



# NVIDIA AR SDK

## System Guide

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# Chapter 1. NVIDIA AR SDK for Windows

NVIDIA® AR SDK enables real-time modeling and tracking of human faces from video.

The SDK is powered by NVIDIA graphics processing units (GPUs) with Tensor Cores, and as a result, the algorithm throughput is greatly accelerated, and latency is reduced.

NVIDIA AR SDK has the following features:

- ▶ **Face detection and tracking (Beta)** detects, localizes, and tracks human faces in images or videos by using bounding boxes.
- ▶ **Facial landmark detection and tracking (Beta)** predicts and tracks the pixel locations of human facial landmark points and head poses in images or videos.

It can predict 68 and 126 landmark points. The 68 detected facial landmarks follow the Multi-PIE 68 point mark-ups information in [Facial point annotations](#). The 126 facial landmark points detector can predict more points on the cheeks, the eyes, and on laugh lines.

- ▶ **Face 3D mesh and tracking (Beta)** reconstructs and tracks a 3D human face and its head pose from the provided facial landmarks.
- ▶ **3D Body Pose tracking (Beta)** predicts and tracks the 3D human pose from images or videos.

It predicts 34 keypoints of body pose in 2D and 3D with Joint Angles and supports multi-person tracking. Refer to [Appendix B](#) for the keypoints.

- ▶ **Eye Contact (Beta)** estimates the gaze angles of a person in an image or video and redirects the gaze to make it frontal.

It can operate in the following modes:

- ▶ Head pose and gaze angles are estimated in camera coordinates without any redirection and another.
- ▶ In addition to estimation, the eyes of the person are redirected to make eye contact with the camera within a permissible range.
- ▶ **Facial Expression Estimation (Beta)** estimates face expression coefficients from the provided facial landmarks.

The AR SDK can be used in a wide variety of applications, such as augmented reality, beautification, 3D face animation, modeling, and so on. The SDK also provides sample

applications that demonstrate the features listed above in real-time by using a webcam or offline videos.

This table lists performance data for the features listed above on supported GPU architectures:

## 1.1. Getting Started with the AR SDK for Windows

This section provides information about how to get started with the AR SDK for Windows.

### 1.1.1. Hardware and Software Requirements

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

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

#### 1.1.1.1. Hardware Requirements

The AR SDK is compatible with GPUs that are based on the NVIDIA Turing™, the NVIDIA Ampere™ architecture, the NVIDIA Ada™ architecture, and have Tensor Cores.

#### 1.1.1.2. Software Requirements

NVIDIA AR SDK requires a specific version of the Windows OS and other associated software on which the SDK depends. The NVIDIA CUDA® and TensorRT™ dependencies are bundled with the SDK Installer. Refer to [Installing NVIDIA AR SDK and Associated Software](#).

Table 1. Software Requirements

Software	Required Version
Windows OS	64-bit Windows 10 or later
Microsoft Visual Studio	2015 (MSVC14.0) or later
CMake	3.12 or later
NVIDIA Graphics Driver for Windows	511.65 or later

## 1.2. Installing the AR SDK and the Associated Software

Here is some information about installing the SDK.

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 AR SDK\` 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-AR-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 `nVARProxy.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 on Windows

The [open source repository](#) includes the source code to build the sample applications, and the `nvARProxy.cpp` proxy file to enable compilation without explicitly linking against the SDK DLL.



**Note:** To download the models and runtime dependencies required by the features, you need to 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.
2. For the source folder, ensure that the path ends in `oss`.
3. For the build folder, ensure that the path ends in `oss/build`.  
Use CMake to configure and generate the Visual Studio solution file.
4. Click **Configure**.
5. When prompted to confirm that CMake can create the build folder, click **OK**.
6. Select **Visual Studio** for the generator and `x64` for the platform.
7. To complete configuring the Visual Studio solution file, click **Finish**.
8. To generate the Visual Studio Solution file, click **Generate**.
9. Verify that the build folder contains the `NvAR_SDK.sln` file.  
Use Visual Studio to generate the `FaceTrack.exe` and `BodyTrack.exe` files from the `NvAR_SDK.sln` file.
10. In CMake, to open Visual Studio, click `Open Project`.
11. In Visual Studio, select **Build > Build Solution**.

