab/matlab_external/upgrading-mex-files-to-use-64-bit-api.html.
MEX 配置为使用 'Microsoft Visual C++ 2015' 以进行 C++ 语言编译。
警告: MATLAB C 和 Fortran API 已更改,现可支持
    包含 2<sup>32-1</sup> 个以上元素的 MATLAB 变量。您需要
    更新代码以利用新的 API。
    您可以在以下网址找到更多的相关信息:
    https://www.mathworks.com/help/matlab/matlab_external/upgrading-mex-files-to-use-64-bit-api.html.
>> v1_compilenn
```

Figure 3.2

My Visual Studio 2015 installation path: C:\Program Files (x86)\VS 2015\professional

(Note: Add the installation directory to the Path of the environment variable  $\rightarrow$  system variable.)

	值
OneDrive	C:\Users\12978\OneDrive
OneDriveConsumer	C:\Users\12978\OneDrive
Path	C:\Users\12978\AppData\Local\Microsoft\WindowsApps;
TEMP	C:\Users\12978\AppData\Local\Temp
TMP	C:\Users\12978\AppData\Local\Temp
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統变量(S) 变量 ComSpec CUDA_PATH CUDA_PATH_V9_0 DriverData NUMBER_OF_PROCESSORS	值 C:\windows\system32\cmd.exe C:\Program Files\NVIDIA GPU Computing Toolkit\CUDA\v9.0 C:\Program Files\NVIDIA GPU Computing Toolkit\CUDA\v9.0 C:\Windows\System32\Drivers\DriverData 16
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Figure 3.3

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NN	C:\Program Files (x86)\NVIDIA Corporation\PhysX\Common	
Dr	%LISEPDPOEILE%) day/bin	

Figure 3.4

(3) Enter vl\_compilenn in the command line window of MATLAB, vl\_compilenn is successfully compiled.

```
>> v1_compilenn
  使用 'Microsoft Visual C++ 2015' 编译。
  MEX 已成功完成。
  使用 'Microsoft Visual C++ 2015' 编译。
fx MEX 已成功完成。
```



(4) Enter test command vl\_testnn in the command line window of MATLAB. vl\_testnn is successfully compiled.

>> v1\_testnn

正在运行 nnspnorm

正在设置 nnspnorm[dataType=single, device=cpu] 设置 nnspnorm[dataType=single, device=cpu] 在 0.0031351 秒内完成 正在运行 nnspnorm[dataType=single, device=cpu]/basic nnspnorm[dataType=single, device=cpu]/basic 在 0.75398 秒内完成 正在拆解 nnspnorm[dataType=single, device=cpu] 拆解 nnspnorm[dataType=single, device=cpu] 在 0 秒内完成 nnspnorm 在 0.75711 秒内完成

\_\_\_\_\_

result =

1×1793 <u>TestResult</u> 数组 - 属性:

Name Passed Failed Incomplete Duration Details 总计:

> 1793 Passed, O Failed, O Incomplete. 135.0925 秒测试时间。

> > Figure 3.6

Fig 3.6 shows that without using CUDA and CUDNN to drive the GPU, the CPU is used alone to run the program compiled by matconvnet.

#### 3.2 GPU compilation

First, look at the computer's CUDA device properties and enter gpuDevice in the MATLAB command line window:

```
>> gpuDevice
ans =
  <u>CUDADevice</u> - 属性:
                      Name: 'NVIDIA GeForce RTX 2060'
                     Index: 1
         ComputeCapability: '7.5'
            SupportsDouble: 1
             DriverVersion: 11.6000
            ToolkitVersion: 9
        MaxThreadsPerBlock: 1024
          MaxShmemPerBlock: 49152
        MaxThreadBlockSize: [1024 1024 64]
               MaxGridSize: [2.1475e+09 65535 65535]
                 SIMDWidth: 32
               TotalMemory: 6.4421e+09
           AvailableMemory: 5.2690e+09
       MultiprocessorCount: 30
              ClockRateKHz: 1200000
               ComputeMode: 'Default'
      GPUOverlapsTransfers: 1
    KernelExecutionTimeout: 1
          CanMapHostMemory: 1
           DeviceSupported: 1
```

Figure 3.7

## 3.1.1 Install CUDA

Follow the steps on the official website to install CUDA: https://docs.nvidia.com/cuda/cuda-quick-start-guide/index.html

Quick Start Guide (PDE) - v11.8.0 ( <u>plder</u> ) - Last updated October 3, 2022 - <u>Send Feedback</u>
CUDA Quick Start Guide Minimal first-steps instructions to get CUDA running on a standard system.
