NVIDIA Performance Primitives (NPP)

Version 8.0

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Chapter 1

NVIDIA Performance Primitives

Note: Starting with release 6.5, NPP is also provided as a static library (libnppc_static.a, libnppi_static.a, and libnpps_static.a) on Linux, Android, and Mac OSes in addition to being provided as a shared library. The static NPP libraries depend on a common thread abstraction layer library called cuLIBOS (libculibos.a) that is now distributed as part of the toolkit. Consequently, cuLIBOS must be provided to the linker when the static library is being linked against. The libnppi library is becoming quite large so to minimize library loading and CUDA runtime startup times it is recommended to use the static library(s) whenever possible. To improve loading and runtime performance when using dynamic libraries NPP 8.0 now includes the full set of nppi sub-libraries in addition to the full sized nppi library itself. Linking to only the sub-libraries that contain functions that your application uses can significantly improve load time and runtime startup performance. Some nppi functions make calls to other nppi and/or npps functions internally so you may need to link to a few extra libraries depending on what function calls your application makes. The nppi sub-libraries are split into sections corresponding to the way that nppi header files are split. There are also static versions of each of the new sub-libraries. The full sized nppi library will be deprecated in the next CUDA release. This list of sub-libraries is as follows:

```
nppial  arithmetic and logical operation functions in nppi_arithmetic_and_logical_operations.h
nppicc  color conversion and sampling functions in nppi_color_conversion.h
nppicom JPEG compression and decompression functions in nppi_compression_functions.h
nppidei data exchange and initialization functions in nppi_data_exchange_and_initialization.h
nppif   filtering and computer vision functions in nppi_filter_functions.h
nppig   geometry transformation functions found in nppi_geometry_transforms.h
nppim   morphological operation functions found in nppi_morphological_operations.h
nppist  statistics and linear transform in nppi_statistics_functions.h and nppi_linear_transforms.
nppisu  memory support functions in nppi_support_functions.h
nppitc  threshold and compare operation functions in nppi_threshold_and_compare_operations.h
```

For example, on Linux, to compile a small application foo using NPP against the dynamic library, the following command can be used:

```
nvcc foo.c  -lnppi  -o foo
```

Whereas to compile against the static NPP library, the following command has to be used:

```
nvcc foo.c  -lnppi_static -lculibos -o foo
```

It is also possible to use the native host C++ compiler. Depending on the host operating system, some additional libraries like pthread or dl might be needed on the linking line. The following command on Linux is suggested:

```
g++ foo.c  -lnppi_static -lculibos -lcudart_static -lpthread -ldl
-I <cuda-toolkit-path>/include -L <cuda-toolkit-path>/lib64 -o foo
```

NPP is a stateless API, as of NPP 6.5 the ONLY state that NPP remembers between function calls is the current stream ID, i.e. the stream ID that was set in the most recent nppSetStream call. The default stream ID is 0. If an application intends to use NPP with multiple streams then it is the responsibility of the application to call nppSetStream whenever it wishes to change stream IDs. Several NPP functions may call other NPP functions internally to complete their functionality. For this reason it is recommended that cudaDeviceSynchronize be called before making an nppSetStream call to change to a new stream ID. This will insure that any internal function calls that have not yet occurred will be completed using the current stream ID before it changes to a new ID. Calling cudaDeviceSynchronize frequently call kill performance so minimizing the frequency of these calls is critical for good performance. It is not necessary to call cudaDeviceSynchronize for stream management while the same stream ID is used for multiple NPP calls. All NPP functions should be thread safe except for the following functions:

```
nppiGraphcut_32s8u - this function has been deprecated in NPP 8.0

nppiGraphcut_32f8u - this function has been deprecated in NPP 8.0

nppiGraphcut8_32s8u - this function has been deprecated in NPP 8.0

nppiGraphcut8_32f8u - this function has been deprecated in NPP 8.0

nppiDCTQuantFwd8x8LS_JPEG_8u16s_C1R

nppiDCTQuantInv8x8LS_JPEG_16s8u_C1R
```

As of NPP version 5.0 and beyond a few parameters for a few pre-5.0 existing image LUT functions have changed from host memory pointers to device memory pointers. Your application will fail (crash or report an error) if you use these functions with host memory pointers. The functions are the nppiLUT_Linear_8u_xxx functions.

Also, pre-5.0 function nppiMeanStdDev8uC1RGetBufferHostSize has been renamed nppiMeanStdDevGetBufferHostSize_8u_C1R.

1.1 What is NPP?

NVIDIA NPP is a library of functions for performing CUDA accelerated processing. The initial set of functionality in the library focuses on imaging and video processing and is widely applicable for developers in these areas. NPP will evolve over time to encompass more of the compute heavy tasks in a variety of problem domains. The NPP library is written to maximize flexibility, while maintaining high performance.

NPP can be used in one of two ways:

- A stand-alone library for adding GPU acceleration to an application with minimal effort. Using this route allows developers to add GPU acceleration to their applications in a matter of hours.
- A cooperative library for interoperating with a developer's GPU code efficiently.

Either route allows developers to harness the massive compute resources of NVIDIA GPUs, while simultaneously reducing development times.

1.2 Documentation

- General API Conventions

- Signal-Processing Specific API Conventions
- Imaging-Processing Specific API Conventions

1.3 Technical Specifications

Supported Platforms:

- Microsoft Windows 7, 8, and 10 (64-bit and 32-bit)
- Microsoft Windows Vista (64-bit and 32-bit)
- Linux (Centos, Ubuntu, and several others) (64-bit and 32-bit)
- Mac OS X (64-bit)
- Android on Arm (32-bit and 64-bit)

1.4 Files

NPP is comprises the following files:

1.4.1 Header Files

- nppdefs.h
- nppcore.h
- nppi::h
- npps::h
- nppversion.h
- npp::h

All those header files are located in the CUDA Toolkit's

```
/include/
```

directory.

1.4.2 Library Files

Starting with Version 5.5 NPP's functionality is now split up into 3 distinct libraries:

- A core library (NPPC) containing basic functionality from the npp.h header files as well as functionality shared by the other two libraries.
- The image processing library NPPI. Any functions from the nppi.h header file (or the various header files named "nppi_xxx.h" are bundled into the NPPI library.

- The signal processing library NPPS. Any function from the npps.h header file (or the various header files named "npps_xxx.h" are bundled into the NPPS library.

On the Windows platform the NPP stub libraries are found in the CUDA Toolkit's library directory:

```
/lib/nppc.lib

/lib/nppi.lib

/lib/npps.lib
```

The matching DLLs are located in the CUDA Toolkit's binary directory. Example

```
/bin/nppi64_55_<build_no>.dll      // Dynamic image-processing library for 64-bit Windows.
```

On Linux and Mac platforms the dynamic libraries are located in the lib directory

```
/lib/libnppc32.so.5.5.<build_no>   // NPP 32-bit dynamic core library for Linux

/lib/libnpps32.5.5.dylib  // NPP 32-bit dynamic signal processing library for Mac
```

1.5 Supported NVIDIA Hardware

NPP runs on all CUDA capable NVIDIA hardware. For details please see http://www.nvidia.com/object/cuda_learn_products.html

Chapter 2

General API Conventions

2.1 Memory Management

The design of all the NPP functions follows the same guidelines as other NVIDIA CUDA libraries like cuFFT and cuBLAS. That is that all pointer arguments in those APIs are device pointers.

This convention enables the individual developer to make smart choices about memory management that minimize the number of memory transfers. It also allows the user the maximum flexibility regarding which of the various memory transfer mechanisms offered by the CUDA runtime is used, e.g. synchronous or asynchronous memory transfers, zero-copy and pinned memory, etc.

The most basic steps involved in using NPP for processing data is as follows:

1. Transfer input data from the host to device using

   ```
   cudaMemCpy(...)
   ```

2. Process data using one or several NPP functions or custom CUDA kernels
3. Transfer the result data from the device to the host using

   ```
   cudaMemCpy(...)
   ```

2.1.1 Scratch Buffer and Host Pointer

Some primitives of NPP require additional device memory buffers (scratch buffers) for calculations, e.g. signal and image reductions (Sum, Max, Min, MinMax, etc.). In order to give the NPP user maximum control regarding memory allocations and performance, it is the user's responsibility to allocate and delete those temporary buffers. For one this has the benefit that the library will not allocate memory unbeknownst to the user. It also allows developers who invoke the same primitive repeatedly to allocate the scratch only once, improving performance and potential device-memory fragmentation .

Scratch-buffer memory is unstructured and may be passed to the primitive in uninitialized form. This allows for reuse of the same scratch buffers with any primitive require scratch memory, as long as it is sufficiently sized.

The minimum scratch-buffer size for a given primitive (e.g. nppsSum_32f()) can be obtained by a companion function (e.g. nppsSumGetBufferSize_32f()). The buffer size is returned via a host pointer as allocation of the scratch-buffer is performed via CUDA runtime host code.

An example to invoke signal sum primitive and allocate and free the necessary scratch memory:

```
// pSrc, pSum, pDeviceBuffer are all device pointers.
Npp32f * pSrc;
Npp32f * pSum;
Npp8u * pDeviceBuffer;
int nLength = 1024;

// Allocate the device memroy.
cudaMalloc((void **)(&pSrc), sizeof(Npp32f) * nLength);
nppsSet_32f(1.0f, pSrc, nLength);
cudaMalloc((void **)(&pSum), sizeof(Npp32f) * 1);

// Compute the appropriate size of the scratch-memory buffer
int nBufferSize;
nppsSumGetBufferSize_32f(nLength, &nBufferSize);
// Allocate the scratch buffer
cudaMalloc((void **)(&pDeviceBuffer), nBufferSize);

// Call the primitive with the scratch buffer
```

```
nppsSum_32f(pSrc, nLength, pSum, pDeviceBuffer);
Npp32f nSumHost;
cudaMemcpy(&nSumHost, pSum, sizeof(Npp32f) * 1, cudaMemcpyDeviceToHost);
printf("sum = %f\n", nSumHost); // nSumHost = 1024.0f;

// Free the device memory
cudaFree(pSrc);
cudaFree(pDeviceBuffer);
cudaFree(pSum);
```

2.2 Function Naming

Since NPP is a C API and therefore does not allow for function overloading for different data-types the NPP naming convention addresses the need to differentiate between different flavors of the same algorithm or primitive function but for various data types. This disambiguation of different flavors of a primitive is done via a suffix containing data type and other disambiguating information.

In addition to the flavor suffix, all NPP functions are prefixed with by the letters "npp". Primitives belonging to NPP's image-processing module add the letter "i" to the npp prefix, i.e. are prefixed by "nppi". Similarly signal-processing primitives are prefixed with "npps".

The general naming scheme is:

npp<module info><PrimitiveName>_<data-type info>[_<additional flavor info>](<parameter list>)

The data-type information uses the same names as the Basic NPP Data Types. For example the data-type information "8u" would imply that the primitive operates on Npp8u data.