## 1.4. Running the Sample Applications on Windows

The SDK provides the FaceTrack, BodyTrack, GazeDirect, and ExpressionApp sample applications.

Before you run the application, connect a camera to the computer on which you plan to run the sample application.



**Note:** The application uses the video feed from this camera.

1. Open a Command Prompt window.
2. To run a sample application, complete one of the following steps:

- ▶ For the `FaceTrack` sample application, from the `samples\FaceTrack` folder, under the root folder of the AR SDK, execute the `run.bat` file.
- ▶ To run the `BodyTrack` sample application, from the `samples\BodyTrack` folder, under the root folder of the AR SDK, execute the `run.bat` file.
- ▶ To run the `ExpressionApp` sample application, from the `samples\ExpressionApp` folder, under the root folder of the AR SDK, execute the `run.bat` file.

This command launches an OpenCV window with the camera feed.

Here is some additional information:

- ▶ `FaceTrack` draws a 3D face mesh over the largest detected face.
- ▶ `GazeRedirect` plots the head pose and estimated gaze for the largest detected face along with a side-by-side view of the gaze redirected face.
- ▶ `BodyTrack` draws a Body Pose skeleton over the detected person.
- ▶ `ExpressionApp` renders a virtual avatar face on a separate frame buffer.

## 1.5. Sample Applications for the SDK

`FaceTrack` is a sample Windows application that demonstrates the face tracking, landmark tracking, and 3D mesh tracking features of the AR SDK. Similarly, `BodyTrack` is a sample Windows application that demonstrates the 3D Body Pose Tracking feature of the SDK.

### 1.5.1. FaceTrack Sample Application

This section provides information about the `FaceTrack` sample application.

#### 1.5.1.1. Command-Line Arguments for the FaceTrack Sample Application

Here is a list of the command-line arguments for the `FaceTrack` sample application.

**--model\_path=path**

Specifies the path to the models.

**--landmarks\_126[=(true|false)]**

Specifies whether to set the number of landmark points to 126 or 68.

- ▶ `true`: set number of landmarks to 126.
- ▶ `false`: set number of landmarks to 68.

**--landmarks\_mode [0|1]**

Specifies whether to set the high quality landmark model or high performance model.

- ▶ `0`: Use high performance landmark model [default mode].
- ▶ `1`: Use high quality landmark model.

**--temporal[=(true|false)]**

Optimizes the results for temporal input frames. If the input is a video, set this value to true.

**--offline\_mode[=(true|false)]**

Specifies whether to use offline video or an online camera video as the input.

- ▶ true: Use offline video as the input.
- ▶ false: Use an online camera as the input.

**--capture\_outputs[=(true|false)]**

If `--offline_mode=false`, specifies whether to enable the following features:

- ▶ Toggling video capture on and off by pressing the **C** key.
- ▶ Saving an image frame by pressing the **S** key.

Additionally, a result file that contains the detected landmarks and /or face boxes is written at the time of capture.

If `--offline_mode=true`, this argument is ignored.

**--cam\_res=[width x] height**

- ▶ If `--offline_mode=false`, specifies the camera resolution, and *width* is optional. If omitted, *width* is computed from *height* to give an aspect ratio of 4:3, for example:

```
--cam_res=640x480 or --cam_res=480.
```

- ▶ If `--offline_mode=true`, this argument is ignored.

**--in\_file=file**

```
--in=file
```

- ▶ If `--offline_mode=true`, specifies the input video file.
- ▶ If `--offline_mode=false`, this argument is ignored.

