NVIDIA Video Effects

System Guide
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Chapter 1. NVIDIA Video Effects SDK for Windows

The NVIDIA® Video Effects SDK for Windows is used to apply effect filters to videos. The SDK is powered by NVIDIA GPUs with Tensor Cores. With Tensor Cores, algorithm throughput is greatly accelerated, and latency is reduced.

The SDK provides the following filters:

- **AI green screen (video background segmentation) (Beta)**, which segments and masks the background areas in a video or image.
- **Background Blur (Beta)**, which uses the segmentation mask from the AI green screen filter, or other sources, and produces a blur effect in the background, in a video, or in an image.
- **Encoder Artifact Reduction (Beta)**, which reduces the blocking and noisy artifacts that are produced from encoding while preserving the details of the original video.
- The ArtifactReduction effect has the following modes:
  - Strength 0, which applies a weak effect.
  - Strength 1, which applies a strong effect.
- **Super resolution (Beta)**, which upscales a video and reduces encoding artifacts.
  This filter enhances the details, sharpens the output, and preserves the content. The SuperRes effect has two modes:
  - Strength 1, which applies strong enhancements.
  - Strength 0, which applies weaker enhancements while reducing encoding artifacts.
- **Upscale (Beta)**, which is a fast and light-weight method to upscale for an input video and sharpen the resulting output.
  This filter can optionally be pipelined with encoder artifact reduction to enhance the scale while reducing the video artifacts.
- **Webcam Denoising (Beta)**, which removes noise from a webcam video while preserving the texture details.
  This effect has the following modes:
  - Strength 0, which applies a weak effect.
  - Strength 1, which applies a strong effect.
1.1. Getting Started with the Video Effects SDK for Windows

The Video Effects SDK requires specific NVIDIA GPUs and a specific version of Windows OS and other associated software on which the SDK depends.

This SDK is designed and optimized for client-side application integration and for local deployment. We do not officially support the testing, experimentation, deployment of this SDK to a datacenter/cloud environment.

1.1.1. Hardware Requirements

The Video Effects SDK is compatible with GPUs that are based on the NVIDIA Turing™ or the NVIDIA Ampere™ architecture and have Tensor Cores.

1.1.2. Software Requirements

The Video Effects SDK requires a specific version of Windows OS and other associated software on which the SDK depends.

Table 1. Software Requirements for Windows

<table>
<thead>
<tr>
<th>Software</th>
<th>Required Version</th>
</tr>
</thead>
<tbody>
<tr>
<td>Windows OS</td>
<td>64-bit Windows 10 or later</td>
</tr>
<tr>
<td>Microsoft Visual Studio</td>
<td>2017 or later</td>
</tr>
<tr>
<td>CMake</td>
<td>3.12 or later</td>
</tr>
<tr>
<td>NVIDIA Graphics Driver for Windows</td>
<td>465.89 or later</td>
</tr>
</tbody>
</table>

1.2. Installing the Video Effects SDK for Windows

Here is information about installing the SDK for Windows.

The SDK is distributed in the following forms:

- The development SDK package.
  The development package includes everything in the SDK including the API headers, runtime dependencies, and sample apps.
- The redistributable SDK package.
  The redistributable package is more convenient if your application only wants to integrate SDK API headers and ask end users to download and install the SDK runtime dependencies.
To develop applications, because the essential contents in these two packages are the same, you can use either package.

The redistributable SDK package comprises the following parts:

- An open-source repository that includes the SDK API headers, the sample applications and their dependency libraries, and a proxy file to enable compilation without the SDK DLLs.
- An installer that installs the following SDK runtime dependencies:
  - The DLLs
  - The models
  - The SDK dependency libraries

The install location is the `C:\Program Files\NVIDIA Corporation\NVIDIA Video Effects\` directory.

For an application that is built on the SDK, the developer can package the runtime dependencies into the application or require application users to use the SDK installer.

**Note:** The source code and sample applications are in the development package and are hosted on GitHub at [https://github.com/nvidia/MAXINE-VFX-SDK](https://github.com/nvidia/MAXINE-VFX-SDK).

To use the SDK redistributable package, download the source code from GitHub and install the SDK binaries.