If a primitive consumes different type data from what it produces, both types will be listed in the order of consumed to produced data type.

Details about the "additional flavor information" is provided for each of the NPP modules, since each problem domain uses different flavor information suffixes.

2.3 Integer Result Scaling

NPP signal processing and imaging primitives often operate on integer data. This integer data is usually a fixed point fractional representation of some physical magnitue (e.g. luminance). Because of this fixed-point nature of the representation many numerical operations (e.g. addition or multiplication) tend to produce results exceeding the original fixed-point range if treated as regular integers.

In cases where the results exceed the original range, these functions clamp the result values back to the valid range. E.g. the maximum positive value for a 16-bit unsigned integer is 32767. A multiplication operation of $4 * 10000 = 40000$ would exceed this range. The result would be clamped to be 32767.

To avoid the level of lost information due to clamping most integer primitives allow for result scaling. Primitives with result scaling have the "Sfs" suffix in their name and provide a parameter "nScaleFactor" that controls the amount of scaling. Before the results of an operation are clamped to the valid output-data range by multiplying them with $2^{\text{-nScaleFactor}}$.

Example: The primitive nppsSqr_8u_Sfs() computes the square of 8-bit unsigned sample values in a signal (1D array of values). The maximum value of a 8-bit value is 255. The square of $255^2 = 65025$ which would be clamped to 255 if no result scaling is performed. In order to map the maximum value of 255 to 255 in the result, one would specify an integer result scaling factor of 8, i.e. multiply each result with $2^{-8} = \frac{1}{2^8} = \frac{1}{256}$. The final result for a signal value of 255 being squared and scaled would be:

$$255^2 \cdot 2^{-8} = 254.00390625$$

which would be rounded to a final result of 254.

A medium gray value of 128 would result in

$$128^2 * 2^{-8} = 64$$

2.4 Rounding Modes

Many NPP functions require converting floating-point values to integers. The NppRoundMode enum lists NPP's supported rounding modes. Not all primitives in NPP that perform rounding as part of their functionality allow the user to specify the round-mode used. Instead they use NPP's default rounding mode, which is NPP_RND_FINANCIAL.

2.4.1 Rounding Mode Parameter

A subset of NPP functions performing rounding as part of their functionality do allow the user to specify which rounding mode is used through a parameter of the NppRoundMode type.

Chapter 3

Signal-Processing Specific API Conventions

3.1 Signal Data

Signal data is passed to and from NPPS primitives via a pointer to the signal's data type.

The general idea behind this fairly low-level way of passing signal data is ease-of-adoption into existing software projects:

- Passing the data pointer rather than a higher- level signal struct allows for easy adoption by not requiring a specific signal representation (that could include total signal size offset, or other additional information). This avoids awkward packing and unpacking of signal data from the host application to an NPP specific signal representation.

3.1.1 Parameter Names for Signal Data

There are three general cases of image-data passing throughout NPP detailed in the following sections.

Those are signals consumed by the algorithm.

3.1.1.1 Source Signal Pointer

The source signal data is generally passed via a pointer named

```
pSrc
```

The source signal pointer is generally defined constant, enforcing that the primitive does not change any image data pointed to by that pointer. E.g.

```
nppsPrimitive_32s(const Npp32s * pSrc, ...)
```

In case the primitive consumes multiple signals as inputs the source pointers are numbered like this:

```
pSrc1, pScr2, ...
```

3.1.1.2 Destination Signal Pointer

The destination signal data is generally passed via a pointer named

```
pDst
```

In case the primitive consumes multiple signals as inputs the source pointers are numbered like this:

```
pDst1, pDst2, ...
```

3.1.1.3 In-Place Signal Pointer

In the case of in-place processing, source and destination are served by the same pointer and thus pointers to in-place signal data are called:

```
pSrcDst
```

3.1.2 Signal Data Alignment Requirements

NPP requires signal sample data to be naturally aligned, i.e. any pointer

```
NppType * p;
```

to a sample in a signal needs to fulfill:

```
assert(p % sizeof(p) == 0);
```

3.1.3 Signal Data Related Error Codes

All NPPI primitives operating on signal data validate the signal-data pointer for proper alignment and test that the point is not null.

Failed validation results in one of the following error codes being returned and the primitive not being executed:

- NPP_NULL_POINTER_ERROR is returned if the image-data pointer is 0 (NULL).
- NPP_ALIGNMENT_ERROR if the signal-data pointer address is not a multiple of the signal's data-type size.

3.2 Signal Length

The vast majority of NPPS functions take a

```
nLength
```

parameter that tells the primitive how many of the signal's samples starting from the given data pointer are to be processed.

3.2.1 Length Related Error Codes

All NPPS primitives taking a length parameter validate this input.

Failed validation results in the following error code being returned and the primitive not being executed:

- NPP_SIZE_ERROR is returned if the length is negative.

Chapter 4

Imaging-Processing Specific API Conventions

4.1 Function Naming

Image processing related functions use a number of suffixes to indicate various different flavors of a primitive beyond just different data types. The flavor suffix uses the following abbreviations:

- "A" if the image is a 4 channel image this indicates the result alpha channel is not affected by the primitive.
- "Cn" the image consists of n channel packed pixels, where n can be 1, 2, 3 or 4.
- "Pn" the image consists of n separate image planes, where n can be 1, 2, 3 or 4.
- "C" (following the channel information) indicates that the primitive only operates on one of the color channels, the "channel-of-interest". All other output channels are not affected by the primitive.
- "I" indicates that the primitive works "in-place". In this case the image-data pointer is usually named "pSrcDst" to indicate that the image data serves as source and destination at the same time.
- "M" indicates "masked operation". These types of primitives have an additional "mask image" as as input. Each pixel in the destination image corresponds to a pixel in the mask image. Only pixels with a corresponding non-zero mask pixel are being processed.
- "R" indicates the primitive operates only on a rectangular "region-of-interest" or "ROI". All ROI primitives take an additional input parameter of type NppiSize, which specifies the width and height of the rectangular region that the primitive should process. For details on how primitives operate on ROIs see: Region-of-Interest (ROI).
- "Sfs" indicates the result values are processed by fixed scaling and saturation before they're written out.

The suffixes above always appear in alphabetical order. E.g. a 4 channel primitive not affecting the alpha channel with masked operation, in place and with scaling/saturation and ROI would have the postfix: "AC4IMRSfs".

4.2 Image Data

Image data is passed to and from NPPI primitives via a pair of parameters:

1. A pointer to the image's underlying data type.
2. A line step in bytes (also sometimes called line stride).

The general idea behind this fairly low-level way of passing image data is ease-of-adoption into existing software projects:

- Passing a raw pointer to the underlying pixel data type, rather than structured (by color) channel pixel data allows usage of the function in a wide variety of situations avoiding risky type cast or expensive image data copies.
- Passing the data pointer and line step individually rather than a higher- level image struct again allows for easy adoption by not requiring a specific image representation and thus avoiding awkward packing and unpacking of image data from the host application to an NPP specific image representation.

4.2.1 Line Step

The line step (also called "line stride" or "row step") allows lines of oddly sized images to start on well-aligned addresses by adding a number of unused bytes at the ends of the lines. This type of line padding has been common practice in digital image processing for a long time and is not particular to GPU image processing.

The line step is the number of bytes in a line **including the padding.** An other way to interpret this number is to say that it is the number of bytes between the first pixel of successive rows in the image, or generally the number of bytes between two neighboring pixels in any column of pixels.

The general reason for the existence of the line step it is that uniformly aligned rows of pixel enable optimizations of memory-access patterns.

Even though all functions in NPP will work with arbitrarily aligned images, best performance can only be achieved with well aligned image data. Any image data allocated with the NPP image allocators or the 2D memory allocators in the CUDA runtime, is well aligned.

Particularly on older CUDA capable GPUs it is likely that the performance decrease for misaligned data is substantial (orders of magnitude).

All image data passed to NPPI primitives requires a line step to be provided. It is important to keep in mind that this line step is always specified in terms of bytes, not pixels.

4.2.2 Parameter Names for Image Data

There are three general cases of image-data passing throughout NPP detailed in the following sections.

4.2.2.1 Passing Source-Image Data

Those are images consumed by the algorithm.

4.2.2.1.1 Source-Image Pointer

The source image data is generally passed via a pointer named

```
pSrc
```

The source image pointer is generally defined constant, enforcing that the primitive does not change any image data pointed to by that pointer. E.g.

```
nppiPrimitive_32s_C1R(const Npp32s * pSrc, ...)
```

In case the primitive consumes multiple images as inputs the source pointers are numbered like this:

```
pSrc1, pScr2, ...
```

4.2.2.1.2 Source-Planar-Image Pointer Array

The planar source image data is generally passed via an array of pointers named

```
pSrc[]
```

The planar source image pointer array is generally defined a constant array of constant pointers, enforcing that the primitive does not change any image data pointed to by those pointers. E.g.

```
nppiPrimitive_8u_P3R(const Npp8u * const pSrc[3], ...)
```

Each pointer in the array points to a different image plane.

4.2.2.1.3 Source-Planar-Image Pointer

The multiple plane source image data is passed via a set of pointers named

```
pSrc1, pSrc2, ...
```

The planar source image pointer is generally defined as one of a set of constant pointers with each pointer pointing to a different input image plane.

4.2.2.1.4 Source-Image Line Step

The source image line step is the number of bytes between successive rows in the image. The source image line step parameter is

```
nSrcStep
```

or in the case of multiple source images

```
nSrcStep1, nSrcStep2, ...
```

4.2.2.1.5 Source-Planar-Image Line Step Array

The source planar image line step array is an array where each element of the array contains the number of bytes between successive rows for a particular plane in the input image. The source planar image line step array parameter is

```
rSrcStep[]
```

4.2.2.1.6 Source-Planar-Image Line Step

The source planar image line step is the number of bytes between successive rows in a particular plane of the multiplane input image. The source planar image line step parameter is

```
nSrcStep1, nSrcStep2, ...
```

4.2.2.2 Passing Destination-Image Data

Those are images produced by the algorithm.

4.2.2.2.1 Destination-Image Pointer

The destination image data is generally passed via a pointer named

```
pDst
```

In case the primitive generates multiple images as outputs the destination pointers are numbered like this:

```
pDst1, pDst2, ...
```

4.2.2.2.2 Destination-Planar-Image Pointer Array

The planar destination image data pointers are generally passed via an array of pointers named

```
pDst[]
```

Each pointer in the array points to a different image plane.