1. Introduction This guide covers the basic instructions needed to install CUDA and verify that a CUDA application can run on each supported platform.
These instructions are intended to be used on a clean installation of a supported platform. For questions which are not answered in this document, please refer to the Windows Installation Guide and Linux Installation Guide.
The CUDA installation packages can be found on the CUDA Downloads Page.
2. Windows When installing CUDA on Windows, you can choose between the Network Installer and the Local Installer. The Network Installer allows you to download only the files you need. The Local Installer is a stand-alone installer with a large initial download. For more details, refer to the Windows Installation Guide.
2.1. Network Installer Perform the following steps to install CUDA and verify the installation.
<ol> <li>Launch the downloaded installer package.</li> <li>Read and accept the EULA.</li> <li>Select "next" to download and install all components.</li> <li>Once the download completes, the installation will begin automatically.</li> <li>Once the installation completes, click "next" to acknowledge the Nsight Visual Studio Edition installation summary.</li> <li>Click "close" to close the installer.</li> <li>Navigate to the Samples' indoyd directory in <u>https://github.com/IVIDIA/cuda-samples/tree/master/Samples/5. Domain. Specific/nbody</u>.</li> <li>Open the <u>inbody</u> Visual Studio solution file for the version of Visual Studio you have installed, for example, <u>inbody_vs2019.sln</u>.</li> </ol>

Figure 3.8



Figure 3.9



GPUOverlapsTransfers: 1

Figure 3.10



Figure 3.11

Open the nbody Visual Studio solution file for the version of Visual Studio you have installed. Then, Open the 'Build'menu within Visual Studio and click 'Build Solution'.

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	781 5100 (5)	nbody_vs2012.sdf	2022/10/12 15:27	SQL Server Com	43
	🥪 ZAT STZG (F:)	nbody_vs2012.sln	2017/9/3 0:32	Microsoft Visual	
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		nbody_vs2013.sln	2017/9/3 0:32	Microsoft Visual	
		nbody_vs2013.vcxproj	2022/10/12 12:15	VC++ Project	
		nbodv vs2015.sln	2017/9/3 0:32	Microsoft Visual	>
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Figure 3.12

Open nbody\_Vs2010. sln as follows:

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Figure 3.13

#### Open nbody\_vs2012. sln as follows:



Figure 3.14

#### Open nbody\_vs2013. sln as follows:

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Figure 3.15

Navigate to the CUDA Samples' build directory and run the nbody sample. Note: Run samples by navigating to the executable's location, otherwise it will fail to locate dependent resources.

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Figure 3.16 (图 3.16)

The execution results are as follows:

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Figure 3.17

The results in Figure 3.17 show that the CUDNN library is installed successfully, and the GPU is used to speed up the operation.

### **3.1.2 Install CUDNN**

Follow the steps on the official website to install CUDNN: <u>https://docs.nvidia.com/deeplearning/cudnn/developer-guide/index.html</u>

NVIDIA CUDNN DOCUMENTATION
3.2. Downloading cuDNN for Windows In order to download cuDNN, ensure you are registered for the <u>NVIDIA Developer Program</u> .
Procedure
1. Go to: NVIDIA cuDNN home page.
2. Click Download.
3. Complete the short survey and click Submit.
4. Accept the Terms and Conditions. A list of available download versions of cuDNN displays.
5. Select the cuDNN version that you want to install. A list of available resources displays.
6. Download the cuDNN package for Windows (zip).
3.3. Installing on Windows
The following steps describe how to build a cubin dependent program.
About this task
You must replace 8.x and 8.x.y.z with your specific cuDNN version.
Package installation (zip)
In the following steps, the package directory path is referred to as <pre>spackagepath&gt;</pre> .