**Note:** If you are using a development package, you can ignore this step.

The sample app source code demonstrates how to integrate API headers and call the SDK APIs. The sample app also includes the `NVVideoEffectsProxy.cpp` file that is used to link against the SDK DLL without requiring an import library [.lib] file. With this file, you can compile the open-source code independently of the SDK installer. However, the SDK runtime dependencies are still required to load the runtime dependencies, the DLLs, and models.

### 1.3. Building the Sample Applications for Windows

To demonstrate the features of the Video Effects SDK, the SDK provides sample applications as source code that you can build and as binary files that you can run without building. You can run each application from the supplied batch file or from the application binary file.

The open source repository includes the source code to build the sample application, and a `NVVideoEffectsProxy.cpp` proxy file to enable compilation without explicitly linking against the SDK DLL.

**Note:** To download the models and runtime dependencies that are required by the features, run the SDK Installer.
1. In the root folder of the downloaded source code, start the CMake GUI and specify the source folder and a build folder for the binary files.
   a). For the source folder, ensure that the path ends in `OSS`.
   b). For the build folder, ensure that the path ends in `OSS/build`.
   c). Use CMake to configure and generate the Visual Studio solution file.
   d). Click Configure.
   e). When prompted to confirm that CMake can create the build folder, click OK.
   f). Select Visual Studio for the generator and x64 for the platform.
   g). To complete configuring the Visual Studio solution file, click Finish.
   h). To generate the Visual Studio Solution file, click Generate.
2. Use Visual Studio to generate the application binary.exe file from the solution file that you generated in the previous step.
3. In CMake, to open Visual Studio, click Open Project.
4. In Visual Studio, select Build > Build Solution.

1.4. Running the Sample Applications on Windows

This section provides information about how to run sample applications on Windows.

1.4.1. Running the AI Green Screen Application

The AI green screen application (`AigsEffectApp.exe`) demonstrates the AI green screen (video background segmentation) feature of the SDK.

The application accepts either a video file or output from a webcam as input and produces video output, which can be stored in a file or displayed in a window.

The application produces the output initially with foreground pixels highlighted. When the `--show` argument is specified, the keys described in Keyboard Controls toggle the behavior of the application.

You can run this application from the supplied batch file or from the application binary file.

When the appropriate `--comp_mode` value is passed via command line, the `AigsEffectApp` sample app also demonstrates the background blur effect.

For more ways to control the application, see the following:
- [AI Green Screen Application Command-Line Reference](#)
- [Keyboard Controls](#)
1.4.2. Running the UpscalePipeline Application

A script file, run.bat, is provided to show you how to run the UpscalePipeline application. This script file is in the samples\UpscalePipelineApp folder, which is under the Video Effects SDK root folder.

**Note:** This batch file is called run.bat in the redistributable installer package and is called run_local.bat in the developer package.

This file adds the paths to the required DLL files to the Path system variable and sets the options required to run the application. The input and output have been set as images in the samples/input folder, but you can set them as images or videos [MP4].

1. Open a Command Prompt window.
2. Navigate to the samples\UpscalePipelineApp folder.
   
   `cd root-folder\samples\UpscalePipelineApp`

3. Execute the run.bat or the run_local.bat file.

For more ways to control the application, see the following:

- UpscalePipeline Application Command-Line Reference
- Keyboard Controls

1.4.3. Running the DenoiseEffect Application

A script file, run.bat, is provided to show you how to run the DenoiseEffect application. This script file is in the samples\DenoiseEffectApp folder, which is under the Video Effects SDK root folder.

**Note:** This batch file is called run.bat in the redistributable installer package and is called run_local.bat in the developer package.

This file adds the paths to the required DLL files to the Path system variable and sets the options that are required to run the application. The input is currently set to a webcam stream and the output to a video file, but you can set them as images or as videos [MP4]. When the sample app is running, you can toggle the effect on and off by pressing the E key.

1. Open a Command Prompt window.
2. Navigate to the samples\DenoiseEffectApp folder.
   
   `cd root-folder\samples\DenoiseEffectApp`

3. Execute the run.bat or the run_local.bat file.

For more ways to control the application, see the following:

- DenoiseEffect Application Command-Line Reference
- Keyboard Controls
1.4.4. Running the VideoEffects Application

A script file, run.bat, is provided to show you how to run the VideoEffects application. This script file is in the samples\VideoEffectsApp folder, which is under the Video Effects SDK root folder.