**--out\_file=file**

```
--out=file
```

- ▶ If `--offline_mode=true`, specifies the output video file.
- ▶ If `--offline_mode=false`, this argument is ignored.

## 1.5.1.2. Keyboard Controls for the FaceTrack Sample Application

The FaceTrack sample application provides keyboard controls to change the runtime behavior of the application.

Here is a list of these controls:

- ▶ **1** selects the face-tracking-only mode and shows only the bounding boxes.
- ▶ **2** selects the face and landmark tracking mode and shows only landmarks.



- ▶ **3** selects face, landmark, and 3D mesh tracking mode and shows only 3D face meshes.
- ▶ **W** toggles the selected visualization mode on and off.
- ▶ **F** toggles the frame rate display.
- ▶ **C** toggles video saving on and off.
  - ▶ When video saving is toggled off, a file is saved with the captured video with a result file that contains the detected face box and/or landmarks.
  - ▶ This control is enabled only if `--offline_mode=false` and `--capture_outputs=true`.
- ▶ **S** saves an image and a result file.

This control is enabled only if `--offline_mode=false` and `--capture_outputs=true`.

## 1.5.2. BodyTrack Sample Application

This section provides information about the BodyTrack sample application.

### 1.5.2.1. Command-Line Arguments for the BodyTrack Sample Application

Here is a list of the command-line arguments for the BodyTrack sample application.

**--model\_path=path**

Specifies the path to the models.

**--mode [= (0 | 1) ]**

Specifies whether to select High Performance mode or High Quality mode.

- ▶ 0: set mode to High Quality.
- ▶ 1: set mode to High Performance.

**--app\_mode [= (0 | 1) ]**

Specifies whether to select Body Detection or Body Pose Detection.

- ▶ 0: set mode to Body Detection.
- ▶ 1: set mode to Body Pose Detection.

**--temporal [= (true | false) ]**

Optimizes the results for temporal input frames. If the input is a video, set this value to true.

**--use\_cuda\_graph [= (true | false) ]**

Uses CUDA Graphs to improve performance. [CUDA graph](#) reduces the overhead of the GPU operation submission of 3D body tracking.

**--offline\_mode [= (true | false) ]**

Specifies whether to use offline video or an online camera video as the input.

- ▶ `true`: Use offline video as the input.
- ▶ `false`: Use an online camera as the input.

**--capture\_outputs[=(true|false)]**

- ▶ If `--offline_mode=false`, specifies whether to enable the following features:
  - ▶ Toggling video capture on and off by pressing the **C** key.
  - ▶ Saving an image frame by pressing the **S** key.

Additionally, a result file that contains the detected landmarks and /or face boxes is written at the time of capture.

- ▶ If `--offline_mode=true`, this argument is ignored.

**--cam\_res=[width x] height**

- ▶ If `--offline_mode=false`, specifies the camera resolution, and *width* is optional. If omitted, *width* is computed from *height* to give an aspect ratio of 4:3.

For example:

```
--cam_res=640x480 or --cam_res=480.
```

- ▶ If `--offline_mode=true`, this argument is ignored.

**--in\_file=file**

```
--in=file
```

- ▶ If `--offline_mode=true`, specifies the input video file.
- ▶ If `--offline_mode=false`, this argument is ignored.

**--out\_file=file**

```
--out=file
```

- ▶ If `--offline_mode=true`, specifies the output video file.
- ▶ If `--offline_mode=false`, this argument is ignored.

**--enable\_people\_tracking[=(true|false)]**

Enables Multi-Person tracking.

**--shadow\_tracking\_age=<unsigned int>**

This argument sets the Shadow Tracking Age for Multi-Person Tracking, and the default value is 90.

**--probation\_age=<unsigned int>**

This argument sets the Probation Age for Multi-Person tracking, and the default value is 10.

**--max\_targets\_tracked=<unsigned int>**

This argument sets the Maximum Targets Tracked. The default value is 30, and the minimum is value is 1.