4.2.2.2.3 Destination-Planar-Image Pointer

The destination planar image data is generally passed via a pointer to each plane of a multiplane output image named

```
pDst1, pDst2, ...
```

4.2.2.2.4 Destination-Image Line Step

The destination image line step parameter is

```
nDstStep
```

or in the case of multiple destination images

```
nDstStep1, nDstStep2, ...
```

4.2.2.2.5 Destination-Planar-Image Line Step Array

The destination planar image line step array is an array where each element of the array contains the number of bytes between successive rows for a particular plane in the output image. The destination planar image line step array parameter is

```
rDstStep[]
```

4.2.2.2.6 Destination-Planar-Image Line Step

The destination planar image line step is the number of bytes between successive rows for a particular plane in a multiplane output image. The destination planar image line step parameter is

```
nDstStep1, nDstStep2, ...
```

4.2.2.3 Passing In-Place Image Data

4.2.2.3.1 In-Place Image Pointer

In the case of in-place processing, source and destination are served by the same pointer and thus pointers to in-place image data are called:

```
pSrcDst
```

4.2.2.3.2 In-Place-Image Line Step

The in-place line step parameter is

```
nSrcDstStep
```

4.2.2.4 Passing Mask-Image Data

Some image processing primitives have variants supporting Masked Operation.

4.2.2.4.1 Mask-Image Pointer

The mask-image data is generally passed via a pointer named

```
pMask
```

4.2.2.4.2 Mask-Image Line Step

The mask-image line step parameter is

```
nMaskStep
```

4.2.2.5 Passing Channel-of-Interest Data

Some image processing primitives support Channel-of-Interest API.

4.2.2.5.1 Channel_of_Interest Number

The channel-of-interest data is generally an integer (either 1, 2, or 3):

```
nCOI
```

4.2.3 Image Data Alignment Requirements

NPP requires pixel data to adhere to certain alignment constraints: For 2 and 4 channel images the following alignment requirement holds: data_pointer % (#channels ∗ sizeof(channel type)) == 0. E.g. a 4 channel image with underlying type Npp8u (8-bit unsigned) would require all pixels to fall on addresses that are multiples of 4 (4 channels ∗ 1 byte size).

As a logical consequence of all pixels being aligned to their natural size the image line steps of 2 and 4 channel images also need to be multiples of the pixel size.

1 and 3 channel images only require that pixel pointers are aligned to the underlying data type, i.e. pData % sizof(data type) == 0. And consequentially line steps are also held to this requirement.

4.2.4 Image Data Related Error Codes

All NPPI primitives operating on image data validate the image-data pointer for proper alignment and test that the point is not null. They also validate the line stride for proper alignment and guard against the step being less or equal to 0. Failed validation results in one of the following error codes being returnd and the primitive not being executed:

- NPP_STEP_ERROR is returned if the data step is 0 or negative.
- NPP_NOT_EVEN_STEP_ERROR is returned if the line step is not a multiple of the pixel size for 2 and 4 channel images.
- NPP_NULL_POINTER_ERROR is returned if the image-data pointer is 0 (NULL).
- NPP_ALIGNMENT_ERROR if the image-data pointer address is not a multiple of the pixel size for 2 and 4 channel images.

4.3 Region-of-Interest (ROI)

In practice processing a rectangular sub-region of an image is often more common than processing complete images. The vast majority of NPP's image-processing primitives allow for processing of such sub regions also referred to as regions-of-interest or ROIs.

All primitives supporting ROI processing are marked by a "R" in their name suffix. In most cases the ROI is passed as a single NppiSize struct, which provides the with and height of the ROI. This raises the question how the primitive knows where in the image this rectangle of (width, height) is located. The "start pixel" of the ROI is implicitly given by the image-data pointer. I.e. instead of explicitly passing a pixel coordinate for the upper-left corner (lowest memory address), the user simply offsets the image-data pointers to point to the first pixel of the ROI.

In practice this means that for an image (pSrc, nSrcStep) and the start-pixel of the ROI being at location (x, y), one would pass

pSrcOffset = pSrc + y $*$ nSrcStep + x $*$ PixelSize;

as the image-data source to the primitive. PixelSize is typically computed as

PixelSize = NumberOfColorChannels $*$ sizeof(PixelDataType).

E.g. for a pimitive like nppiSet_16s_C4R() we would have

- NumberOfColorChannels == 4;
- sizeof(Npp16s) == 2;
- and thus PixelSize = 4 $*$ 2 = 8;

4.3.1 ROI Related Error Codes

All NPPI primitives operating on ROIs of image data validate the ROI size and image's step size. Failed validation results in one of the following error codes being returned and the primitive not being executed:

- NPP_SIZE_ERROR is returned if either the ROI width or ROI height are negative.
- NPP_STEP_ERROR is returned if the ROI width exceeds the image's line step. In mathematical terms $(\text{widthROI} * \text{PixelSize}) > \text{nLinStep}$ indicates an error.

4.4 Masked Operation

Some primitive support masked operation. An "M" in the suffix of those variants indicates masked operation. Primitives supporting masked operation consume an additional input image provided via a Mask-Image Pointer and Mask-Image Line Step. The mask image is interpreted by these primitives as a boolean image. The values of type Npp8u are interpreted as boolean values where a values of 0 indicates false, any non-zero values true.

Unless otherwise indicated the operation is only performed on pixels where its spatially corresponding mask pixel is true (non-zero). E.g. a masked copy operation would only copy those pixels in the ROI that have corresponding non-zero mask pixels.

4.5 Channel-of-Interest API

Some primitives allow restricting operations to a single channel of interest within a multi-channel image. These primitives are suffixed with the letter "C" (after the channel information, e.g. nppiCopy_-8u_C3CR(...). The channel-of-interest is generally selected by offsetting the image-data pointer to point directly to the channel- of-interest rather than the base of the first pixel in the ROI. Some primitives also explicitly specify the selected channel number and pass it via an integer, e.g. nppiMean_StdDev_8u_-C3CR(...).

4.5.1 Select-Channel Source-Image Pointer

This is a pointer to the channel-of-interest within the first pixel of the source image. E.g. if pSrc is the pointer to the first pixel inside the ROI of a three channel image. Using the appropriate select-channel copy primitive one could copy the second channel of this source image into the first channel of a destination image given by pDst by offsetting the pointer by one:

```
nppiCopy_8u_C3CR(pSrc + 1, nSrcStep, pDst, nDstStep, oSizeROI);
```

4.5.2 Select-Channel Source-Image

Some primitives allow the user to select the channel-of-interest by specifying the channle number (nCOI). This approach is typically used in the image statistical functions. For example,

```
nppiMean_StdDev_8u_C3CR(pSrc, nSrcStep, oSizeROI, nCOI, pDeviceBuffer, pMean, pStdDev );
```

The channel-of-interest number can be either 1, 2, or 3.

4.5.3 Select-Channel Destination-Image Pointer

This is a pointer to the channel-of-interest within the first pixel of the destination image. E.g. if pDst is the pointer to the first pixel inside the ROI of a three channel image. Using the appropriate select-channel copy primitive one could copy data into the second channel of this destination image from the first channel of a source image given by pSrc by offseting the destination pointer by one:

```
nppiCopy_8u_C3CR(pSrc, nSrcStep, pDst + 1, nDstStep, oSizeROI);
```

4.6 Source-Image Sampling

A large number of NPP image-processing functions consume at least one source image and produce an output image (e.g. nppiAddC_8u_C1RSfs() or nppiFilterBox_8u_C1R()). All NPP functions falling into this category also operate on ROIs (see Region-of-Interest (ROI)) which for these functions should be considered to describe the destination ROI. In other words the ROI describes a rectangular region in the destination image and all pixels inside of this region are being written by the function in question.

In order to use such functions successfully it is important to understand how the user defined destination ROI affects which pixels in the input image(s) are being read by the algorithms. To simplify the discussion of ROI propagation (i.e. given a destination ROI, what are the ROIs in in the source(s)), it makes sense to distinguish two major cases:

1. Point-Wise Operations: These are primitives like nppiAddC_8u_C1RSfs(). Each output pixel requires exaclty one input pixel to be read.

2. Neighborhood Operations: These are primitives like nppiFilterBox_8u_C1R(), which require a group of pixels from the source image(s) to be read in order to produce a single output.

4.6.1 Point-Wise Operations

As mentioned above, point-wise operations consume a single pixel from the input image (or a single pixel from each input image, if the operation in question has more than one input image) in order to produce a single output pixel.

4.6.2 Neighborhood Operations

In the case of neightborhood operations a number of input pixels (a "neighborhood" of pixels) is read in the input image (or images) in order to compute a single output pixel. All of the functions for image_-filtering_functions and image_morphological_operations are neigborhood operations.

Most of these functions have parameters that affect the size and relative location of the neighborhood: a mask-size structure and an achor-point structure. Both parameters are described in more detail in the next subsections.

4.6.2.1 Mask-Size Parameter

Many NPP neighborhood operations allow the user to specify the size of the neightborhood via a parameter usually named oMaskSize of type NppiSize. In those cases the neighborhood of pixels read from the source(s) is exactly the size of the mask. Assuming the mask is anchored at location (0, 0) (see Anchor-Point Parameter below) and has a size of (w, h), i.e.

```
assert(oMaskSize.w == w);
assert(oMaskSize.h == h);
assert(oAnchor.x == 0);
assert(oAnchor.y == 0);
```

a neighborhood operation would read the following source pixels in order to compute destiation pixel $D_{i,j}$:

$$\begin{array}{llll} S_{i,j} & S_{i,j+1} & \ldots & S_{i,j+w-1} \\ S_{i+1,j} & S_{i+1,j+1} & \ldots & S_{i+1,j+w-1} \\ \vdots & \vdots & \ddots & \vdots \\ S_{i+h-1,j} & S_{i+h-1,j+1} & \ldots & S_{i+h-1,j+w-1} \end{array}$$

4.6.2.2 Anchor-Point Parameter

Many NPP primitives perforing neighborhood operations allow the user to specify the relative location of the neighborhood via a parameter usually named oAnchor of type NppiPoint. Using the anchor a developer can chose the position of the mask (see Mask-Size Parameter) relative to current pixel index.

Using the same example as in Mask-Size Parameter, but this time with an anchor position of (a, b):

```
assert(oMaskSize.w == w);
assert(oMaskSize.h == h);
assert(oAnchor.x == a);
assert(oAnchor.y == b);
```

the following pixels from the source image would be read:

$$\begin{array}{llll} S_{i-a,j-b} & S_{i-a,j-b+1} & \ldots & S_{i-a,j-b+w-1} \\ S_{i-a+1,j-b} & S_{i-a+1,j-b+1} & \ldots & S_{i-a+1,j-b+w-1} \\ \vdots & \vdots & \ddots & \vdots \\ S_{i-a+h-1,j-b} & S_{i-a+h-1,j-b+1} & \ldots & S_{i-a+h-1,j-b+w-1} \end{array}$$

4.6.2.3 Sampling Beyond Image Boundaries

NPP primitives in general and NPP neighborhood operations in particular require that all pixel locations read and written are valid and within the boundaries of the respective images. Sampling outside of the defined image data regions results in undefined behavior and may lead to system instabilty.

This poses a problem in practice: when processing full-size images one cannot choose the destination ROI to be the same size as the source image. Because neigborhood operations read pixels from an enlarged source ROI, the destination ROI must be shrunk so that the expanded source ROI does not exceed the source image's size.

