Optical Flow OpenCV Implementation

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1. Introduction

- It is an implementation of optical flow algorithm with OpenCV and Visual Studio 2017 (any Visual Studio version can be used, but better to get VS2017) using VC++.
- This guide shows steps for VS2017 with OpenCV 2.4.9 on Windows 10. (We recommend you to do this assignment with the same versions to avoid any unexpected errors/issues)

• Implementation can run either real time to track moving objects (using webcam) or between two frames.

Visual Studio 2017 - Installation

Download the Visual Studio 2017 (Community version) from the following link: <u>https://visualstudio.microsoft.com/downloads/</u>

(For Mac OS, select MacOS from the top right of this webpage (see purple arrow))

Downloads





Version: 15.8

Release notes

Compare editions

How to install offline

Visual Studio 2017

Full-featured integrated development environment (IDE) for Android, iOS, Windows, web, and cloud

Community	Professional	Enterprise		
Powerful IDE, free for students, open-source contributors, and individuals	Professional IDE best suited to small teams	Scalable, end-to-end solution for teams of any size		
Free download 🕹	Free trial 🕹	Free trial 🛃		
Download Preview >	Download Preview >	Download Preview >		



Release notes

Visual Studio Code

The fast, free and open-source code editor that adapts to your needs

Free download 🕹

By downloading and using Visual Studio Code, you agree to the license terms and privacy statement.

Visual Studio 2017 - Installation

Open the installer once it has been downloaded.

Follow through the instructions till you reach to this window:



Visual Studio 2017 - Installation

- Select the following Workloads:
 - .NET desktop development
 - Desktop development with C++
 - Universal Windows Platform development
 - Visual Studio Extension development
- Then select "**Install while downloading**" option from dropdown button at the bottom right of the opened window.
- Click the **install** button.
- It might take longer depending on the computer (for a 64-bit CORE i3 machine with 4GB RAM, it took couple of hours at least).
- You will need to reboot your machine once everything is installed.



2. OpenCV

• OpenCV (Open Source Computer Vision Library) is an open source computer vision and machine learning software library.

• OpenCV was built to provide a common infrastructure for computer vision applications and to accelerate the use of machine perception in the commercial products.

 The library has more than 2500 optimized algorithms, which includes a comprehensive set of both classic and state-of-the-art computer vision and machine learning algorithms.



- These algorithms can be used to:
 - $\circ\,$ detect and recognize faces,
 - identify objects,
 - classify human actions in videos,
 - track camera movements,
 - track moving objects,
 - extract 3D models of objects,
 - produce 3D point clouds from stereo cameras,
 - \circ etc.











 It has C++, C, Python, Java and MATLAB interfaces and supports Windows, Linux, Android and Mac OS.





3. Downloading the Required Software

 Download from (opencv.org) or any other website that offers the download. You can download from the given link below:

<u>http://sourceforge.net/projects/opencvlibrary/files/</u> <u>opencv-win/2.4.9</u>

• For this tutorial, version 2.4.9 will be used.

4. Installing OpenCV

- Installation requires about 4GB of free disk space.
- Run the downloaded executable file (Note that the OpenCV installer simply creates a folder named "opencv" in the chosen "Extract to:"directory).

&	7-Zip self-extracting archive	×
Extract to:		
	Extract Cance	1

 You should choose an extraction directory that is safe, accessible, and unlikely to change. This guide uses an "Extract to:" directory of "C:\".

8 6	1% Ext	1% Extracting			
		2			
Elapsed time:	00:00:10	Total size:		3810 MB	
Remaining time:	00:08:44	Speed:		7304 KB/s	
Files:	0	Processed:		72 MB	
Compression ratio:		Compressed size:			



• When it closes, confirm that the **opencv** directory was created in your **Extract to:** directory of choice:

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★ Favorites	퉬 Program Files	11/9/2014 3:44 PM	File folder
🗥 OneDrive	퉬 Program Files (x86)	11/16/2014 9:44 AM	File folder
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in This PC	퉬 Windows	11/17/2014 10:28	File folder
🖶 Network	퉬 Windows.old	11/9/2014 6:36 PM	File folder
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• Then, go to https://www.dropbox.com/login and then sign in using the following information:

Email: robot.vision.files@gmail.com ,

and Password: robotvision

Download the OpticalFlow_vs.zip file on your computer.
 Note: This folder contains the implementation for Optical Flow assignment.