The VideoEffects application can be used to demonstrate the following features:

- Artifact reduction
- Super Resolution
- Upscale

Note: This batch file is called run.bat in the redistributable installer package and is called run_local.bat in the developer package.

This file adds the paths to the required DLL files to the Path system variable and sets the options that are required to run the application. The input and output have been set as images in the samples/input folder, but you can set them as images or as videos (MP4).

1. Open a Command Prompt window.
2. Navigate to the samples\VideoEffectsApp folder.
   ```
   cd root-folder\samples\VideoEffectsApp
   ```
3. Execute the run.bat or the run_local.bat file.

For more ways to control the application, see the following:

- VideoEffects Application Command-Line Reference
- Keyboard Controls
Chapter 2. NVIDIA Video Effects SDK for Linux

The Video Effects SDK for Linux is used to apply effect filters to videos. The SDK is powered by NVIDIA GPUs with Tensor Cores. With Tensor Cores, algorithm throughput is greatly accelerated, and latency is reduced.

The SDK provides the following filters:

- **AI green screen (video background segmentation) (Beta)**, which segments and masks the background areas in a video or image.
- **Background Blur (Beta)**, which uses the segmentation mask from the AI green screen filter, or other sources, and produces a blur effect in the background, in a video, or in an image.
- **Encoder Artifact Reduction (Beta)**, which reduces the blocking and noisy artifacts that are produced from encoding while preserving the details of the original video.
- The ArtifactReduction effect has the following modes:
  - Strength 0, which applies a weak effect.
  - Strength 1, which applies a strong effect.
- **Super resolution (Beta)**, which upscales a video and reduces encoding artifacts.
  This filter enhances the details, sharpens the output, and preserves the content. The SuperRes effect has two modes:
  - Strength 1, which applies strong enhancements.
  - Strength 0, which applies weaker enhancements while reducing encoding artifacts.
- **Upscale (Beta)**, which is a fast and light-weight method to upscale for an input video and sharpen the resulting output.
  This filter can optionally be pipelined with encoder artifact reduction to enhance the scale while reducing the video artifacts.
- **Webcam Denoising (Beta)**, which removes noise from a webcam video while preserving the texture details.
  This effect has the following modes:
  - Strength 0, which applies a weak effect.
  - Strength 1, which applies a strong effect.
2.1. Getting Started with the Video Effects SDK on Linux

The Video Effects SDK requires specific NVIDIA GPUs, specific versions of the Linux OS, and other associated software on which the SDK depends.

This SDK is designed and optimized for server-side (datacenter/cloud) deployment. We do not officially support the testing, experimentation and production deployment of this SDK to client-side application integration and local deployment.

2.1.1. Hardware Requirements

The Video Effects SDK is compatible with GPUs that are based on NVIDIA Turing™, NVIDIA Volta™, or the NVIDIA Ampere™ architecture.

Note: For best performance with NVIDIA T4 and other server GPUs, make sure that you use a server that meets the thermal and airflow requirements for these types of products. Refer to https://www.nvidia.com/en-us/data-center/tesla/tesla-qualified-servers-catalog/ for the latest list of qualified servers.

2.1.2. Software Requirements

NVIDIA Video Effects SDK requires a specific version of Linux and other associated software on which the SDK depends.

Table 2. Software Requirements for Linux

<table>
<thead>
<tr>
<th>Software</th>
<th>Required Version</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linux</td>
<td>Ubuntu 18.04 or CentOS 7</td>
</tr>
<tr>
<td>CUDA</td>
<td>11.3u1</td>
</tr>
<tr>
<td>TensorRT</td>
<td>8.0.1.6 (for NVIDIA CUDA® 11.3)</td>
</tr>
<tr>
<td>cudnn</td>
<td>8.2.1 (for the appropriate NVIDIA TensorRT™/CUDA versions)</td>
</tr>
<tr>
<td>CMake</td>
<td>3.10</td>
</tr>
<tr>
<td>opencv</td>
<td>3.2+ or 4.x (for sample apps only)</td>
</tr>
<tr>
<td>NVIDIA Graphics Driver for Linux</td>
<td>465.19.01+</td>
</tr>
</tbody>
</table>
2.2. Installing the NVIDIA Video Effects SDK for Linux

The SDK is delivered as a .tar.gz package, which is a compressed tar format.