For cases where this "shrinking" of the destination image size is unacceptable, NPP provides a set of border-expanding Copy primitives. E.g. nppiCopyConstBorder_8u_C1R(), nppiCopyReplicateBorder_8u_C1R() and nppiCopyWrapBorder_8u_C1R(). The user can use these primitives to "expand" the source image's size using one of the three expansion modes. The expanded image can then be safely passed to a neighborhood operation producing a full-size result.

Chapter 5

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Chapter 6

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Chapter 7

Module Documentation

7.1 NPP Core

Basic functions for library management, in particular library version and device property query functions.

Functions

- const NppLibraryVersion ∗ nppGetLibVersion (void)

  Get the NPP library version.

- NppGpuComputeCapability nppGetGpuComputeCapability (void)

  What CUDA compute model is supported by the active CUDA device?

- int nppGetGpuNumSMs (void)

  Get the number of Streaming Multiprocessors (SM) on the active CUDA device.

- int nppGetMaxThreadsPerBlock (void)

  Get the maximum number of threads per block on the active CUDA device.

- int nppGetMaxThreadsPerSM (void)

  Get the maximum number of threads per SM for the active GPU.

- int nppGetGpuDeviceProperties (int ∗pMaxThreadsPerSM, int ∗pMaxThreadsPerBlock, int ∗pNumberOfSMs)

  Get the maximum number of threads per SM, maximum threads per block, and number of SMs for the active GPU.

- const char ∗ nppGetGpuName (void)

  Get the name of the active CUDA device.

- cudaStream_t nppGetStream (void)

  Get the NPP CUDA stream.

- unsigned int nppGetStreamNumSMs (void)

  Get the number of SMs on the device associated with the current NPP CUDA stream.

- unsigned int nppGetStreamMaxThreadsPerSM (void)

  Get the maximum number of threads per SM on the device associated with the current NPP CUDA stream.

- void nppSetStream (cudaStream_t hStream)

  Set the NPP CUDA stream.

7.1.1 Detailed Description

Basic functions for library management, in particular library version and device property query functions.

7.1.2 Function Documentation

7.1.2.1 NppGpuComputeCapability nppGetGpuComputeCapability (void)

What CUDA compute model is supported by the active CUDA device?

Before trying to call any NPP functions, the user should make a call this function to ensure that the current machine has a CUDA capable device.

Returns:

An enum value representing if a CUDA capable device was found and what level of compute capabilities it supports.

7.1.2.2 int nppGetGpuDeviceProperties (int ∗ *pMaxThreadsPerSM*, int ∗ *pMaxThreadsPerBlock*, int ∗ *pNumberOfSMs*)

Get the maximum number of threads per SM, maximum threads per block, and number of SMs for the active GPU.

Returns:

cudaSuccess for success, -1 for failure

7.1.2.3 const char∗ nppGetGpuName (void)

Get the name of the active CUDA device.

Returns:

Name string of the active graphics-card/compute device in a system.

7.1.2.4 int nppGetGpuNumSMs (void)

Get the number of Streaming Multiprocessors (SM) on the active CUDA device.

Returns:

Number of SMs of the default CUDA device.

7.1.2.5 const NppLibraryVersion∗ nppGetLibVersion (void)

Get the NPP library version.

Returns:

A struct containing separate values for major and minor revision and build number.

7.1.2.6 int nppGetMaxThreadsPerBlock (void)

Get the maximum number of threads per block on the active CUDA device.

Returns:

Maximum number of threads per block on the active CUDA device.

7.1.2.7 int nppGetMaxThreadsPerSM (void)

Get the maximum number of threads per SM for the active GPU.

Returns:

Maximum number of threads per SM for the active GPU

7.1.2.8 cudaStream_t nppGetStream (void)

Get the NPP CUDA stream.

NPP enables concurrent device tasks via a global stream state varible. The NPP stream by default is set to stream 0, i.e. non-concurrent mode. A user can set the NPP stream to any valid CUDA stream. All CUDA commands issued by NPP (e.g. kernels launched by the NPP library) are then issed to that NPP stream.

7.1.2.9 unsigned int nppGetStreamMaxThreadsPerSM (void)

Get the maximum number of threads per SM on the device associated with the current NPP CUDA stream.

NPP enables concurrent device tasks via a global stream state varible. The NPP stream by default is set to stream 0, i.e. non-concurrent mode. A user can set the NPP stream to any valid CUDA stream. All CUDA commands issued by NPP (e.g. kernels launched by the NPP library) are then issed to that NPP stream. This call avoids a cudaGetDeviceProperties() call.

7.1.2.10 unsigned int nppGetStreamNumSMs (void)

Get the number of SMs on the device associated with the current NPP CUDA stream.

NPP enables concurrent device tasks via a global stream state varible. The NPP stream by default is set to stream 0, i.e. non-concurrent mode. A user can set the NPP stream to any valid CUDA stream. All CUDA commands issued by NPP (e.g. kernels launched by the NPP library) are then issed to that NPP stream. This call avoids a cudaGetDeviceProperties() call.

7.1.2.11 void nppSetStream (cudaStream_t *hStream*)

Set the NPP CUDA stream.

See also:

nppGetStream()

7.2 NPP Type Definitions and Constants

Data Structures

- struct NppLibraryVersion
- struct NppiPoint

  2D Point

- struct NppiSize

  2D Size This struct typically represents the size of a a rectangular region in two space.

- struct NppiRect

  2D Rectangle This struct contains position and size information of a rectangle in two space.

- struct NppiHaarClassifier_32f
- struct NppiHaarBuffer

Modules

- Basic NPP Data Types

Defines

- #define NPP_MIN_8U (0)

  Minimum 8-bit unsigned integer.

- #define NPP_MAX_8U (255)

  Maximum 8-bit unsigned integer.

- #define NPP_MIN_16U (0)

  Minimum 16-bit unsigned integer.

- #define NPP_MAX_16U (65535)

  Maximum 16-bit unsigned integer.

- #define NPP_MIN_32U (0)

  Minimum 32-bit unsigned integer.

- #define NPP_MAX_32U (4294967295U)

  Maximum 32-bit unsigned integer.

- #define NPP_MIN_64U (0)

  Minimum 64-bit unsigned integer.

- #define NPP_MAX_64U (18446744073709551615ULL)

  Maximum 64-bit unsigned integer.

- #define NPP_MIN_8S (-127 - 1)

  Minimum 8-bit signed integer.

- #define NPP_MAX_8S (127)

  Maximum 8-bit signed integer.

- #define NPP_MIN_16S (-32767 - 1)

  Minimum 16-bit signed integer.

- #define NPP_MAX_16S (32767)

  Maximum 16-bit signed integer.

- #define NPP_MIN_32S (-2147483647 - 1)

  Minimum 32-bit signed integer.

- #define NPP_MAX_32S (2147483647)

  Maximum 32-bit signed integer.

- #define NPP_MAX_64S (9223372036854775807LL)

  Maximum 64-bit signed integer.

- #define NPP_MIN_64S (-9223372036854775807LL - 1)

  Minimum 64-bit signed integer.

- #define NPP_MINABS_32F (1.175494351e-38f)

  Smallest positive 32-bit floating point value.

- #define NPP_MAXABS_32F (3.402823466e+38f)

  Largest positive 32-bit floating point value.

- #define NPP_MINABS_64F (2.2250738585072014e-308)

  Smallest positive 64-bit floating point value.

- #define NPP_MAXABS_64F (1.7976931348623158e+308)

  Largest positive 64-bit floating point value.

Enumerations

- enum NppiInterpolationMode {
  NPPI_INTER_UNDEFINED = 0,
  NPPI_INTER_NN = 1,
  NPPI_INTER_LINEAR = 2,
  NPPI_INTER_CUBIC = 4,
  NPPI_INTER_CUBIC2P_BSPLINE,
  NPPI_INTER_CUBIC2P_CATMULLROM,
  NPPI_INTER_CUBIC2P_B05C03,
  NPPI_INTER_SUPER = 8,
  NPPI_INTER_LANCZOS = 16,
  NPPI_INTER_LANCZOS3_ADVANCED = 17,
  NPPI_SMOOTH_EDGE = (1 << 31) }

Filtering methods.

- enum NppiBayerGridPosition {
  NPPI_BAYER_BGGR = 0,
  NPPI_BAYER_RGGB = 1,
  NPPI_BAYER_GBRG = 2,
  NPPI_BAYER_GRBG = 3 }

  Bayer Grid Position Registration.

- enum NppiMaskSize {
  NPP_MASK_SIZE_1_X_3,
  NPP_MASK_SIZE_1_X_5,
  NPP_MASK_SIZE_3_X_1 = 100,
  NPP_MASK_SIZE_5_X_1,
  NPP_MASK_SIZE_3_X_3 = 200,
  NPP_MASK_SIZE_5_X_5,
  NPP_MASK_SIZE_7_X_7 = 400,
  NPP_MASK_SIZE_9_X_9 = 500,
  NPP_MASK_SIZE_11_X_11 = 600,
  NPP_MASK_SIZE_13_X_13 = 700,
  NPP_MASK_SIZE_15_X_15 = 800 }

  Fixed filter-kernel sizes.

- enum NppiDifferentialKernel {
  NPP_FILTER_SOBEL,
  NPP_FILTER_SCHARR }

  Differential Filter types.

- enum NppStatus {
  NPP_NOT_SUPPORTED_MODE_ERROR = -9999,
  NPP_INVALID_HOST_POINTER_ERROR = -1032,
  NPP_INVALID_DEVICE_POINTER_ERROR = -1031,
  NPP_LUT_PALETTE_BITSIZE_ERROR = -1030,
  NPP_ZC_MODE_NOT_SUPPORTED_ERROR = -1028,
  NPP_NOT_SUFFICIENT_COMPUTE_CAPABILITY = -1027,
  NPP_TEXTURE_BIND_ERROR = -1024,
  NPP_WRONG_INTERSECTION_ROI_ERROR = -1020,
  NPP_HAAR_CLASSIFIER_PIXEL_MATCH_ERROR = -1006,
  NPP_MEMFREE_ERROR = -1005,
  NPP_MEMSET_ERROR = -1004,
  NPP_MEMCPY_ERROR = -1003,
  NPP_ALIGNMENT_ERROR = -1002,
  NPP_CUDA_KERNEL_EXECUTION_ERROR = -1000,