5. Start a new Visual C++ Project for Optical Flow File -> New -> Project

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	Save Selected Items	Ctrl+S		Get Started	1
	Save Selected Items As				Get code from a rer open something or
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	Source Control	•		Maximize your productivity with these tip:	
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	Recent Files	•			🐴 Open Folder
	Recent Projects and Solutions	•			🍅 Open Website
	Exit	Alt+F4		Recent	

- Visual C++ -> Windows Console Application
- Write the name you choose for the project. For example, Optical_Flow
- Then, Press OK.

Numbers with arrows in the figure shows steps.



You will see the following window, when the project has been successfully created.



• Then, close the project.

• File -> Close Solution

M	Optical_Flow - Microsoft Visual Studio	o Preview									PREVIEW		7 🗗 🤇	Quick Launch (Ct	trl+Q)
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• Copy the following files (listed on next slide)

From: OpticalFlow_vs directory (the extracted zip file you have already downloaded from the Dropbox).

<the directory that contains the extracted zip file>\ OpticalFlow_vs\OpticalFlow_vs\OptiFlow

For example, C:\OpticalFlow_vs\OpticalFlow_vs\OpticalFlow_vs\OptiFlow

 $\underline{\textbf{To:}}$ the project folder

- <the new project directory>\Optical_Flow\Optical_Flow
- For example, C:\Users\Vision\source\repos\Optical_Flow\Optical_Flow

between.h	between.cpp	image0.jpg
common.h	cv_pyrlk.cpp	image1.jpg
resource.h	main.cpp	stdafx.h
Tracker.h	Tracker.cpp	stdafx.cpp
targetver.h		

• In the new project directory, perform the following steps:

- 1. Delete the cpp file that contains the main function (its name is the same as the project name).
- For example, delete
- C:\Users\Vision\source\repos\Optical_Flow\Optical_Flow\Optical_Flow .cpp

2. Rename main.cpp to be the same name as the deleted file.

<u>Copy all dll files</u>

From the following directory:

<OpenCV install directory>\build\\x86\vc11\bin

For example, C:\opencv\build\x86\vc11\bin

<u>To</u>

<the new project directory>\Optical_Flow\Optical_Flow

For example, C:\Users\Vision\source\repos\Optical_Flow\Optical_Flow

- Then, open the project again.
- File -> Open -> Project/Solution

×	Start Page - Microsoft Visual Studio Preview								
File	File Edit View Project Debug Team Tools Test Analyze Window Help								
	New	•	-	x86 👻 🕨	Attach Auto	× 🎜 🚽			
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	Save Selected Items As		2	File	Ctrl+O				
2 ⁰	Save All	Ctrl+Shift+S		Convert					
	Source Control	•	—	Maximize your	productivity with these tips and	tricks for Visual Studio			
	Page Setup			Take advantage	of the newest technologies to d	leploy beautiful, low-cost and			
	Print	Ctrl+P		reliable website					
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	Recent Files	•							
	Recent Projects and Solutions	•							
	Exit	Alt+F4		Rece	nt				
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Select the **Optical_Flow.sln** file from the newly created Optical_Flow project directory. Click **Open.**

🔀 Open Project					×
← → ∽ ↑ 🔒 > Vision	> source > repos > Optical_Flow >	~ Č	Search Optical_FI	ow	9
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∧ N A Quick access	lame ^	Date modified	Туре	Size	
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📃 Desktop 🖈	Optical_Flow	10/31/2018 9:42 PM	File folder		
🚽 🕂 Downloads 🖈 🛛	Coptical_Flow	10/31/2018 9:15 PM	Microsoft Visual S	2 KB	
Documents Pictures Optical_Flow Optical_Flow_fir: OpticalFlow_vs OptiFlow Microsoft Visual S repos					
File name:	Optical_Flow		 ✓ All Project Files (Open 	(*.sln;*.dsw;*.vc Cancel	· ·

- Now, we need to add the source files (copied from Dropbox project to our project directory in previous step) to our solution.
- Right click on "Source Files" -> Add -> Existing Item



- Then, choose all h (header) and cpp files.
- Numbers with arrows shows steps.