## 1.5.2.2. Keyboard Controls for the BodyTrack Sample Application

The `BodyTrack` sample application provides keyboard controls to change the runtime behavior of the application.

Here is a list of these controls:

- ▶ **1** selects the *body-tracking-only* mode and shows only the bounding boxes.
- ▶ **2** selects the *body and body pose* tracking mode and shows the bounding boxes and body pose keypoints.
- ▶ **W** toggles the selected visualization mode on and off.
- ▶ **F** toggles the frame rate display.
- ▶ **C** toggles video saving on and off.
  - ▶ When video saving is toggled off, a file is saved with the captured video with a result file that contains the detected face box and/or landmarks.
  - ▶ This control is enabled only if `--offline_mode=false` and `--capture_outputs=true`.
- ▶ **S** saves an image and a result file.

This control is enabled only if `--offline_mode=false` and `--capture_outputs=true`.

### 1.5.3. Eye Contact Sample Application

This section provides information about the GazeRedirect sample application.

#### 1.5.3.1. Command-Line Arguments for the Eye Contact Sample Application

Here is a list of the command-line arguments for the GazeRedirect sample application.

##### **--model\_path=path**

Specifies the path to the models.

##### **--landmarks\_126[=(true|false)]**

Specifies whether to set the number of landmark points to 126 or 68 for computation of keypoints.

- ▶ `true`: set number of landmarks to 126.
- ▶ `false`: set number of landmarks to 68.

##### **--temporal[=(true|false)]**

When set to `true`, the landmark computation for eye contact is temporally optimized.

##### **--offline\_mode[=(true|false)]**

Specifies whether to use offline video or an online camera video as the input.

- ▶ `true`: Use offline video as the input.
- ▶ `false`: Use an online camera as the input.

##### **--redirect\_gaze[=(true|false)]**

- ▶ Specifies whether to redirect the gaze.
  - ▶ `true`: Gaze angles are estimated and redirected to make the person look frontal within a permissible range of angles.
  - ▶ `false`: Only perform gaze estimation, do not redirect the gaze.

**--split\_screen\_view=[(true|false)]**

This argument is applicable when redirection is enabled. It specifies whether to show the original video in addition to output video. If `--offline_mode=false`, split screen mode can be toggled on and off by pressing the O key.

- ▶ `true`: Show the original video and gaze redirected output videos side by side. The visualizations are displayed on the original video. .
- ▶ `false`: Show only the gaze redirected output video.

**--draw\_visualizations=[(true|false)]**

When set to true, visualizations for the head pose and gaze direction are displayed. In addition, the head translation (x,y,z) and gaze angles (pitch, yaw) are displayed on the original video. The head pose visualization follows the red, green, blue as the x,y, and z color coding. If gaze redirection is enabled, the split screen view should be enabled to draw the visualization. If `--offline_mode=false`, visualization mode can be toggled on and off by pressing the W key.

**--capture\_outputs=[(true|false)]**

If `--offline_mode=false`, video capture can be toggled on and off by pressing the C key. A result file that contains the output video is written at the time of capture. In case if `--offline_mode=true`, this argument is ignored.

**--cam\_res=[width x] height**

If `--offline_mode=false`, specifies the camera resolution, and width is optional. If you omit a value for the width, this value is computed from the height for an aspect ratio of 4:3 (for example, `--cam_res=640x480` or `--cam_res=480`).

If `--offline_mode=true`, this argument is ignored.

**--in=file**

- ▶ If `--offline_mode=true`, specifies the input video file.
- ▶ If `--offline_mode=false`, this argument is ignored.

**--out=file**

- ▶ If `--offline_mode=true`, specifies the output video file.
- ▶ If `--offline_mode=false`, this argument is ignored.

**-eyesize\_sensitivity=<integer 2-5>**

This argument correlates with the size of the eye region used to redirect the eyes. Larger the value, larger is the eye region. Default value is set to 3.