NPP_ROUND_MODE_NOT_SUPPORTED_ERROR = -213,
NPP_QUALITY_INDEX_ERROR = -210,
NPP_RESIZE_NO_OPERATION_ERROR = -201,
NPP_OVERFLOW_ERROR = -109,
NPP_NOT_EVEN_STEP_ERROR = -108,
NPP_HISTOGRAM_NUMBER_OF_LEVELS_ERROR = -107,
NPP_LUT_NUMBER_OF_LEVELS_ERROR = -106,
NPP_CORRUPTED_DATA_ERROR = -61,
NPP_CHANNEL_ORDER_ERROR = -60,
NPP_ZERO_MASK_VALUE_ERROR = -59,
NPP_QUADRANGLE_ERROR = -58,
NPP_RECTANGLE_ERROR = -57,
NPP_COEFFICIENT_ERROR = -56,
NPP_NUMBER_OF_CHANNELS_ERROR = -53,
NPP_COI_ERROR = -52,
NPP_DIVISOR_ERROR = -51,
NPP_CHANNEL_ERROR = -47,
NPP_STRIDE_ERROR = -37,
NPP_ANCHOR_ERROR = -34,
NPP_MASK_SIZE_ERROR = -33,
NPP_RESIZE_FACTOR_ERROR = -23,
NPP_INTERPOLATION_ERROR = -22,
NPP_MIRROR_FLIP_ERROR = -21,
NPP_MOMENT_00_ZERO_ERROR = -20,
NPP_THRESHOLD_NEGATIVE_LEVEL_ERROR = -19,
NPP_THRESHOLD_ERROR = -18,
NPP_CONTEXT_MATCH_ERROR = -17,
NPP_FFT_FLAG_ERROR = -16,
NPP_FFT_ORDER_ERROR = -15,
NPP_STEP_ERROR = -14,
NPP_SCALE_RANGE_ERROR = -13,
NPP_DATA_TYPE_ERROR = -12,
NPP_OUT_OFF_RANGE_ERROR = -11,
NPP_DIVIDE_BY_ZERO_ERROR = -10,
NPP_MEMORY_ALLOCATION_ERR = -9,
NPP_NULL_POINTER_ERROR = -8,
NPP_RANGE_ERROR = -7,
NPP_SIZE_ERROR = -6,
NPP_BAD_ARGUMENT_ERROR = -5,
NPP_NO_MEMORY_ERROR = -4,
NPP_NOT_IMPLEMENTED_ERROR = -3,

NPP_ERROR = -2,
NPP_ERROR_RESERVED = -1,
NPP_NO_ERROR = 0,
NPP_SUCCESS = NPP_NO_ERROR,
NPP_NO_OPERATION_WARNING = 1,
NPP_DIVIDE_BY_ZERO_WARNING = 6,
NPP_AFFINE_QUAD_INCORRECT_WARNING = 28,
NPP_WRONG_INTERSECTION_ROI_WARNING = 29,
NPP_WRONG_INTERSECTION_QUAD_WARNING = 30,
NPP_DOUBLE_SIZE_WARNING = 35,
NPP_MISALIGNED_DST_ROI_WARNING = 10000 }

Error Status Codes.

- enum NppGpuComputeCapability {
NPP_CUDA_UNKNOWN_VERSION = -1,
NPP_CUDA_NOT_CAPABLE = 0,
NPP_CUDA_1_0 = 100,
NPP_CUDA_1_1 = 110,
NPP_CUDA_1_2 = 120,
NPP_CUDA_1_3 = 130,
NPP_CUDA_2_0 = 200,
NPP_CUDA_2_1 = 210,
NPP_CUDA_3_0 = 300,
NPP_CUDA_3_2 = 320,
NPP_CUDA_3_5 = 350,
NPP_CUDA_3_7 = 370,
NPP_CUDA_5_0 = 500,
NPP_CUDA_5_2 = 520,
NPP_CUDA_5_3 = 530,
NPP_CUDA_6_0 = 600 }
- enum NppiAxis {
NPP_HORIZONTAL_AXIS,
NPP_VERTICAL_AXIS,
NPP_BOTH_AXIS }
- enum NppCmpOp {
NPP_CMP_LESS,
NPP_CMP_LESS_EQ,
NPP_CMP_EQ,
NPP_CMP_GREATER_EQ,
NPP_CMP_GREATER }

- enum NppRoundMode {
  NPP_RND_NEAR,
  NPP_ROUND_NEAREST_TIES_TO_EVEN = NPP_RND_NEAR,
  NPP_RND_FINANCIAL,
  NPP_ROUND_NEAREST_TIES_AWAY_FROM_ZERO = NPP_RND_FINANCIAL,
  NPP_RND_ZERO,
  NPP_ROUND_TOWARD_ZERO = NPP_RND_ZERO }

  Rounding Modes.

- enum NppiBorderType {
  NPP_BORDER_UNDEFINED = 0,
  NPP_BORDER_NONE = NPP_BORDER_UNDEFINED,
  NPP_BORDER_CONSTANT = 1,
  NPP_BORDER_REPLICATE = 2,
  NPP_BORDER_WRAP = 3,
  NPP_BORDER_MIRROR = 4 }
- enum NppHintAlgorithm {
  NPP_ALG_HINT_NONE,
  NPP_ALG_HINT_FAST,
  NPP_ALG_HINT_ACCURATE }
- enum NppiAlphaOp {
  NPPI_OP_ALPHA_OVER,
  NPPI_OP_ALPHA_IN,
  NPPI_OP_ALPHA_OUT,
  NPPI_OP_ALPHA_ATOP,
  NPPI_OP_ALPHA_XOR,
  NPPI_OP_ALPHA_PLUS,
  NPPI_OP_ALPHA_OVER_PREMUL,
  NPPI_OP_ALPHA_IN_PREMUL,
  NPPI_OP_ALPHA_OUT_PREMUL,
  NPPI_OP_ALPHA_ATOP_PREMUL,
  NPPI_OP_ALPHA_XOR_PREMUL,
  NPPI_OP_ALPHA_PLUS_PREMUL,
  NPPI_OP_ALPHA_PREMUL }
- enum NppsZCType {
  nppZCR,
  nppZCXor,
  nppZCC }
- enum NppiHuffmanTableType {
  nppiDCTable,
  nppiACTable }

- enum NppiNorm {
  nppiNormInf = 0,
  nppiNormL1 = 1,
  nppiNormL2 = 2 }

7.2.1 Define Documentation

7.2.1.1 #define NPP_MAX_16S (32767)

Maximum 16-bit signed integer.

7.2.1.2 #define NPP_MAX_16U (65535)

Maximum 16-bit unsigned integer.

7.2.1.3 #define NPP_MAX_32S (2147483647)

Maximum 32-bit signed integer.

7.2.1.4 #define NPP_MAX_32U (4294967295U)

Maximum 32-bit unsigned integer.

7.2.1.5 #define NPP_MAX_64S (9223372036854775807LL)

Maximum 64-bit signed integer.

7.2.1.6 #define NPP_MAX_64U (18446744073709551615ULL)

Maximum 64-bit unsigned integer.

7.2.1.7 #define NPP_MAX_8S (127)

Maximum 8-bit signed integer.

7.2.1.8 #define NPP_MAX_8U (255)

Maximum 8-bit unsigned integer.

7.2.1.9 #define NPP_MAXABS_32F (3.402823466e+38f)

Largest positive 32-bit floating point value.

7.2.1.10 #define NPP_MAXABS_64F (1.7976931348623158e+308)

Largest positive 64-bit floating point value.

7.2.1.11 #define NPP_MIN_16S (-32767 - 1)

Minimum 16-bit signed integer.

7.2.1.12 #define NPP_MIN_16U (0)

Minimum 16-bit unsigned integer.

7.2.1.13 #define NPP_MIN_32S (-2147483647 - 1)

Minimum 32-bit signed integer.

7.2.1.14 #define NPP_MIN_32U (0)

Minimum 32-bit unsigned integer.

7.2.1.15 #define NPP_MIN_64S (-9223372036854775807LL - 1)

Minimum 64-bit signed integer.

7.2.1.16 #define NPP_MIN_64U (0)

Minimum 64-bit unsigned integer.

7.2.1.17 #define NPP_MIN_8S (-127 - 1)

Minimum 8-bit signed integer.

7.2.1.18 #define NPP_MIN_8U (0)

Minimum 8-bit unsigned integer.

7.2.1.19 #define NPP_MINABS_32F (1.175494351e-38f)

Smallest positive 32-bit floating point value.

7.2.1.20 #define NPP_MINABS_64F (2.2250738585072014e-308)

Smallest positive 64-bit floating point value.

7.2.2 Enumeration Type Documentation

7.2.2.1 enum NppCmpOp

Enumerator:

NPP_CMP_LESS

NPP_CMP_LESS_EQ
NPP_CMP_EQ
NPP_CMP_GREATER_EQ
NPP_CMP_GREATER

7.2.2.2 enum NppGpuComputeCapability

Enumerator:

NPP_CUDA_UNKNOWN_VERSION	Indicates that the compute-capability query failed.
NPP_CUDA_NOT_CAPABLE	Indicates that no CUDA capable device was found.
NPP_CUDA_1_0	Indicates that CUDA 1.0 capable device is machine's default device.
NPP_CUDA_1_1	Indicates that CUDA 1.1 capable device is machine's default device.
NPP_CUDA_1_2	Indicates that CUDA 1.2 capable device is machine's default device.
NPP_CUDA_1_3	Indicates that CUDA 1.3 capable device is machine's default device.
NPP_CUDA_2_0	Indicates that CUDA 2.0 capable device is machine's default device.
NPP_CUDA_2_1	Indicates that CUDA 2.1 capable device is machine's default device.
NPP_CUDA_3_0	Indicates that CUDA 3.0 capable device is machine's default device.
NPP_CUDA_3_2	Indicates that CUDA 3.2 capable device is machine's default device.
NPP_CUDA_3_5	Indicates that CUDA 3.5 capable device is machine's default device.
NPP_CUDA_3_7	Indicates that CUDA 3.7 capable device is machine's default device.
NPP_CUDA_5_0	Indicates that CUDA 5.0 capable device is machine's default device.
NPP_CUDA_5_2	Indicates that CUDA 5.2 capable device is machine's default device.
NPP_CUDA_5_3	Indicates that CUDA 5.3 capable device is machine's default device.
NPP_CUDA_6_0	Indicates that CUDA 6.0 or better is machine's default device.

7.2.2.3 enum NppHintAlgorithm

Enumerator:

NPP_ALG_HINT_NONE
NPP_ALG_HINT_FAST
NPP_ALG_HINT_ACCURATE

7.2.2.4 enum NppiAlphaOp

Enumerator:

NPPI_OP_ALPHA_OVER
NPPI_OP_ALPHA_IN
NPPI_OP_ALPHA_OUT
NPPI_OP_ALPHA_ATOP
NPPI_OP_ALPHA_XOR

NPPI_OP_ALPHA_PLUS
NPPI_OP_ALPHA_OVER_PREMUL
NPPI_OP_ALPHA_IN_PREMUL
NPPI_OP_ALPHA_OUT_PREMUL
NPPI_OP_ALPHA_ATOP_PREMUL
NPPI_OP_ALPHA_XOR_PREMUL
NPPI_OP_ALPHA_PLUS_PREMUL
NPPI_OP_ALPHA_PREMUL

7.2.2.5 enum NppiAxis

Enumerator:

NPP_HORIZONTAL_AXIS
NPP_VERTICAL_AXIS
NPP_BOTH_AXIS

7.2.2.6 enum NppiBayerGridPosition

Bayer Grid Position Registration.