- VS2017 creates pch.h and pch.cpp files for precompiled headers. Since we copied stdafx.h and stdafx.cpp, we need to remove pch.* files to avoid errors for the sake of this project.
- NOTE: Read more about when they are useful in this <u>link</u> If you are interested.

Do the following:

- Remove pch.h and pch.cpp from the "Source Files" i.e.
- Right click on "pch.cpp" -> Remove -> Delete -> Ok
- Repeat for "pch.h"

Note: You may not see the pch.h file under the

"Source Files". In that case, just delete pch.cpp

Solution Explorer	- ₽ ×
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Search Solution Explorer (Ctrl+;)	<i>-</i> ۹
 Solution 'Optical_Flow' (1 project) Solution 'Optical_Flow Image: References Image: External Dependencies Image: Header Files 	
🚎 Resource Files	
 ✓ Source Files > *+ between.cpp > between.h > common.h > *+ cv_pyrlk.cpp > *+ Optical_Flow.cpp *+ stdafx.cpp is stdafx.h in targetver.h > *+ Tracker.cpp in tracker.h 	

6. Editing the Project Properties

 Open the Project
 Properties window via the Solution Explorer view.

Right click
 Project>Properties



Optical_Flow Property Pages × Active(Debug) Active(Win32) Configuration Manager... Configuration: Platform: \sim \sim Configuration Properties General General **Target Platform** Windows 10 Debugging Windows SDK Version 10.0.17134.0 VC++ Directories Output Directory \$(SolutionDir)\$(Configuration)\ ▷ C/C++ Intermediate Directory \$(Configuration)\ b Linker Target Name \$(ProjectName) Manifest Tool Target Extension .exe XML Document Generator Extensions to Delete on Clean *.cdf;*.cache;*.obj;*.obj.enc;*.ilk;*.ipdb;*.iobj;*.resources;*.tlb;*.tli;* Browse Information Build Log File \$(IntDir)\$(MSBuildProjectName).log b Build Events Platform Toolset Visual Studio 2017 (v141) Custom Build Step Enable Managed Incremental Build No Code Analysis Project Defaults Configuration Type Application (.exe) Use of MFC Use Standard Windows Libraries Character Set Use Unicode Character Set Common Language Runtime Support No Common Language Runtime Support .NET Target Framework Version Whole Program Optimization No Whole Program Optimization Windows Store App Support No Target Platform The current target platform of the project. < ≻ OK Cancel Apply

Select <u>VC++ Directories</u> on the left pane of the Project Properties window.

Optical_Flow Property Pages		? ×
Configuration: Active(Debug)	 Platform: Active(Win32) 	✓ Configuration Manager
 Configuration Properties General Debugging VC++ Directories C/C++ Linker Manifest Tool XML Document Generator Browse Information Build Events Custom Build Step Code Analysis 	Include Directories \$(VC_IncludePath);\$(W Reference Directories \$(VC_ReferencesPath_x) Library Directories \$(VC_LibraryPath_x86); Library WinRT Directories \$(WindowsSDK_Metad) Source Directories \$(VC_SourcePath);	\$(WindowsSDK_LibraryPath_x86);\$(NETFXK
< >>	Executable Directories Path to use when searching for executable files while building a VC++ variable PATH.	project. Corresponds to environment
		OK Cancel Apply

6.1 Adding the OpenCV Include Directories

• Edit the Include Directories to point to include the three following directories:

<OpenCV install directory>\build\include <OpenCV install directory>\build\include\opencv <OpenCV install directory>\build\include\opencv2

Optical_Flow Propert	ty Pages			? ×
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			ОК	Cancel Apply

- For example, if your install directory was C:\opencv, include the three following directories:
- C:\opencv\build\include
- C:\opencv\build\include\opencv
- C:\opencv\build\include\opencv2

	ODCITY FUGCS
Include Directories ? ×	Include Directories
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Inherited values:	Inherited values:
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Inherit from parent or project defaults	Inherit from parent or project defaults
OK Cancel	ОК
	4

Numbers in the left figure shows the steps.