**--use\_cuda\_graph=[(true|false)]**

Uses CUDA Graphs to improve performance. [CUDA graph](#) reduces the overhead of the GPU operation submission of Eye contact networks. By default, this is set to false.

### 1.5.3.2. Keyboard Controls for the Eye Contact Sample Application

The `GazeRedirect` sample application provides keyboard controls to change the runtime behavior of the application.

Here is a list of these controls:

- ▶ **F** toggles the frame rate display.
- ▶ **C** toggles video saving on and off.

When video saving is toggled off, a file is saved with the captured video with a result file that contains the detected face box and/or landmarks. This control is enabled only if `--offline_mode=false` and `--capture_outputs=true`.

- ▶ **L** toggles the display of landmarks.

When the display of landmarks is toggled on, facial landmarks are displayed in addition to head pose and gaze. This control is enabled only if `--offline_mode=false` and `--draw_visualization=true`.

- ▶ **O** toggles the split screen view.

When toggled on, both the original and gaze redirected frames are displayed side-by-side. If `--draw_visualization=true` or `visualization` is toggled on, the head pose and gaze visualizations are displayed on the original frame. Landmarks are also displayed on the original frame optionally.

This control is enabled only if `--offline_mode=false` and `--redirect_gaze=true`.

- ▶ **W** toggles the visualizations.

When the visualization is toggled on, head pose, gaze and landmarks can be visualized on the original frame. When toggled off, the visualizations are not displayed. This control is enabled only if `--offline_mode=false`. When `--redirect_gaze=true`, visualizations are seen only when `--split_screen_mode` is also enabled or toggled on.

### 1.5.4. ExpressionApp Sample Application

`ExpressionApp` is a sample application using the AR SDK to extract face expression signals from video. These signals are used to control the expressions, pose and gaze of a 3D morphable face model. The application can either process real-time video from a webcam or offline videos from files. It illustrates the facial keypoints that are tracked, plots the expression signals that are derived, and renders an animated 3D avatar mesh.

The sample app demonstrates the following approaches to expression estimation:

- ▶ Facial Expression Estimation (default and is recommended for avatar animation).
- ▶ Face3DReconstruction-based expression estimation.

Facial Expression Estimation is the preferred feature for avatar animation.

Face3DReconstruction is demonstrated for its ability to track the face over time for AR effects. In addition to expression estimation, this feature enables identity face shape estimation and is better demonstrated in the `FaceTrack` sample application. The resulting expression

weights from Facial Expression Estimation are also more accurate than the weights from Face3DReconstruction.

### 1.5.4.1. Command-Line Arguments for the ExpressionApp Sample Application

Here is a list of the command-line arguments for the ExpressionApp sample application.

**--cam\_res=[width x] height**

Specifies the resolution as height or width x height.

**--codec=<fourcc>**

The FOURCC code for the desired codec, and the default value is `avc1`.

**--debug[=(true|false)]**

Reports the debugging information, and the default value is `false`.

**--expr\_mode=<number>**

SDK feature used for generation expressions. The default value is 2.

- ▶ 1=Face3DReconstruction
- ▶ 2=Facial Expression Estimation

**--pose\_mode=<number>**

Pose mode used for the FaceExpressions feature only. The default value is 0.

- ▶ 0=3DOF
- ▶ 1=6DOF

**--face\_model=<file>**

Specifies the face model to be used for fitting, and the default value is `face_model2.nvf`.

**--filter=<bitfield>**

Here are the available values:

- ▶ 1: face box
- ▶ 2: landmarks
- ▶ 4: pose
- ▶ 16: expressions
- ▶ 32: gaze
- ▶ 256: eye and mouth closure

The default value is 55, which means face box, landmarks, pose, expressions, gaze, and no closure.

**--gaze=<number>**

Specifies the gaze estimation mode:

- ▶ 0=implicit
- ▶ 1=explicit

The default value is 0.