The package contains the video effects library and header files, which need to be extracted to the /usr/local/VideoFX directory.

You can download the prerequisites from https://developer.nvidia.com.

### Table 3. Downloading the Prerequisites

<table>
<thead>
<tr>
<th>Prerequisite</th>
<th>Download location</th>
</tr>
</thead>
<tbody>
<tr>
<td>CUDA</td>
<td><a href="https://developer.nvidia.com/cuda">https://developer.nvidia.com/cuda</a></td>
</tr>
<tr>
<td>TensorRT</td>
<td><a href="https://developer.nvidia.com/tensorrt">https://developer.nvidia.com/tensorrt</a></td>
</tr>
<tr>
<td>cudnn</td>
<td><a href="https://developer.nvidia.com/cudnn">https://developer.nvidia.com/cudnn</a></td>
</tr>
</tbody>
</table>

See Software Requirements for more information about the version numbers for <version> below).

- To install CUDA (include graphics driver):
  
  $ sudo sh cuda_<version>_<OS>_linux.run

- To install TensorRT:
  
  $ sudo tar -xvf TensorRT-<version>_<OS>_<version>.linux.x86_64-gnu.cuda-<version>_<version>.cudnn<version>_<OS>_tar.gz -C /usr/local

- To install cudnn:
  
  $ sudo tar -xvf cudnn-<version>_<OS>_<version>.tar.gz -C /usr/local

- To install the SDK:
  
  $ sudo tar -xvf NVIDIA_VFX_SDK_<OS>_version_<version>.tar.gz -C /usr/local

To install CUDA 11.1 and preserve older (supported) graphics drivers, such as versions 418 and 440, you need to carefully install the CUDA toolkit and the CUDA compatibility package. Refer to CUDA Compatibility and the README_quickstart.md file for more information.

**Note:** If you plan to use an older (supported) graphics driver, you must set LD_LIBRARY_PATH to include the compatibility package by running the following command:

```bash
export LD_LIBRARY_PATH=/usr/local/cuda/compat:$LD_LIBRARY_PATH
```
2.3. Building the Sample Applications on Linux

To demonstrate the features of the Video Effects SDK, the SDK provides sample applications as source code that you can build. You can then run each application from the supplied shell script or from the application binary file.

To build the sample applications, run the following command:

```
/usr/local/VideoFX/share/build_samples.sh
```

Follow the prompts to provide an install location and build the sample apps. The script might prompt you to install the necessary prerequisites.

2.4. Running the Sample Applications on Linux

This section provides information about how to run the sample applications in Linux.

2.4.1. Running the AI Green Screen Application from the Shell Script

The AI green screen application, AigsEffectApp, demonstrates the AI green screen (video background segmentation) feature of the SDK. The application accepts an image, a video file, or the output from a webcam as input and produces video output, which can be stored in a file or displayed in a window.

The `~/mysamples` folder contains the following shell scripts:

- `run_aigs_webcam.sh`
- `run_aigs_image.sh`

To run the AI green screen sample application on a sample image that is included in the SDK, run the following command:

```
$ cd ~/mysamples
$ ./run_aigs_image.sh
```

This step creates an output image called `aigs_image_out.jpg`.

To run the AI green screen sample application by using a connected webcam that displays on the screen, run the following command:

```
$ cd ~/mysamples
$ ./run_aigs_webcam.sh
```

**Note:** To run the application directly from the command line, review the contents of the shell script.
For more ways to control the application, see the following:

- Al Green Screen Application Command-Line Reference
- Keyboard Controls

### 2.4.2. Running the UpscalePipeline Application from the Shell Script

Here is information about how to run the UpscalePipeline application on Linux.

To run the UpscalePipeline sample application on the sample images in the SDK, run the following command:

```bash
$ cd ~/mysamples
$ ./run_upscalepipeline.sh
```

**Note:** To run the application directly from the command line, review the contents of the shell script.

For more ways to control the application, see the following:

- UpscalePipeline Application Command-Line Reference
- Keyboard Controls

### 2.4.3. Running the DenoiseEffect Application from the Shell Script

The `~/mysamples` folder contains the `run_denoiseeffect.sh` shell script.