1. Adds new line

?

X V 🔨

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Macros>>

Cancel

, ,

2. Browse to the directories you wish to add.

 \times

NOTE: You can either copy these three lines directly or browse to them to select the directories.
6.2 Adding the OpenCV Library Directories

- Edit the Library Directories to include the following directory:
- <OpenCV install directory>\build\x86\vc11\lib

Optical_Flow Property Pages		? ×
Configuration: Active(Debug)	✓ Platform: Active(Win32)	✓ Configuration Manager
 Configuration Properties General Debugging VC++ Directories C/C++ Linker Manifest Tool XML Document Generator Browse Information Build Events Custom Build Step Code Analysis 	 General Executable Directories Include Directories Reference Directories Library Directories Source Directories Exclude Directories Exclude Directories Exclude Directories 	s(VC_ExecutablePath_x86);\$(WindowsSDK_ExecutablePath);\$(VS_E C:\opencv\build\include\opencv2;C:\opencv\build\include\ope \$(VC_ReferencesPath_x86); 5);\$(WindowsSDK_LibraryPath_x86);\$(NETFXKitsDir)Lib\um\x86 <edit> s(vC_sourcePath); \$(VC_IncludePath);\$(WindowsSDK_IncludePath);\$(VC_ExecutableP \$(VC_IncludePath);\$(WindowsSDK_IncludePath);\$(VC_ExecutableP *s while building a VC++ project. Corresponds to environment variable</edit>
< >	LIB.	OK Cancel Apply

• For example, if your install directory was C:\opencv, add the following library directory:

C:\opencv\build\x86\vc11\lib

Library Directories		?	×
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<			>
Inherited values:			
\$(VC_LibraryPath_x86) \$(WindowsSDK_LibraryPath_x86) \$(NETFXKitsDir)Lib\um\x86			^
			\sim
Inherit from parent or project defaults			
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6.3 Referencing Required OpenCV Libraries

 To add OpenCV libraries, you must add the .lib files to Linker>Input>AdditionalDependencies.

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Configuration P	roperties	Additional De	pendencies	b;uu	id.lib;odbc32.lib;	odbccp32.lib;%	6(AdditionalDep	endencie	2s) 🗸
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Debugging		Ignore Specifi	c Default Libraries						
VC++ Direct	ories	Module Defini	ition File						
▷ C/C++		Add Module t	o Assembly						
Linker		Embed Manad	ged Resource File						
General		Force Symbol	References						
Input		Delay Loaded	DIIs						
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opencv calib3d249.lib opencv calib3d249d.lib opencv_contrib249.lib opency contrib249d.lib opencv_core249.lib opency core249d.lib opency features2d249.lib opencv features2d249d.lib opency flann249.lib opencv flann249d.lib opencv gpu249.lib opency gpu249d.lib opencv highgui249.lib opencv highgui249d.lib opency imgproc249.lib opencv imgproc249d.lib opency legacy249.lib opencv legacy249d.lib opencv ml249.lib opency ml249d.lib opencv nonfree249.lib opency nonfree249d.lib opency objdetect249.lib opencv objdetect249d.lib opencv_ocl249.lib opency ocl249d.lib opency photo249.lib opency photo249d.lib opencv stitching249.lib opencv_stitching249d.lib opency superres249.lib opencv superres249d.lib opency ts249.lib opencv ts249d.lib opencv video249.lib opencv video249d.lib opencv videostab249.lib opencv videostab249d.lib

Copy and paste the .lib files listed here into **Additional Dependencies** (left figure).

Additional Dependencies	?	×	Additional Dependencies	?
		^	opencv_videostab249.lib opencv_videostab249d.lib	
<		>	- r -	
Evaluated value:			Evaluated value:	
%(AdditionalDependencies)		~	opencv_calib3d249.lib opencv_calib3d249d.lib opencv_contrib249.lib	
Inherited values:			a Inherited values:	
kernel32.lib user32.lib gdi32.lib winspool.lib		^	kernel32.lib suser32.lib gdi32.lib winspool.lib	
✓ Inherit from parent or project defaults	Macro	os>>	। └── Inherit from parent or project defaults	Macr
ок	Can	icel	ок	Can

Note: Copying them from the slide may introduce some extra spaces at the end of each line which may result in errors. Instead, copy them from the following text file:

(https://docs.google.com/document/d/13a5ehxuOc3DNDamqYrc7RnCpNjDUwqOl4Vn9J9i3apo/edit).

