



VRWORKS VIDEO SDK 1.1

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Overview Guide



DOCUMENT CHANGE HISTORY

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VRWORKS 360 VIDEO OVERVIEW

Welcome to the VRWorks 360 Video SDK 1.1. This guide introduces you to the capabilities of the SDK and gets you started with stitching 360-degree panoramas.



Note: All file and folder locations in this document are relative to the root folder of the SDK.

INTRODUCTION

The VRWorks 360 Video SDK is an NVIDIA® CUDA®-based GPU-accelerated SDK for stitching multiple camera feeds into monoscopic and stereoscopic panoramas. The SDK package has the following components:

- ▶ High-Level SDK
- ▶ Low-Level SDK:
 - Low-Level Video SDK
 - Low-Level Audio SDK
- ▶ Camera Calibration SDK

This chapter provides information regarding each of these components.

HIGH-LEVEL SDK

(NVSTITCH - NVIDIA STITCHING SDK)

Package location

This SDK resides in the `\nvstitch` folder.

Function

- ▶ Camera calibration based on footage
- ▶ Monoscopic and stereoscopic stitching
- ▶ Mixing audio from multiple sources
- ▶ Audio stereo imaging effect
- ▶ Support multiple input and output formats
- ▶ Scale stereoscopic stitching performance with multiple GPUs

Supported input formats

- ▶ Video: MP4, H.264, BMP, CUDA buffer
- ▶ Audio: PCM, AAC

Supported output formats

- ▶ Video: MP4, H.264, BMP, CUDA buffer
- ▶ Audio: PCM, AAC

Suggested use

For developers, this is a great starting point as the interfaces here encompass all the functionality necessary to stitch videos and images into panoramas. At the same time, this SDK allows users to selectively enable and disable individual components for a customizable pipeline.

Getting started

- ▶ To view this SDK in action, execute:
`\samples\nvstitch_sample\run.bat`
- ▶ To get started with development, refer to *VRWorks 360 High Level Programming Guide*.

LOW-LEVEL VIDEO SDK

(NVSS - NVIDIA VIDEO STITCH SDK)

Package location

This SDK resides in the `\nvstitch` folder.

Function

- ▶ Monoscopic and stereoscopic stitching of video and images only
- ▶ Supports multiple input and output formats

Supported input formats

Video: CUDA buffer

Supported output formats

Video: CUDA buffer

Suggested use

- ▶ For developers, this SDK should be used only if you want to customize your stitching pipeline and use the stitching capability in conjunction with other components.
- ▶ The SDK assumes that any demultiplexing of video and audio is handled before the SDK is called.
- ▶ The SDK does not support any handling of the audio stream.

Getting started

- ▶ To view this SDK in action:
 - For stereoscopic stitching, execute:
`\samples\nvss_sample\run.bat`
 - For monoscopic stitching, execute:
`\samples\nvss_sample\run_mono.bat`
- ▶ To get started with development, refer to the *VRWorks 360 Low Level Video Programming Guide*.

LOW-LEVEL AUDIO SDK (NVSF - NVIDIA SOUND FIELD SDK)

Package location

This SDK resides in the `\nvstitch` folder.

Function

- ▶ Combines audio from multiple sources into a single output stream
- ▶ Applies a stereo spread effect for improved stereo imaging
- ▶ Applies a user-specified gain to output

Supported input formats

Audio: PCM

Supported output formats

Audio: PCM

Suggested usage

- ▶ The SDK merges audio in PCM format from multiple input streams into a single stereo output.
- ▶ The merge can be customized to apply a stereo spread effect during audio processing for immersive stereo imaging.
- ▶ A user-specified gain can be optionally applied to the output audio.

Getting started

- ▶ To view this SDK in action, execute:

```
\samples\nvsf_sample\run.bat
```

- ▶ To get started with development, refer to the *VRWorks 360 Low Level Audio Programming Guide*.

CAMERA CALIBRATION SDK (NVCALIB - NVIDIA CALIBRATION SDK)

Package location

This SDK resides in the `\nvcalib` folder.

Function

Determines and refines the camera intrinsics and extrinsics.

Supported input formats

PNG, JPEG and BMP for footage and XML for camera parameter estimates

Supported output formats

XML for camera parameter estimates

Suggested use

Well-calibrated camera parameters are crucial to good stitching quality. Camera calibration is scene dependent and may need input camera parameter estimates to be provided. Refer to *VRWorks 360 Video Calibration Programming Guide* for more details.