**--cheekpuff [= (true | false) ]**

(Experimental) Enable cheek puff blendshapes. The default value is `false`.

**--fov=<degrees>**

Field of view, in degrees, and 0 implies orthographic. The default value is 0.

**--help**

Prints the help message.

**--in=<file>**

Specifies the input file, and the default value is `webcam 0`.

**--loop [= (true | false) ]**

Plays the same video repeatedly.

**--model\_dir=<path>**

Specifies the directory that contains the TRT models.

**--model\_path=<path>**

Specifies the directory that contains the TRT models.

**--out=<file>**

Specifies the output file.

**--render\_model=<file>**

Specifies the face model that will be used for rendering, and the default is `face_model2.nvf`. Use `face_model3.nvf` for a more comprehensive visualization model using partitions.

**--show [= (true | false) ]**

Shows the results, and unless `--out` is empty, the default value is `false`.

**--show\_ui [= (true | false) ]**

Shows the expression calibration UI, and the default value is `false`.

**--temporal=<bitfield>**

Applies the temporal filter. See `--filter` for more information.

**--view\_mode=<bitfield>**

Here are the values:

- ▶ 1: mesh
- ▶ 2: image
- ▶ 4: plot
- ▶ 8: landmarks

The default value is 15, which means all.

**--verbose [= (true | false) ]**

Reports interesting information, and the default `off`.

## 1.5.4.2. Keyboard Controls for the ExpressionApp Sample Application

The ExpressionApp sample application provides keyboard controls to change the runtime behavior of the application.

Here is a list of these controls:

- ▶ **Escape**, **q** or **Q** to quit
- ▶ **m** to toggle mesh display
- ▶ **n** to calibrate expression weights
- ▶ **i** to toggle image display
- ▶ **p** to toggle plot display
- ▶ **l** to toggle landmark display
- ▶ **f** to toggle frame rate display
- ▶ **L** or **ctrl-L** to toggle landmark filtering
- ▶ **N** or **ctrl-N** to un-calibrate expression weights
- ▶ **P** or **ctrl-P** to toggle pose filtering
- ▶ **E** or **ctrl-E** to toggle expression filtering
- ▶ **G** or **ctrl-G** to toggle gaze filtering
- ▶ **C** or **ctrl-C** to toggle closure enhancement
- ▶ **M** or **ctrl-M** toggles pose mode
- ▶ **1** expressions from mesh fitting
- ▶ **2** expressions from DNN (Facial Expression Estimation)

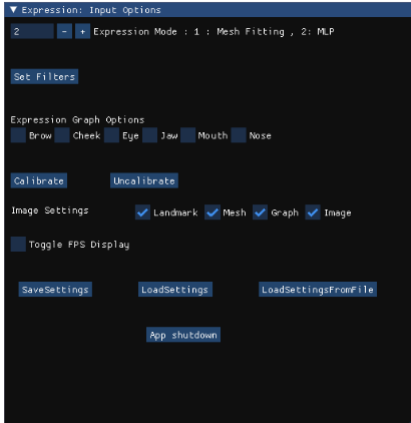
## 1.5.4.3. Application GUI

The GUI is simple and easy to use. Expression coefficients and their fine-tuned control can be displayed by selecting the **Expression Graph** checkboxes. To set different display options, in Expression Mode, enter 1 or 2. You can save or load settings by clicking **SaveSettings** and **LoadSettings**.



**Note:** The calibration process might require some fine tuning, which can take time.





#### 1.5.4.4. Expression Coefficient Transfer Function

The ExpressionApp estimates the expression coefficients for each frame that serves as the input. To extract the maximum expressivity in the final model, use each expression coefficient. To achieve additional expressivity and responsiveness, you can optionally tune additional parameters through calibration. Refer to Calibration for more information.