Procedure
1. Navigate to your <packagepath> directory containing the cuDNN package.</packagepath>
2. Unzip the cuDNN package. cumm-windows-x80_04archive.zip
<ol> <li>Copy the following files from the unzipped package into the NVIDIA cuDNN directory.</li> <li>a. Copy bin/cudnn*.dll to C:\Program Files\NVIDIA\CUDNN\v8.x\bin.</li> </ol>
b. Copy include\cudnn*.h to C:\Program Files\WIDIA\CUDNN\v8.x\include.
c.Copy lib/cudnn*.lib to C:\Program Files\NVIDIA/CUDNN/v8.x\lib.
4. Set the following environment variable to point to where cuDNN is located. To access the value of the \$(PATH) environment variable, perform the following steps: a. Open a command prompt from the Start menu.
b. Type Run and hit Enter.
c. Issue the control sysdm.cpl command.
d. Select the Advanced tab at the top of the window.
e. Click Environment Variables at the bottom of the window,
f. Add the NVIDIA cuDNN bin directory path to the PATH variable:
Variable Name: PATH Value to Add: C:\Frogram Files\WVIDIA\CUDUN\v6.x\bin
5. Add rufNN to your Visual Studio protect
a. Open the Visual Studio project, right-click on the project name in Solution Explorer, and choose Properties.
b. Click VC++ Directories and append C:\Program Files\WUDIA\CUDMN\V6.x\include to the Include Directories field.
c. Click Linker > General and append C: VProgram Files/WNDIACUDMNV6.xX1b to the Additional Library Directories field.
c. Lick Linker > Input and append cudnn.lib to the Additional Dependencies field and click OK.
3.4. Uperading cuDNN having cuDNN and delete the old cuDNN bin, 11b, and header files. Remove the path to the directory containing cuDNN from the \$(PATH) environment variable. Reinstall a newer cuDNN version by following the steps in berailling on Whoden

Figure 3.18

Execute the following code in MATLAB:

#### (1) Enter mex-setup c++ in the MATLAB command line window.

Figure 3.19

(2) Enter vl compilenn ('enableGpu', true, ...'cudaRoot', 'C:\Program Files\NVIDIA

GPU Computing Toolkit\CUDA\v9.0', ... % Installation path of CUDA 'cudaMethod', 'nvcc', 'enableCudnn', 'true', ... 'cudnnRoot', 'C:\Program Files\NVIDIA GPU Computing Toolkit\CUDNN\cudnn-9.0-windows10-x64-v7\cuda'); % Installation path of CUDNN

>> mex -setup c++
MEX 配置为使用 'Microsoft Visual C++ 2015' 以进行 C++ 语言编译。
警告: MATLAB C 和 Fortran API 已更改,现可支持
 包含 2^32-1 个以上元素的 MATLAB 变量。您需要
 更新代码以利用新的 API。
 您可以在以下网址找到更多的相关信息:
 <u>https://www.mathworks.com/help/matlab/matlab\_external/upgrading-mex-files-to-use-64-bit-api.html</u>。
>> vl\_compilenn('enableGpu', true, ...
'cudaRoot', 'C:\Program Files\NVIDIA GPU Computing Toolkit\CUDA\v9.0', ... % CUDA的安装路径
'cudaMethod', 'nvcc', 'enableCudnn', 'true', ...