To run the DenoiseEffect sample application on the sample images in the SDK, run the following command:

`. /run_denoiseeffect.sh`

The input is currently set to a webcam stream and the output to a video file, but you can set them as images or as videos. When the sample app is running, you can toggle the effect on and off by pressing the `E` key.

**Note:** To run the application directly from the command line, review the contents of the shell script.

For more ways to control the application, see the following:

- DenoiseEffect Application Command-Line Reference
- Keyboard Controls

### 2.4.4. Running the Batch Effect Application from the Shell Script

Some of the effects can take advantage of batching to achieve higher performance. The `BatchEffectApp` contains code that illustrates the extra steps that are needed to
simultaneously process a batch of images. Unlike the other sample applications, this application accepts multiple images to be used as input.

**Note:** The ~/mysamples folder contains the run_batcheffect.sh shell script.

To run the BatchEffectApp on a batch of sample images, run:

```
$ cd ~/mysamples
$ ./run_batcheffect.sh
```

**Note:** To run the application directly from the command line, review the content of the shell script.

For more ways to control the application, see the following:

- BatchEffectApp Command-Line Reference
- Keyboard Controls

### 2.4.5. Running the Batch Denoise Effect Application from the Shell Script

The Batch Denoise Effect Application can be used to denoise frames from multiple video streams in user-specified batches. BatchDenoiseEffectApp contains code that illustrates the extra steps that are needed to simultaneously process multiple video streams. The app assumes that the input videos have the same resolution and length. Unlike the other sample applications, this application accepts multiple videos to be used as input.

**Note:** The ~/mysamples folder contains the run_batchdenoiseeffect.sh shell script.

To run the BatchDenoiseEffectApp on a batch of sample images, run:

```
$ cd ~/mysamples
$ ./run_batchdenoiseeffect.sh inFile1 [ ... inFileN ]
```

This process denoises the videos in the N input files, inFile1 to inFileN and writes the output to the N corresponding output files.

**Note:** Currently sample input videos for batch denoising are not supplied with the SDK.

### 2.4.6. Running the VideoEffects Application from the Shell Script

Here is some information about running the VideoEffects application. The ~/mysamples folder contains the run_videoeffects.sh shell script.

To run the VideoEffects sample application on the sample images in the SDK, run the following command:

```
./run_videoeffects.sh
```

For more ways to control the application, see the following:
- VideoEffects Application Command-Line Reference
- Keyboard Controls

Note: To run the application directly from the command line, review the contents of the shell script.
To demonstrate the features of the Video Effects SDK, the SDK provides sample applications as source code that you can build and as binary files that you can run without building. You can run each application from the supplied shell script or from the application binary file.

**Important:** To quit the application, you cannot just close the window. You need to enter Q or Escape.

### 3.1. AI Green Screen Application

This section provides command-line and keyboard control information for the AI green screen application.

#### 3.1.1. AI Green Screen Application Command-Line Reference

Here is the command-line reference information for the AI green screen application.

```bash
c AigsEffectApp [arguments...]
```

Here are the arguments:

- **--in_file=path**
  The image file or video file for the application to process.

- **--webcam[=(true|false)]**
  If true, use a webcam as input instead of a file.

- **--cam_res=[widthx]height**
  If --webcam is true, specify the resolution of the webcam. width is optional. If omitted, width is computed from height to give an aspect ratio of 16:9. For example:
  ```bash
  --cam_res=1280x720 or --cam_res=720
  ```

  If --webcam is false, this argument is ignored.

- **--out_file=path**
  The file in which the video output is to be stored.

- **--show[=(true|false)]**
  If true, display the resulting video output in a window.
--model_dir=path
The path to the folder that contains the model files to be used for the transformation.

--codec=fourcc
The four-character code (FOURCC) of the video codec of the output video file. The default is H264.

--help
Display help information for the command.

--mode=(0|1)
Selects the mode in which to run the application:

- 0 selects the best quality.
- 1 selects fastest performance.

--comp_mode=(0|1|2|3|4|5|6)
Where mode selects which composition mode to use:

- 0: Displays the segmentation mask (compMatte).
- 1: Overlays the mask on top of the image (compLight).
- 2: Provides a composition with a BGR={0,255,0} background image (compGreen).
- 3: Provides a composition with a BGR={255,255,255} background image (compWhite).
- 4: No composition but displays the input image (compNone).
- 5: Overlays the mask on the image (compBG).
- 6: Applies a background blur filter on the input image by using the segmentation mask (compBlur).