Enumerator:

NPPI_BAYER_BGGR Default registration position.
NPPI_BAYER_RGGB
NPPI_BAYER_GBRG
NPPI_BAYER_GRBG

7.2.2.7 enum NppiBorderType

Enumerator:

NPP_BORDER_UNDEFINED
NPP_BORDER_NONE
NPP_BORDER_CONSTANT
NPP_BORDER_REPLICATE
NPP_BORDER_WRAP
NPP_BORDER_MIRROR

7.2.2.8 enum NppiDifferentialKernel

Differential Filter types.

Enumerator:

NPP_FILTER_SOBEL
NPP_FILTER_SCHARR

7.2.2.9 enum NppiHuffmanTableType

Enumerator:

nppiDCTable DC Table.

nppiACTable AC Table.

7.2.2.10 enum NppiInterpolationMode

Filtering methods.

Enumerator:

NPPI_INTER_UNDEFINED

NPPI_INTER_NN Nearest neighbor filtering.

NPPI_INTER_LINEAR Linear interpolation.

NPPI_INTER_CUBIC Cubic interpolation.

NPPI_INTER_CUBIC2P_BSPLINE Two-parameter cubic filter (B=1, C=0).

NPPI_INTER_CUBIC2P_CATMULLROM Two-parameter cubic filter (B=0, C=1/2).

NPPI_INTER_CUBIC2P_B05C03 Two-parameter cubic filter (B=1/2, C=3/10).

NPPI_INTER_SUPER Super sampling.

NPPI_INTER_LANCZOS Lanczos filtering.

NPPI_INTER_LANCZOS3_ADVANCED Generic Lanczos filtering with order 3.

NPPI_SMOOTH_EDGE Smooth edge filtering.

7.2.2.11 enum NppiMaskSize

Fixed filter-kernel sizes.

Enumerator:

NPP_MASK_SIZE_1_X_3

NPP_MASK_SIZE_1_X_5

NPP_MASK_SIZE_3_X_1

NPP_MASK_SIZE_5_X_1

NPP_MASK_SIZE_3_X_3

NPP_MASK_SIZE_5_X_5

NPP_MASK_SIZE_7_X_7

NPP_MASK_SIZE_9_X_9

NPP_MASK_SIZE_11_X_11

NPP_MASK_SIZE_13_X_13

NPP_MASK_SIZE_15_X_15

7.2.2.12 enum NppiNorm

Enumerator:

nppiNormInf maximum

nppiNormL1 sum

nppiNormL2 square root of sum of squares

7.2.2.13 enum NppRoundMode

Rounding Modes.

The enumerated rounding modes are used by a large number of NPP primitives to allow the user to specify the method by which fractional values are converted to integer values. Also see Rounding Modes.

For NPP release 5.5 new names for the three rounding modes are introduced that are based on the naming conventions for rounding modes set forth in the IEEE-754 floating-point standard. Developers are encouraged to use the new, longer names to be future proof as the legacy names will be deprecated in subsequent NPP releases.

Enumerator:

NPP_RND_NEAR Round to the nearest even integer.

All fractional numbers are rounded to their nearest integer. The ambiguous cases (i.e. <integer>.5) are rounded to the closest even integer. E.g.

- roundNear(0.5) = 0
- roundNear(0.6) = 1
- roundNear(1.5) = 2
- roundNear(-1.5) = -2

NPP_ROUND_NEAREST_TIES_TO_EVEN Alias name for NPP_RND_NEAR.

NPP_RND_FINANCIAL Round according to financial rule.

All fractional numbers are rounded to their nearest integer. The ambiguous cases (i.e. <integer>.5) are rounded away from zero. E.g.

- roundFinancial(0.4) = 0
- roundFinancial(0.5) = 1
- roundFinancial(-1.5) = -2

NPP_ROUND_NEAREST_TIES_AWAY_FROM_ZERO Alias name for NPP_RND_-FINANCIAL.

NPP_RND_ZERO Round towards zero (truncation).

All fractional numbers of the form <integer>.<decimals> are truncated to <integer>.

- roundZero(1.5) = 1
- roundZero(1.9) = 1
- roundZero(-2.5) = -2

NPP_ROUND_TOWARD_ZERO Alias name for NPP_RND_ZERO.

7.2.2.14 enum NppStatus

Error Status Codes.

Almost all NPP function return error-status information using these return codes. Negative return codes indicate errors, positive return codes indicate warnings, a return code of 0 indicates success.

Enumerator:

NPP_NOT_SUPPORTED_MODE_ERROR

NPP_INVALID_HOST_POINTER_ERROR

NPP_INVALID_DEVICE_POINTER_ERROR

NPP_LUT_PALETTE_BITSIZE_ERROR

NPP_ZC_MODE_NOT_SUPPORTED_ERROR ZeroCrossing mode not supported.

NPP_NOT_SUFFICIENT_COMPUTE_CAPABILITY

NPP_TEXTURE_BIND_ERROR

NPP_WRONG_INTERSECTION_ROI_ERROR

NPP_HAAR_CLASSIFIER_PIXEL_MATCH_ERROR

NPP_MEMFREE_ERROR

NPP_MEMSET_ERROR

NPP_MEMCPY_ERROR

NPP_ALIGNMENT_ERROR

NPP_CUDA_KERNEL_EXECUTION_ERROR

NPP_ROUND_MODE_NOT_SUPPORTED_ERROR Unsupported round mode.

NPP_QUALITY_INDEX_ERROR Image pixels are constant for quality index.

NPP_RESIZE_NO_OPERATION_ERROR One of the output image dimensions is less than 1 pixel.

NPP_OVERFLOW_ERROR Number overflows the upper or lower limit of the data type.

NPP_NOT_EVEN_STEP_ERROR Step value is not pixel multiple.

NPP_HISTOGRAM_NUMBER_OF_LEVELS_ERROR Number of levels for histogram is less than 2.

NPP_LUT_NUMBER_OF_LEVELS_ERROR Number of levels for LUT is less than 2.

NPP_CORRUPTED_DATA_ERROR Processed data is corrupted.

NPP_CHANNEL_ORDER_ERROR Wrong order of the destination channels.

NPP_ZERO_MASK_VALUE_ERROR All values of the mask are zero.

NPP_QUADRANGLE_ERROR The quadrangle is nonconvex or degenerates into triangle, line or point.

NPP_RECTANGLE_ERROR Size of the rectangle region is less than or equal to 1.

NPP_COEFFICIENT_ERROR Unallowable values of the transformation coefficients.

NPP_NUMBER_OF_CHANNELS_ERROR Bad or unsupported number of channels.

NPP_COI_ERROR Channel of interest is not 1, 2, or 3.

NPP_DIVISOR_ERROR Divisor is equal to zero.

NPP_CHANNEL_ERROR Illegal channel index.

NPP_STRIDE_ERROR Stride is less than the row length.

NPP_ANCHOR_ERROR Anchor point is outside mask.

NPP_MASK_SIZE_ERROR Lower bound is larger than upper bound.

NPP_RESIZE_FACTOR_ERROR

NPP_INTERPOLATION_ERROR

NPP_MIRROR_FLIP_ERROR

NPP_MOMENT_00_ZERO_ERROR

NPP_THRESHOLD_NEGATIVE_LEVEL_ERROR

NPP_THRESHOLD_ERROR

NPP_CONTEXT_MATCH_ERROR

NPP_FFT_FLAG_ERROR

NPP_FFT_ORDER_ERROR

NPP_STEP_ERROR Step is less or equal zero.

NPP_SCALE_RANGE_ERROR

NPP_DATA_TYPE_ERROR

NPP_OUT_OFF_RANGE_ERROR

NPP_DIVIDE_BY_ZERO_ERROR

NPP_MEMORY_ALLOCATION_ERR

NPP_NULL_POINTER_ERROR

NPP_RANGE_ERROR

NPP_SIZE_ERROR

NPP_BAD_ARGUMENT_ERROR

NPP_NO_MEMORY_ERROR

NPP_NOT_IMPLEMENTED_ERROR

NPP_ERROR

NPP_ERROR_RESERVED

NPP_NO_ERROR Error free operation.

NPP_SUCCESS Successful operation (same as NPP_NO_ERROR).

NPP_NO_OPERATION_WARNING Indicates that no operation was performed.

NPP_DIVIDE_BY_ZERO_WARNING Divisor is zero however does not terminate the execution.

NPP_AFFINE_QUAD_INCORRECT_WARNING Indicates that the quadrangle passed to one of affine warping functions doesn't have necessary properties.

First 3 vertices are used, the fourth vertex discarded.

NPP_WRONG_INTERSECTION_ROI_WARNING The given ROI has no interestion with either the source or destination ROI.

Thus no operation was performed.

NPP_WRONG_INTERSECTION_QUAD_WARNING The given quadrangle has no intersection with either the source or destination ROI.

Thus no operation was performed.

NPP_DOUBLE_SIZE_WARNING Image size isn't multiple of two.

Indicates that in case of 422/411/420 sampling the ROI width/height was modified for proper processing.

NPP_MISALIGNED_DST_ROI_WARNING Speed reduction due to uncoalesced memory accesses warning.

7.2.2.15 enum NppsZCType

Enumerator:

nppZCR sign change

nppZCXor sign change XOR

nppZCC sign change count_0

7.3 Basic NPP Data Types

Data Structures

- struct NPP_ALIGN_8

  Complex Number This struct represents an unsigned int complex number.

- struct NPP_ALIGN_16

  Complex Number This struct represents a long long complex number.

Typedefs

- typedef unsigned char Npp8u

  8-bit unsigned chars

- typedef signed char Npp8s

  8-bit signed chars

- typedef unsigned short Npp16u

  16-bit unsigned integers

- typedef short Npp16s

  16-bit signed integers

- typedef unsigned int Npp32u

  32-bit unsigned integers

- typedef int Npp32s

  32-bit signed integers

- typedef unsigned long long Npp64u

  64-bit unsigned integers

- typedef long long Npp64s

  64-bit signed integers

- typedef float Npp32f

  32-bit (IEEE) floating-point numbers

- typedef double Npp64f

  64-bit floating-point numbers

- typedef struct NPP_ALIGN_8 Npp32uc

  Complex Number This struct represents an unsigned int complex number.

- typedef struct NPP_ALIGN_8 Npp32sc

  Complex Number This struct represents a signed int complex number.

- typedef struct NPP_ALIGN_8 Npp32fc

  Complex Number This struct represents a single floating-point complex number.

- typedef struct NPP_ALIGN_16 Npp64sc

  Complex Number This struct represents a long long complex number.

- typedef struct NPP_ALIGN_16 Npp64fc

  Complex Number This struct represents a double floating-point complex number.

Functions

- struct __align__ (2)

  Complex Number This struct represents an unsigned char complex number.

- struct __align__ (4)

  Complex Number This struct represents an unsigned short complex number.