'cudnnRoot', 'C:\Program Files\NVIDIA GPU Computing Toolkit\CUDNN\cudnn-9.0-windows10-x64-v7\cuda'); % cuDNN的路径

Figure 3.20

The compilation results are as follows:

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^	c:\program files\nvidia gpu computing toolkit\cuda\v9.0\include\crt\math_functions.h(6229): warning C4819: 该文件包含不能在当前代码页(936)中表示的字符。请将该文
	c:\program files\nvidia gpu computing toolkit\cuda\v9.0\include\crt\math_functions.h(7104): warning C4819: 该文件包含不能在当前代码页(936)中表示的字符。请将该文/
	c:\program files\nvidia gpu computing toolkit\cuda\v9.0\include\crt\math_functions.h(7914): warning C4819: 该文件包含不能在当前代码页(936)中表示的字符。请将该文
	使用 'Microsoft Visual C++ 2015 (C)' 编译。
	MEX 已成功完成。
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	MEX 已成功完成。
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	使用 'Microsoft Visual C++ 2015 (C)' 编译。
	MEX 已成功完成。

Figure 3.21

(3) Enter run vl\_setupnn in the command line window of MATLAB (在 MATLAB 的命令行窗口中输入 run vl\_setupnn)

使用 'Microsoft Visual C++ 2015 (C)' 编译。 MEX 已成功完成。 fx >> run v1\_setupnn

Figure 3.22

(4) Enter vl\_testnn('gpu', true) on the command line window of MATLAB

```
使用 'Microsoft Visual C++ 2015 (C)' 编译。
MEX 已成功完成。
>> run v1_setupnn
>> v1_testnn('gpu', true)
fx
```

```
Figure 3.23
```

vl_nnnormalizelp.mexw64     vl_nnpool.mexw64     vl_nnroipool.mexw64     vl_taccummex.mexw64     vl_taccummex.mexw64     vl_taccummex.mexw64     vl_taccummex.mexw64     vl_nnbnorm.mexw64     (MEX 文件)     个     /作区     ⑦			× <	result =	
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Figure 3.24

Fig 3.24 shows that the matconvnet test code runs successfully in the GPU environment.

After the compilation of CPU and GPU, you can run the code of WSWTNN-PnP.

## 4. Run the WSWTNN-PnP method code

#### 4.1 Code download:

website: https://github.com/LiuTing20a/WSWTNN-PnP1

#### 4.2 Run Demo\_WSWTNN\_PnP

The code is running::

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🗄 📕 FFDNet			2	96	Correspo	onding Contr	ibutor: Ting Liu	(Email:	: liuting@nudt.edu.cn)			
🕀 📕 Figs1			3	96	Author A	fflications	: National Univer	sity of	f Defense Technology, China			
functions			4	96	To run t	he code, yo	u should install	Matconv	vnet first.			
tensor tool	hox-v3 1		5 % Written by Ting Liu									
WSWTNNte	TNNtool				6 % 2022-10-16							
Demo_WSV	VTNN_PnP.m			7 - tic;								
				8 -	cl	c;						
				9 -	cl	ear;						
				10 -	cl	ose all;						
				11 -	ad	dpath(1	CUNCTIONS/ )			% Add path		
				13 -	au	woDir= '	WCWTNN-F	/ mP公开\moculte\1\	× .	6 save patch		
				14 -	im	gnath='	\WSWTNN-Pr	P公开\data\1\':		6 Data input nath		
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				16	59	patch	parameters	1				
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				18 -	sl	ideStep	=40;	% sliding step				
				19 -	la	nbdaL =	0.8;	% L				
				20 -	le	n = leng	th(imgDir);	% The length of	ingDir			
				21 -	21 - 🖓 for i=1:len							
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				命令行	窗口							
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				it	er 8,	nu=0.00	2, err=0.04	5564,  T 0 = 20				
				it	er 9,	nu=0.00	2, err=0.02	295,  T 0 = 15				
				it	er 10	mu=0.0	02, err=0.0	46826,  T 0 = 13				
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Figure 4.1

Experimental results in the process of code running are shown as follows:

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I WSWTNNtool	6 % 2022-10-16	
Demo_WSWTNN_PnP.m	i = tic;	
	10 - close all:	
	11 - addpath('functions/')	
	12 - addpath('WSWINHtool/')	
	13 - saveDir='\WSWINN-PnP公开\results	