3.1.2. Keyboard Controls
Here is the keyboard control information for the AI green screen application.
The sample application provides keyboard controls for changing the run-time behavior of the application:

- C: Toggles between the following ways of rendering the image:
  - Displaying a semi-transparent white overlay on the subject:
    - 0: Displays the segmentation mask (compMatte).
    - 1: Overlays the mask on top of the image (compLight).
    - 2: Provides a composition with a BGR={0,255,0} background image (compGreen).
    - 3: Provides a composition with a BGR={255,255,255} background image (compWhite).
    - 4: No composition but displays the input image (compNone).
    - 5: Overlays the mask on the image (compBG).
    - 6: Applies a background blur filter on the input image by using the segmentation mask (compBlur).
  - Replacing the background with a solid green color.
3.2. **UpscalePipeline Application**

This section provides command-line and keyboard control information for the UpscalePipeline application.

3.2.1. **UpscalePipeline Application Command-Line Reference**

Here is the command-line reference information for the UpscalePipeline application.

\[ \text{UpscalePipelineApp [arguments...]} \]

Here are the arguments:

- `--in_file=path`  
  The image file or video file for the application to process.

- `--out_file=path`  
  The file in which the video output is to be stored.

- `--resolution=NNN`  
  The output image/video vertical resolution, which is scaled from the input vertical resolution by 1.3333, 1.5, 2, 3, or 4.

- `--show=[true|false]`  
  If true, displays the resulting video output in a window.

- `--model_dir=path`  
  The path to the folder that contains the model files that will be used for the transformation.

- `--codec=fourcc`  
  The four-character code (FOURCC) of the video codec of the output video file. The default is H264.

- `--ar_mode=(0|1) for ArtifactReduction`  
  Selects the strength of the filter to be applied:
  - 0 selects a weak effect.
  - 1 selects a strong effect.

- `--upscale_strength=[0.0-1.0] for Upscale`  
  Selects the strength of the upscale filter to be applied:
  - 0 selects no enhancement.
  - 1 selects the maximum crispness.
  
  The default value is 0.4.

- `--progress`  
  Show the progress.
--verbose [=(true|false)]
  Verbose output.
--debug [=(true|false)]
  Prints extra debugging information.
--help
  Displays help information for the command.

3.2.2. Keyboard Controls
Here is the keyboard control information for the UpscalePipeline application.
The sample application provides keyboard controls for changing the run-time behavior of the application:
- F: Toggles the frame rate display on and off.
- Q or Escape: exits the app, and cleanly finishes writing any output file.

3.3. DenoiseEffect Application
This section provides command-line and keyboard control information for the DenoiseEffect application.

3.3.1. DenoiseEffect Application Command-Line Reference
Here is the command-line reference information for the DenoiseEffect application.

DenoiseEffectApp [arguments...]

Here are the arguments:

--in_file=path
  The image file or video file for the application to process.
--out_file=path
  The file in which the image or the video output is to be stored.
--show[=(true|false)]
  If true, displays the resulting video output in a window.
--model_dir=path
  The path to the folder that contains the model files that will be used for the transformation.
--codec=fourcc
  The four-character code (FOURCC) of the video codec of the output video file. The default value is H264.
Lossless codec, such as the Huffman Lossless Codec (FOURCC=HFYU), can be used to save the output video without any compression artifacts. On Windows, to use the Huffman Lossless Codec, download the opencv_ffmpeg346_64.dll file from https://sourceforge.net/projects/opencvlibrary/files/3.4.6/ and copy to a location on the app’s search path.
--strength=[0|1]
  ▶ 0 selects a weak effect.
  ▶ 1 selects a strong effect.

--progress
  Shows the progress.

--webcam
  Uses the webcam as input.

--verbose [=(true|false)]
  Verbose output

--debug[=(true|false)]
  Prints extra debugging.

--help
  Displays help information for the command.

3.3.2. Keyboard Controls
Here is the keyboard control information for the DenoiseEffect application.
The sample application provides keyboard controls for changing the run-time behavior of the application:
  ▶ E: Toggles the effect on and off.
  ▶ F: Toggles the frame rate display on and off.
  ▶ Q or Escape: exits the app, and cleanly finishes writing any output file.