The parameters that are tuned during calibration are applied to a transfer function, where the coefficients range between 0 and 1:

- ▶ 0: This expression blendshape is not activated.
- ▶ 1: This expression blendshape is fully activated.

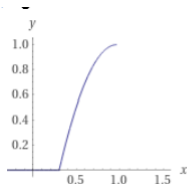
To fine tune the expressivity, a transfer function is applied to the expression coefficients before they are sent over for rendering the model to introduce scaling, offsets, and non-linearities. The transfer function looks like the following:

$$y = 1 - (\text{pow}(1 - (\max(x + a, 0) * b), c)), \{0 \leq x \leq 1\})$$

Where  $x$  is the input coefficient, and  $y$  is the output coefficient. Here are the parameters:

- ▶  $a$  = offset
- ▶  $b$  = scale
- ▶  $c$  = exponent

The parameters are tunable from the application's GUI for each expression mode.



The plot of the function is  $a=-0.3$ ,  $b=1.5$ ,  $c=2$ .

By playing around with the parameters, you can get a feeling for their effects, specifically for larger expression shapes such as `jawOpen`, or brow expressions. Instead of randomly trying to use parameters, you can use semi-automatic calibration to tune the parameters.

### 1.5.4.5. Calibration

The calibration process comprises automatic and manual portions. For each step, you can determine the a, b, and c parameters.



**Note:** Calibration is not required, but it aids in the responsiveness and the accuracy of shape coefficients, especially to properly close the lips and add responsiveness to speech.

Here is the calibration process:

1. Calibrate the neutral expression.

This is the automatic part of the calibration process where you sit straight in front of the web camera, keep a neutral face while looking straight into the camera, and click **Calibrate**. This function computes the offset parameters for each expression based on your neutral face and estimates the scaling parameters based on the offsets. The bar graph now keeps most expression coefficients close to zero when you maintain a neutral face.

2. Scale the expressions.

For example, focus on the following expressions:

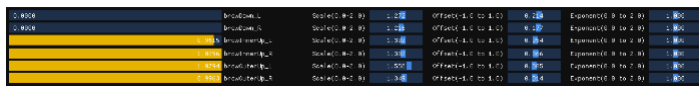
- ▶ `browInnerUp_R`
- ▶ `browInnerUp_L`
- ▶ `browOuterUp_R`
- ▶ `browOuterUp_L`

Most people are can completely raise their eyebrows, which corresponds to these expression coefficients to be set to 1.

When you select the **Brow** checkbox in Expression Graph Options, the brow-related expressions are displayed in a new window.

- a). In the Expression Graph Options section in the GUI, select the Brow checkbox. A new window displays the brow-related expressions.
- b). o tune the scaling, perform the full eyebrow raise expression, and move the sliders to correspond to the scale parameter until all four expression coefficients are close to 1.

If you scale the expressions too much, it will lead to over exposure.



- c). Repeat the same process for `browDown_R` and `browDown_L` while lowering the eyebrows.

Not all expressions can be isolated the same way as brow shapes can but some additional expression scalings can be applied.

Here is a subset of expressions that can be scaled in a relatively isolated manner:

- ▶ browDown\_L
- ▶ browDown\_R
- ▶ browInnerUp\_L
- ▶ browInnerUp\_R
- ▶ browOuterUp\_L
- ▶ browOuterUp\_R
- ▶ cheekPuff\_L
- ▶ cheekPuff\_R
- ▶ eyeBlink\_L
- ▶ eyeBlink\_R
- ▶ jawForward
- ▶ jawLeft
- ▶ jawOpen
- ▶ jawRight
- ▶ mouthClose
- ▶ mouthLeft
- ▶ mouthRight
- ▶ mouthSmile\_L
- ▶ mouthSmile\_R

Try to isolate individual shapes and apply scaling accordingly to max out these expressions.



**Note:** `mouthClose` is a special shape and should not be tuned individually. It works as a corrective shape for the `jawOpen` shape. This means it should have the same scaling and the same exponent as the `jawOpen` shape and should be tuned accordingly. Otherwise it will lead to intersections where the upper and lower lips intersect past each other.