Variables

- Npp8uc
- Npp16uc
- Npp16sc

7.3.1 Typedef Documentation

7.3.1.1 typedef short Npp16s

16-bit signed integers

7.3.1.2 typedef unsigned short Npp16u

16-bit unsigned integers

7.3.1.3 typedef float Npp32f

32-bit (IEEE) floating-point numbers

7.3.1.4 typedef struct NPP_ALIGN_8 Npp32fc

Complex Number This struct represents a single floating-point complex number.

7.3.1.5 typedef int Npp32s

32-bit signed integers

7.3.1.6 typedef struct NPP_ALIGN_8 Npp32sc

Complex Number This struct represents a signed int complex number.

7.3.1.7 typedef unsigned int Npp32u

32-bit unsigned integers

7.3.1.8 typedef struct NPP_ALIGN_8 Npp32uc

Complex Number This struct represents an unsigned int complex number.

7.3.1.9 typedef double Npp64f

64-bit floating-point numbers

7.3.1.10 typedef struct NPP_ALIGN_16 Npp64fc

Complex Number This struct represents a double floating-point complex number.

7.3.1.11 typedef long long Npp64s

64-bit signed integers

7.3.1.12 typedef struct NPP_ALIGN_16 Npp64sc

Complex Number This struct represents a long long complex number.

7.3.1.13 typedef unsigned long long Npp64u

64-bit unsigned integers

7.3.1.14 typedef signed char Npp8s

8-bit signed chars

7.3.1.15 typedef unsigned char Npp8u

8-bit unsigned chars

7.3.2 Function Documentation

7.3.2.1 struct __align__ (4) `[read]`

Complex Number This struct represents an unsigned short complex number.

Complex Number This struct represents a short complex number.

< Real part

< Imaginary part

< Real part

< Imaginary part

7.3.2.2 struct __align__ (2) `[read]`

Complex Number This struct represents an unsigned char complex number.

< Real part

< Imaginary part

7.3.3 Variable Documentation

7.3.3.1 Npp16sc

7.3.3.2 Npp16uc

7.3.3.3 Npp8uc

7.4 Compression

Image compression primitives.

Modules

- Quantization Functions

Typedefs

- typedef struct NppiDecodeHuffmanSpec NppiDecodeHuffmanSpec

Functions

- NppStatus nppiDecodeHuffmanSpecGetBufSize_JPEG (int ∗pSize)

  Returns the length of the NppiDecodeHuffmanSpec structure.

- NppStatus nppiDecodeHuffmanSpecInitHost_JPEG (const Npp8u ∗pRawHuffmanTable, NppiHuffmanTableType eTableType, NppiDecodeHuffmanSpec ∗pHuffmanSpec)

  Creates a Huffman table in a format that is suitable for the decoder on the host.

- NppStatus nppiDecodeHuffmanSpecInitAllocHost_JPEG (const Npp8u ∗pRawHuffmanTable, NppiHuffmanTableType eTableType, NppiDecodeHuffmanSpec ∗∗ppHuffmanSpec)

  Allocates memory and creates a Huffman table in a format that is suitable for the decoder on the host.

- NppStatus nppiDecodeHuffmanSpecFreeHost_JPEG (NppiDecodeHuffmanSpec ∗pHuffmanSpec)

  Frees the host memory allocated by nppiDecodeHuffmanSpecInitAllocHost_JPEG.

- NppStatus nppiDecodeHuffmanScanHost_JPEG_8u16s_P1R (const Npp8u ∗pSrc, Npp32s nLength, Npp32s restartInterval, Npp32s Ss, Npp32s Se, Npp32s Ah, Npp32s Al, Npp16s ∗pDst, Npp32s nDstStep, NppiDecodeHuffmanSpec ∗pHuffmanTableDC, NppiDecodeHuffmanSpec ∗pHuffmanTableAC, NppiSize oSizeROI)

  Huffman Decoding of the JPEG decoding on the host.

- NppStatus nppiDecodeHuffmanScanHost_JPEG_8u16s_P3R (const Npp8u ∗pSrc, Npp32s nLength, Npp32s nRestartInterval, Npp32s nSs, Npp32s nSe, Npp32s nAh, Npp32s nAl, Npp16s ∗apDst[3], Npp32s aDstStep[3], NppiDecodeHuffmanSpec ∗apHuffmanDCTable[3], NppiDecodeHuffmanSpec ∗apHuffmanACTable[3], NppiSize aSizeROI[3])

  Huffman Decoding of the JPEG decoding on the host.

7.4.1 Detailed Description

Image compression primitives.

The JPEG standard defines a flow of level shift, DCT and quantization for forward JPEG transform and inverse level shift, IDCT and de-quantization for inverse JPEG transform. This group has the functions for both forward and inverse functions.

These functions can be found in either the nppi or nppicom libraries. Linking to only the sub-libraries that you use can significantly save link time, application load time, and CUDA runtime startup time when using dynamic libraries.

7.4.2 Typedef Documentation

7.4.2.1 typedef struct NppiDecodeHuffmanSpec NppiDecodeHuffmanSpec

7.4.3 Function Documentation

7.4.3.1 NppStatus nppiDecodeHuffmanScanHost_JPEG_8u16s_P1R (const Npp8u ∗ *pSrc*, Npp32s *nLength*, Npp32s *restartInterval*, Npp32s *Ss*, Npp32s *Se*, Npp32s *Ah*, Npp32s *Al*, Npp16s ∗ *pDst*, Npp32s *nDstStep*, NppiDecodeHuffmanSpec ∗ *pHuffmanTableDC*, NppiDecodeHuffmanSpec ∗ *pHuffmanTableAC*, NppiSize *oSizeROI*)

Huffman Decoding of the JPEG decoding on the host.

Input is expected in byte stuffed huffman encoded JPEG scan and output is expected to be 64x1 macro blocks.

Parameters:

pSrc Byte-stuffed huffman encoded JPEG scan.

nLength Byte length of the input.

restartInterval Restart Interval, see JPEG standard.

Ss Start Coefficient, see JPEG standard.

Se End Coefficient, see JPEG standard.

Ah Bit Approximation High, see JPEG standard.

Al Bit Approximation Low, see JPEG standard.

pDst Destination-Image Pointer.

nDstStep Destination-Image Line Step.

pHuffmanTableDC DC Huffman table.

pHuffmanTableAC AC Huffman table.

oSizeROI Region-of-Interest (ROI).

Returns:

Error codes:

- NPP_SIZE_ERROR For negative input height/width or not a multiple of 8 width/height.
- NPP_STEP_ERROR If input image width is not multiple of 8 or does not match ROI.
- NPP_NULL_POINTER_ERROR If the destination pointer is 0.

7.4.3.2 NppStatus nppiDecodeHuffmanScanHost_JPEG_8u16s_P3R (const Npp8u ∗ *pSrc*, Npp32s *nLength*, Npp32s *nRestartInterval*, Npp32s *nSs*, Npp32s *nSe*, Npp32s *nAh*, Npp32s *nAl*, Npp16s ∗ *apDst*[3], Npp32s *aDstStep*[3], NppiDecodeHuffmanSpec ∗ *apHuffmanDCTable*[3], NppiDecodeHuffmanSpec ∗ *apHuffmanACTable*[3], NppiSize *aSizeROI*[3])

Huffman Decoding of the JPEG decoding on the host.

Input is expected in byte stuffed huffman encoded JPEG scan and output is expected to be 64x1 macro blocks.

Parameters:

pSrc Byte-stuffed huffman encoded JPEG scan.

nLength Byte length of the input.

nRestartInterval Restart Interval, see JPEG standard.

nSs Start Coefficient, see JPEG standard.

nSe End Coefficient, see JPEG standard.

nAh Bit Approximation High, see JPEG standard.

nAl Bit Approximation Low, see JPEG standard.

apDst Destination-Image Pointer.

aDstStep Destination-Image Line Step.

apHuffmanDCTable DC Huffman tables.

apHuffmanACTable AC Huffman tables.

aSizeROI Region-of-Interest (ROI).

Returns:

Error codes:

- NPP_SIZE_ERROR For negative input height/width or not a multiple of 8 width/height.
- NPP_STEP_ERROR If input image width is not multiple of 8 or does not match ROI.
- NPP_NULL_POINTER_ERROR If the destination pointer is 0.

7.4.3.3 NppStatus nppiDecodeHuffmanSpecFreeHost_JPEG (NppiDecodeHuffmanSpec $*$ *pHuffmanSpec*)

Frees the host memory allocated by nppiDecodeHuffmanSpecInitAllocHost_JPEG.

Parameters:

pHuffmanSpec Pointer to the Huffman table for the decoder

7.4.3.4 NppStatus nppiDecodeHuffmanSpecGetBufSize_JPEG (int $*$ *pSize*)

Returns the length of the NppiDecodeHuffmanSpec structure.

Parameters:

pSize Pointer to a variable that will receive the length of the NppiDecodeHuffmanSpec structure.

Returns:

Error codes:

- NPP_NULL_POINTER_ERROR If one of the pointers is 0.

7.4.3.5 NppStatus nppiDecodeHuffmanSpecInitAllocHost_JPEG (const Npp8u ∗ *pRawHuffmanTable*, NppiHuffmanTableType *eTableType*, NppiDecodeHuffmanSpec ∗∗ *ppHuffmanSpec*)

Allocates memory and creates a Huffman table in a format that is suitable for the decoder on the host.

Parameters:

pRawHuffmanTable Huffman table formated as specified in the JPEG standard.

eTableType Enum specifying type of table (nppiDCTable or nppiACTable).

ppHuffmanSpec Pointer to returned pointer to the Huffman table for the decoder

Returns:

Error codes:

- NPP_NULL_POINTER_ERROR If one of the pointers is 0.

7.4.3.6 NppStatus nppiDecodeHuffmanSpecInitHost_JPEG (const Npp8u ∗ *pRawHuffmanTable*, NppiHuffmanTableType *eTableType*, NppiDecodeHuffmanSpec ∗ *pHuffmanSpec*)

Creates a Huffman table in a format that is suitable for the decoder on the host.

Parameters:

pRawHuffmanTable Huffman table formated as specified in the JPEG standard.

eTableType Enum specifying type of table (nppiDCTable or nppiACTable).

pHuffmanSpec Pointer to the Huffman table for the decoder

Returns:

Error codes:

- NPP_NULL_POINTER_ERROR If one of the pointers is 0.

7.5 Quantization Functions

Typedefs

- typedef struct NppiDCTState NppiDCTState

Functions

- NppStatus nppiQuantFwdRawTableInit_JPEG_8u (Npp8u ∗hpQuantRawTable, int nQualityFactor)

  Apply quality factor to raw 8-bit quantization table.

- NppStatus nppiQuantFwdTableInit_JPEG_8u16u (const Npp8u ∗hpQuantRawTable, Npp16u ∗hpQuantFwdRawTable)

  Initializes a quantization table for nppiDCTQuantFwd8x8LS_JPEG_8u16s_C1R().

- NppStatus nppiQuantInvTableInit_JPEG_8u16u (const Npp8u ∗hpQuantRawTable, Npp16u ∗hpQuantFwdRawTable)

  Initializes a quantization table for nppiDCTQuantInv8x8LS_JPEG_16s8u_C1R().