3.4. BatchEffectApp Application
This section provides command-line and keyboard control information for the BatchEffectApp application.

3.4.1. BatchEffectApp Command-Line Reference
Here is the command-line reference information for the BatchEffectApp application.

BatchEffectApp [flags ...] inFile1 [ inFileN ...]

Here are the flags:

--out_file=<path>
  Output video files to be written, which is a pattern with a %u or %d that defaults to "BatchOut_%02u.mp4".

--effect=<effect>
  One of the following effects will be applied:
  ▶ Transfer
  ▶ ArtifactReduction
  ▶ SuperRes


- GreenScreen
- Upscale

```--strength=<value>```
The strength of an effect:

- [0.0, 1.0] range for upscaling.

```--scale=<scale>```
The scale factor that will be applied, which are 1.3333333, 1.5, 2, 3, or 4.

```--mode=<mode>```
For SuperRes and ArtifactReduction, the mode values are 0 or 1:

- 0: weak effect
- 1: strong effect

```--model_dir=<path>```
The path to the directory that contains the models.

```--verbose```
Verbose output.

```--help```
A help message.

### 3.4.2. Keyboard Controls
Here is the keyboard control information for the BatchEffectApp application.

The sample application provides keyboard controls for changing the run-time behavior of the application:

- F: Toggles the frame rate display on and off.
- Q or Escape: exits the app, and cleanly finishes writing any output file.

### 3.5. BatchDenoiseEffectApp Application
This section provides command-line and keyboard control information for the BatchDenoiseEffectApp application.

#### 3.5.1. BatchDenoiseEffectApp Command-Line Reference
Here is the command-line reference information for the BatchDenoiseEffectApp application.

```
BatchDenoiseEffectApp [flags ...] inFile1 [ inFileN ...]
```

Here are the flags:

```--out_file=<path>```
Output video files to be written, which is a pattern with a %u or %d that defaults to "BatchOut_%02u.mp4". 

--strength=<value>
The values for Strength are 0 or 1.
--batchsize=<value>
The size of the batch. Default: 8
--model_dir=<path>
The path to the directory that contains the models.
--verbose
Verbose output.
--help
A help message.

3.5.2. Keyboard Controls
Here is the keyboard control information for the BatchDenoiseEffectApp application.
The sample application provides keyboard controls for changing the run-time behavior of the application:

- F: Toggles the frame rate display on and off.
- Q or Escape: exits the app, and cleanly finishes writing any output file.

3.6. VideoEffects Application
This section provides command-line and keyboard control information for the VideoEffects application.

3.6.1. VideoEffects Application Command-Line Reference
Here is the command-line reference information for the VideoEffects application.

VideoEffectApp [arguments...]
Here are the arguments:

--in_file=path
The image file or video file for the application to process.
--effect=ArtifactReduction, SuperRes, or Upscale
This argument selects the effect that will be applied:

- ArtifactReduction: removes the encoder artifact without changing the resolution.
- SuperRes: removes artifact (mode 0) and upscaler to the specified output resolution.
- Upscale: Fast upscaler that increases the video resolution to the specified output resolution.

Note: You can also select any of the effects that are listed when you run the VideoEffectsApp with the --help flag.
--resolution=NNN
The desired output vertical resolution from Upscale and SuperRes, scaled 1.3333x, 1.5x, 2x,
3x or 4x times the input.

--out_file=path
The file in which the video output is to be stored.

--show=[true|false]
If true, displays the resulting video output in a window.

--model_dir=path
The path to the folder that contains the model files to be used for the transformation.

--codec=fourcc
The four-character code (FOURCC) of the video codec of the output video file. The default
value is H264.

--strength=[0.0-1.0] for Upscale
Continuous variable values to adjust sharpness.

--mode=(0 or 1) for SuperRes or ArtifactReduction
Selects the mode of the filter to be applied:

- 0 selects a weak effect.
- 1 selects a strong effect.

--verbose=[true|false]
Verbose output.

--debug
Print extra debugging.

--help
Display help information for the command.

3.6.2. Keyboard Controls
Here is the keyboard control information for the VideoEffects application.

The sample application provides keyboard controls for changing the run-time behavior of the
application:

- F: Toggles the frame rate display on and off.
- Q or Escape: exits the app, and cleanly finishes writing any output file.
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