	14 - ingpath='\WSWINH-PnP公开\data\1\'	
	15 - imgDir = dir([imgpath '*. bmp']); mgp	ath
	16 %% patch parameters	
	17 - patchSize =40; % patch size	
	18 - slidestep = 40; % sliding step	
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	21 - [for jel]en	
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	$ter 2$ , $m = 0.002$ , $er = 0.1451$ , $ T _0 = 57$	
	iter 4, mu=0.002, err=0.12344, $ T 0 = 57$	
	iter 1, mu=0.002, err=0.29333,  T 0 = 23558	
	iter 2, mu=0.002, err=0.50786,  T 0 = 59	
详细信息	^ iter 3, mu=0.002, err=0.14539,  T 0 = 55	
工作区		
名称 ▲ 值 最大值	iter 1, mu=0.002, err=0.29284,  T 0 = 23525	
A 150x200 uint8 211	1ter 2, mu=0.002, err=0.50828, [T]0 = 53	
backing 150x200 double 199.0777	iter 5, mu=0.002, err=0.14559, $ 1 0  = 48$	
cornerStren 150x200 double 63.3211	iter 5 mu=0.002 err=0.21741 $ T 0 = 42$	
E 750x200 uint8 211	iter 6, mu=0.002, err=0.20117,  T 0 = 38	
img 150x200 double 211	iter 7, mu=0.002, err=0.12682,  T 0 = 32	
imgDir 110x1 struct	$\vee f_{x}$	
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Figure 4.2

#### Code running completed:

A MATLAB R201	8a									
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当前文件夹				🖉 编辑器	∦ - D:\3	60安全涉	刘览器下载	獻光场图像目标检测\红外图像小目标检测\WSWTNN-PnP公开\Demo_WSWTNN_PnP.m		
□ 名称▲				Den	no_WSV	VTNN_P	PnP.m >	trpca_WSWTNNpnp.m 🗙 🕂		
<ul> <li>● 呑称▲</li> <li>● GEDNet</li> <li>● FFDNet</li> <li>● Figs1</li> <li>● functions</li> <li>● results</li> <li>● tensor_toolbox-v3.1</li> <li>● WSWTNNtool</li> <li>● Demo_WSWTNN_PnP.m</li> </ul>				55 - 34 35 - 36 - 37 - 38 - 39 - 40 - 41 - 42 - 43 - 43 - 44 - 45 - 46 - 47 - 48 - 49 - 50 - 51 -	<pre>lineword, iseword, = Structure_tensor_remove(img, S), % step 2: calculate corner strength function cornerStrength = (((lambdal.Hambda2).((lambdal.Hambda2))); % step 3: obtain final weight asp maxYalue = (max(lambdal.hambda2).(Select the maximum of lambdal and lambda2 priorWeight = mat2gray(cornerStrength .* maxYalue); % step 4: construct path tensor of weight map tenW = gen_patch_ten(priorWeight, patchSize, slideStep); % The proposed VSUTENP-PnP model lambda4 = lambdaL / sqrt(max(nl,n2)*n3); % regularization term [tenB, tenT] = trpca_VSUTENP-PnP model % recover the target and background image tarImg = res_patch_ten_mean(tenB, img, patchSize, slideStep); % recover target image backImg = res_patch_ten_mean(tenB, img, patchSize, slideStep); % recover target image max = max(max(double(img))); E = uint8(mat2gray(tarImg)*maxv); % target image % save the results is mine(f [ Low_DB( lawbda*); % Dackground image % save the results </pre>					
				52 —	im	write(A	A, [savel	Dir 'background/' imgDir(i).name]); % Save background image		
				53 —	end					
				54 —	toc;					
				命令行窗						
				iter 1, mu=0.002, err=0.013147,  T 0 = 36 iter 14, mu=0.002, err=0.038816,  T 0 = 36 iter 1, mu=0.002, err=0.23932,  T 0 = 23498 iter 2, mu=0.002, err=0.50735,  T 0 = 78						
详细信息			^	iter	3, <b>n</b> u=	0.002,	err=0.14	4522,  T 0 = 70		
工作区			۲	iter	4, nu=	0.002,	err=0.12	2339,  T 0 = 67		
名称▲	值	最大值		iter	o, nu≕	0.002,	err=0.21	173, 110 = 62		
A backImg cornerStren E i i i i i i i i i i j i i i i i i i i	150x200 uint8 150x200 double 150x200 double 150x200 uint8 110 150x200 double 110x1 struct	211 199.0777 63.3211 211 110 211	~	iter iter iter iter 时间i fx >>	5, nu= 7, nu= 8, nu= 9, nu= 10, nu= 已过 44.	0.002, 0.002, 0.002, 0.002, =0.002, 572040	err=0.20 err=0.12 err=0.04 err=0.02 err=0.0 秒。	N099,  10 = 30 2672,  T 0 = 48 5128,  T 0 = 44 22826,  T 0 = 42 246793,  T 0 = 42		
.				• • • •						

Figure 4.3



The experimental results are stored in the folder

Figure 4.4