### 3. Determine the expression exponents.

This step is the least scientific one, but it provides additional expressivity and responsiveness, especially for mouth shapes that can be slightly muted during speech. A high exponent value makes the expression more responsive in the low range of values, and a low exponent mutes the expression. Another approach to increase the responsiveness while talking is to increase the exponents of all mouth-related blendshapes to a specific value, for example between 1.5 and 2. The values depend on your needs which is why each calibration is an individual process.

If the exponent of the `jawOpen` or `mouthClose` shape is changed, change the value of the other shape to the same value because the shapes work with each other.

To reset the calibration settings, click **UnCalibrate**.

### 1.5.4.6. Saving and Loading Calibration Files

When you have finished calibrating, to save it, click **SaveSettings**. To load the previously saved settings, the `ExpressionAppSettings.json` file in the application folder, click **LoadSettings**. To load a specific file from a previous calibration setting, click **LoadSettingsFromFile**.



**Note:** A calibration file generally corresponds to a person in a specific setting (lighting conditions being mostly the same and the camera should be the same). If the capture setting is different, in general, a new calibration session needs to take place.

### 1.5.4.7. GUI Window

Windows are resizable. If all expressions are not displayed in the calibration window, group them by using the check boxes. Keyboard shortcuts only work when the `ExpressionApp` main window is in focus.

### 1.5.4.8. Calibration Between Modes

When switching between expression mode 1 and expression mode 2, the calibration settings should not be the same. The two modes estimate expression shapes differently, so the set of coefficients will vary significantly, and you need to start a new calibration session.

## 1.6. Additional Information

This section has additional information about using the AR SDK.

### 1.6.1. Saving the Output Video in a Lossless Format

Lossless codec, such as the Ut Video Codec, can be used to save an output video of the sample applications without any compression artifacts. For example, to save an output video with this codec, use the `--codec=ULY0` option.

## 1.7. Environment Variables

Here is information about the environmental variables in the AR SDK.

The environmental variables are as follows:

- ▶ `NVAR_MODEL_DIR`

If the application has not provided the path to the model's directory by setting the `NvAR_Parameter_Config_ModelDir` string, the SDK tries to load the models from the path in the `NVAR_MODEL_DIR` environment variable. The SDK installer sets `NVAR_MODEL_DIR` to `%ProgramFiles%\NVIDIA Corporation\NVIDIA AR SDK\models`.

► `NV_AR_SDK_PATH`

By default, applications that use the SDK will try to load the SDK DLL and its dependencies from the SDK install directory, for example, `%ProgramFiles%\NVIDIA Corporation\NVIDIA AR SDK\models`. Applications might also want to include and load the SDK DLL and its dependencies directly from the application folder.

To prevent the files from being loaded from the install directory, the application can set this environment variable to `USE_APP_PATH`. If `NV_AR_SDK_PATH` is set to `USE_APP_PATH`, instead of loading the binaries from the Program Files install directory, the SDK follows the standard OS search order to load the binaries. For example, the app folder followed by the `PATH` environment variable.



**Important:** Set this variable only for the application process. Setting this variable as a user or a system variable affects other applications that use the SDK.

## 1.8. Performance reference

This table lists performance data for features of the NVIDIA AR SDK on supported GPU architectures.

Table 2.

Feature	Latency (in milliseconds)		
	RTX 2060	RTX 3090	RTX 4090
Face detection and tracking	0.56	0.37	0.28
Facial landmark detection and tracking	1.1	0.93	0.67
3D Body pose tracking	3.38	1.76	1.37
Eye contact	4.35	2.72	2.41
Facial Expression Estimation	1.92	1.2	0.76



**Note:** Eye Contact latency computed at 720p video resolution. Facial Landmark tracking computed with 68 landmark points detected on face.

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