6.4 The Preprocessor Definitions

• C/C++ -> Preprocessor ->Preprocessor Definitions

Configuration:	Active(Debug)	 Platform: 	Active(Win32)	~	Configuration Manager.
▲ Configuration	ion Properties	Preprocessor Def	finitions	WIN32;_DEBUG;_CONSOLE;%(Pre	eprocessorDefinitions)
General		Undefine Prepro	cessor Definitions	<edit></edit>	
Debugg	ging	Undefine All Pre	processor Definitions	<inherit defa<="" from="" or="" parent="" project="" td=""><td>aults></td></inherit>	aults>
VC++ [Directories	Ignore Standard	Include Paths	110	
▲ C/C++		Preprocess to a F	ile	No	
Gen	eral	Preprocess Supp	ress Line Numbers	No	
Opt	imization	Keep Comments		No	
	processor				
Cod	le Generation				
Lan	guage				
Pred	compiled Headers				
Out	put Files				
Brov	wse Information				
Adv	anced				
All (Options				
Con	nmand Line				
Linker					
Manifes	st Tool				
XML Do	ocument Generator				
Browse	Information				
Build Ev	/ents				
Custom	n Build Step	Preprocessor Defin	itions		
Code A	nalysis	Defines a preprocess	ing symbols for your so	ource file.	

• Then, add the following:

_CRT_SECURE_NO_WARNINGS and ...NO_DEPRECATE

Preprocessor Definitions		?	×
_CRT_SECURE_NO_WARNINGS WIN32			^
_DEBUG			~
<			>
Evaluated value:			
_CRT_SECURE_NO_WARNINGS WIN32			^
_DEBUG			~
<			>
Inherited values:			
_UNICODE UNICODE			^
			J
·			
✓ Inherit from parent or project defaults		Macr	os>>
	ОК	Car	ncel

Purpose: Adding

_CRT_SECURE_NO_WARNINGS and _CRT_SECURE_NO_DEPRECATE to Preprocessor Definitions

removes/supresses the precompiler secure warnings that come up when you build the project.

6.5 Command Arguments

- Project Properties > Configuration Properties > Debugging >Command Arguments
- Add one of the following argument to your project:
- i) camera: is for real-time tracking using the webcam.
- ii) frames: apply Optical flow between two frames.

Optical_Flow Pro	operty Pages			? ×
Configuration:	Active(Debug)	V Platform: Active(V)	Win32)	✓ Configuration Manager
 ✓ Configurat General ✓ Debugg ✓ C++ E ♦ C/C++ ♦ Linker ♦ Manife: ♦ XML Do ♦ Browse ♦ Build E ♦ Custom 	 ▷ Linker ▷ Manifest Tool ▷ XML Document Generator ▷ Browse Information 	Velatform: Active(Debugger to launch: Local Windows Debugger Command Command Arguments Working Directory Attach Debugger Type Environment Merge Environment SQL Debugging Amp Default Accelerator	Vin32) S(TargetPath) frames S(ProjectDir) No Auto Yes No WARP software accelerato	
٢	>	Command Arguments The command line arguments		OK Cancel Apply

Do the following for each .cpp file:

Select the file in the **solution explorer**. Click on **properties**. Select the **C++** options. Choose **precompiled Headers**. Select **none**.

NOTE: For VS2015 and older, you don't need to do this step.



Repeat the above step for all .cpp files.

6.6 Run The Project/Solution

- Save the project.
- Start debugging (F5).









7.1 KLT Tracker

• Detect Harris corners in the first frame



"flat" region: no change in all directions

"edge": no change along the edge direction





7.1 KLT Tracker

• Build the Optical Flow Pyramid



- For each Harris corner compute motion between consecutive frames
- Link motion vectors in successive frames to get a track for each Harris point



Thank You