Getting started

- ▶ To view this SDK in action, execute:

```
\samples\nvcalib_sample\run.bat
```

- ▶ To get started with development, refer to the *VRWorks 360 Video Calibration Programming Guide*.

SAMPLES

The `\samples` folder contains source code that demonstrates the usage of all the SDKs discussed so far. For more details, review the `readme.txt` file at `\samples`.

MINIMUM REQUIREMENTS

- Hardware:** Compatible with NVIDIA® **Maxwell™** and later generations of GPUs (GeForce GTX 900 series and Quadro M5000 and higher).
- Software:**
- 64-bit Windows
 - NVIDIA graphics driver version 388.59 or later
 - Microsoft Visual Studio 2015 (MSVC14.0)
 - CUDA 9.0 Toolkit (NVCalib only)
 - CMake 3.2 or above

RUNNING THE SAMPLES AND VIEWING OUTPUTS

Viewing a previously-stitched output on a monitor or an HMD

- ▶ A sample stitched output file is located in the folder `\samples`.
- ▶ The file is named `sample_stitched_360_TB.mp4`.
- ▶ The file may be viewed in either of the following ways:
 - Viewed using Oculus Rift, HTC Vive, or any portable VR viewer
 - Launched in any desktop video player.

Running the sample code to produce matching results

Execute:

```
\samples\nvstitch_sample\run.bat
```

This command outputs an MP4 file in the same directory.

A file comparison with the sample provided should differ only in the timestamp in the metadata.

Building the sample application from source files

1. Run CMAKE version 3.2.0 or later in the root folder of the SDK.
2. Specify where to put the binaries.
3. Select configure/generate (using Visual Studio 2015 x64).

This step creates the `vrworks360.sln` file that you can open and then use to build the samples.
4. After you build the `nvstitch_sample.exe` file, you can use that file with the same `run.bat` file to stitch with your newly created executable.

This step outputs an MP4 file in the same directory. The newly created file should have the same content as the sample provided.

Adapting the sample application for a custom rig and input feed

At this point you should become familiar with the files in the footage directory. The *.jpg files are used for calibration and single frame stitching, and the *.mp4 files are the main source files for video stitching. This content would come from your camera rig for as many cameras as are on the rig.

1. To specify the source footage to the stitcher, create an `image_input.xml` and/or `video_input.xml` file to match your footage.
2. Create a `rig_spec.xml` file that matches the layout of the cameras for your specific rig.

The sample provided is for an equatorial 8-camera layout and can be modified accordingly.

After these changes are made, the same process above can be used to calibrate, stitch, and view your content.

FAQ

Q. What GPUs are currently supported?

- A. The SDK is designed to run on all NVIDIA Maxwell™ and later generations of GPUs.

For offline stitching, requirements are based on video memory capacity:

- For monoscopic stitching, NVIDIA recommends the use of GeForce GTX 1060 6GB card or Quadro P4000 card.
- For stereoscopic stitching, NVIDIA recommends the use of GeForce GTX 1080 card or Quadro P4000 card.

For real-time stitching, requirements are based on the GPU compute performance:

- For monoscopic stitching of eight 4K 30 fps video inputs to a 4K 30 fps output, NVIDIA recommends the use of GeForce GTX 1060 and up.
- For stereoscopic stitching of eight 4K 30 fps video sources to a 4K 30 fps output, NVIDIA recommends the use of 2 GeForce GTX 1080Ti cards or 2 Quadro P6000 cards.

Q. Are there any operating system requirements?

- A. The SDK is compatible with all Microsoft Windows 7 and above Windows operating systems.

Q. Are there any restrictions on the number of GPUs that can be used?

- A. Monoscopic stitching is not GPU scalable in this package. If you have multiple GPUs on your system, it will run on the most performance-advantaged GPU.

Stereoscopic stitching is GPU scalable. It will utilize all compatible (compute capability 5.2 and above) NVIDIA GPUs available on the system.

Q. Are there any restrictions on redistribution of the SDK binaries?

A. For details about licensing, refer to the license file:

`\VRWorks_SDK_License_Agreement_Public.pdf`

SUPPORT AND HELP

Please send any questions, comments, or bug reports to nvstitch-support@nvidia.com. When submitting a bug report, please note your OS, GPU model, and driver version.

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