- NppStatus nppiDCTQuantFwd8x8LS_JPEG_8u16s_C1R (const Npp8u ∗pSrc, int nSrcStep, Npp16s ∗pDst, int nDstStep, const Npp16u ∗pQuantFwdTable, NppiSize oSizeROI)

  Forward DCT, quantization and level shift part of the JPEG encoding.

- NppStatus nppiDCTQuantInv8x8LS_JPEG_16s8u_C1R (const Npp16s ∗pSrc, int nSrcStep, Npp8u ∗pDst, int nDstStep, const Npp16u ∗pQuantInvTable, NppiSize oSizeROI)

  Inverse DCT, de-quantization and level shift part of the JPEG decoding.

- NppStatus nppiDCTInitAlloc (NppiDCTState ∗∗ppState)

  Initializes DCT state structure and allocates additional resources.

- NppStatus nppiDCTFree (NppiDCTState ∗pState)

  Frees the additional resources of the DCT state structure.

- NppStatus nppiDCTQuantFwd8x8LS_JPEG_8u16s_C1R_NEW (const Npp8u ∗pSrc, int nSrcStep, Npp16s ∗pDst, int nDstStep, const Npp8u ∗pQuantizationTable, NppiSize oSizeROI, NppiDCTState ∗pState)

  Forward DCT, quantization and level shift part of the JPEG encoding.

- NppStatus nppiDCTQuantInv8x8LS_JPEG_16s8u_C1R_NEW (const Npp16s ∗pSrc, int nSrcStep, Npp8u ∗pDst, int nDstStep, const Npp8u ∗pQuantizationTable, NppiSize oSizeROI, NppiDCTState ∗pState)

  Inverse DCT, de-quantization and level shift part of the JPEG decoding.

7.5.1 Typedef Documentation

7.5.1.1 typedef struct NppiDCTState NppiDCTState

7.5.2 Function Documentation

7.5.2.1 NppStatus nppiDCTFree (NppiDCTState ∗ *pState*)

Frees the additional resources of the DCT state structure.

See also:

nppiDCTInitAlloc

Parameters:

pState Pointer to DCT state structure.

Returns:

NPP_SUCCESS Indicates no error. Any other value indicates an error or a warning
NPP_SIZE_ERROR Indicates an error condition if any image dimension has zero or negative value
NPP_NULL_POINTER_ERROR Indicates an error condition if pState pointer is NULL

7.5.2.2 NppStatus nppiDCTInitAlloc (NppiDCTState ∗∗ *ppState*)

Initializes DCT state structure and allocates additional resources.

See also:

nppiDCTQuantFwd8x8LS_JPEG_8u16s_C1R_NEW(), nppiDCTQuantInv8x8LS_JPEG_16s8u_-C1R_NEW.

Parameters:

ppState Pointer to pointer to DCT state structure.

Returns:

NPP_SUCCESS Indicates no error. Any other value indicates an error or a warning
NPP_SIZE_ERROR Indicates an error condition if any image dimension has zero or negative value
NPP_NULL_POINTER_ERROR Indicates an error condition if pBufSize pointer is NULL

7.5.2.3 NppStatus nppiDCTQuantFwd8x8LS_JPEG_8u16s_C1R (const Npp8u ∗ *pSrc*, int *nSrcStep*, Npp16s ∗ *pDst*, int *nDstStep*, const Npp16u ∗ *pQuantFwdTable*, NppiSize *oSizeROI*)

Forward DCT, quantization and level shift part of the JPEG encoding.

Input is expected in 8x8 macro blocks and output is expected to be in 64x1 macro blocks.

Parameters:

pSrc Source-Image Pointer.

nSrcStep Source-Image Line Step.

pDst Destination-Image Pointer.

nDstStep Destination-Image Line Step.

pQuantFwdTable Forward quantization tables for JPEG encoding created using nppiQuantInvTableInit_JPEG_8u16u().

oSizeROI Region-of-Interest (ROI).

Returns:

Error codes:

- NPP_SIZE_ERROR For negative input height/width or not a multiple of 8 width/height.
- NPP_STEP_ERROR If input image width is not multiple of 8 or does not match ROI.
- NPP_NULL_POINTER_ERROR If the destination pointer is 0.

7.5.2.4 NppStatus nppiDCTQuantFwd8x8LS_JPEG_8u16s_C1R_NEW (const Npp8u ∗ *pSrc*, int *nSrcStep*, Npp16s ∗ *pDst*, int *nDstStep*, const Npp8u ∗ *pQuantizationTable*, NppiSize *oSizeROI*, NppiDCTState ∗ *pState*)

Forward DCT, quantization and level shift part of the JPEG encoding.

Input is expected in 8x8 macro blocks and output is expected to be in 64x1 macro blocks. The new version of the primitive takes the ROI in image pixel size and works with DCT coefficients that are in zig-zag order.

Parameters:

pSrc Source-Image Pointer.

nSrcStep Source-Image Line Step.

pDst Destination-Image Pointer.

nDstStep Image width in pixels x 8 x sizeof(Npp16s).

pQuantizationTable Quantization Table in zig-zag order.

oSizeROI Region-of-Interest (ROI).

pState Pointer to DCT state structure. This structure must be initialized allocated and initialized using nppiDCTInitAlloc().

Returns:

Error codes:

- NPP_SIZE_ERROR For negative input height/width or not a multiple of 8 width/height.
- NPP_STEP_ERROR If input image width is not multiple of 8 or does not match ROI.
- NPP_NULL_POINTER_ERROR If the destination pointer is 0.

7.5.2.5 NppStatus nppiDCTQuantInv8x8LS_JPEG_16s8u_C1R (const Npp16s ∗ *pSrc*, int *nSrcStep*, Npp8u ∗ *pDst*, int *nDstStep*, const Npp16u ∗ *pQuantInvTable*, NppiSize *oSizeROI*)

Inverse DCT, de-quantization and level shift part of the JPEG decoding.

Input is expected in 64x1 macro blocks and output is expected to be in 8x8 macro blocks.

Parameters:

pSrc Source-Image Pointer.

nSrcStep Image width in pixels x 8 x sizeof(Npp16s).

pDst Destination-Image Pointer.

nDstStep Image width in pixels x 8 x sizeof(Npp16s).

pQuantInvTable Inverse quantization tables for JPEG decoding created using nppiQuantInvTableInit_JPEG_8u16u().

oSizeROI Region-of-Interest (ROI).

Returns:

Error codes:

- NPP_SIZE_ERROR For negative input height/width or not a multiple of 8 width/height.
- NPP_STEP_ERROR If input image width is not multiple of 8 or does not match ROI.
- NPP_NULL_POINTER_ERROR If the destination pointer is 0.

7.5.2.6 NppStatus nppiDCTQuantInv8x8LS_JPEG_16s8u_C1R_NEW (const Npp16s ∗ *pSrc*, int *nSrcStep*, Npp8u ∗ *pDst*, int *nDstStep*, const Npp8u ∗ *pQuantizationTable*, NppiSize *oSizeROI*, NppiDCTState ∗ *pState*)

Inverse DCT, de-quantization and level shift part of the JPEG decoding.

Input is expected in 64x1 macro blocks and output is expected to be in 8x8 macro blocks. The new version of the primitive takes the ROI in image pixel size and works with DCT coefficients that are in zig-zag order.

Parameters:

pSrc Source-Image Pointer.

nSrcStep Image width in pixels x 8 x sizeof(Npp16s).

pDst Destination-Image Pointer.

nDstStep Destination-Image Line Step.

pQuantizationTable Quantization Table in zig-zag order.

oSizeROI Region-of-Interest (ROI).

pState Pointer to DCT state structure. This structure must be initialized allocated and initialized using nppiDCTInitAlloc().

Returns:

Error codes:

- NPP_SIZE_ERROR For negative input height/width or not a multiple of 8 width/height.
- NPP_STEP_ERROR If input image width is not multiple of 8 or does not match ROI.
- NPP_NULL_POINTER_ERROR If the destination pointer is 0.

7.5.2.7 NppStatus nppiQuantFwdRawTableInit_JPEG_8u (Npp8u $*$ *hpQuantRawTable*, int *nQualityFactor*)

Apply quality factor to raw 8-bit quantization table.

This is effectively and in-place method that modifies a given raw quantization table based on a quality factor. Note that this method is a host method and that the pointer to the raw quantization table is a host pointer.

Parameters:

hpQuantRawTable Raw quantization table.

nQualityFactor Quality factor for the table. Range is [1:100].

Returns:

Error code: NPP_NULL_POINTER_ERROR is returned if hpQuantRawTable is 0.

7.5.2.8 NppStatus nppiQuantFwdTableInit_JPEG_8u16u (const Npp8u $*$ *hpQuantRawTable*, Npp16u $*$ *hpQuantFwdRawTable*)

Initializes a quantization table for nppiDCTQuantFwd8x8LS_JPEG_8u16s_C1R().

The method creates a 16-bit version of the raw table and converts the data order from zigzag layout to original row-order layout since raw quantization tables are typically stored in zigzag format.

This method is a host method. It consumes and produces host data. I.e. the pointers passed to this function must be host pointers. The resulting table needs to be transferred to device memory in order to be used with nppiDCTQuantFwd8x8LS_JPEG_8u16s_C1R() function.

Parameters:

hpQuantRawTable Host pointer to raw quantization table as returned by nppiQuantFwdRawTableInit_JPEG_8u(). The raw quantization table is assumed to be in zigzag order.

hpQuantFwdRawTable Forward quantization table for use with nppiDCTQuantFwd8x8LS_JPEG_-8u16s_C1R().

Returns:

Error code: NPP_NULL_POINTER_ERROR pQuantRawTable is 0.

7.5.2.9 NppStatus nppiQuantInvTableInit_JPEG_8u16u (const Npp8u $*$ *hpQuantRawTable*, Npp16u $*$ *hpQuantFwdRawTable*)

Initializes a quantization table for nppiDCTQuantInv8x8LS_JPEG_16s8u_C1R().

The nppiDCTQuantFwd8x8LS_JPEG_8u16s_C1R() method uses a quantization table in a 16-bit format allowing for faster processing. In addition it converts the data order from zigzag layout to original row-order layout. Typically raw quantization tables are stored in zigzag format.

This method is a host method and consumes and produces host data. I.e. the pointers passed to this function must be host pointers. The resulting table needs to be transferred to device memory in order to be used with nppiDCTQuantFwd8x8LS_JPEG_8u16s_C1R() function.

Parameters:

hpQuantRawTable Raw quantization table.

hpQuantFwdRawTable Inverse quantization table.

Returns:

NPP_NULL_POINTER_ERROR pQuantRawTable or pQuantFwdRawTable is0.

Chapter 8

Data Structure Documentation

8.1 NPP_ALIGN_16 Struct Reference

Complex Number This struct represents a long long complex number.

`#include <nppdefs.h>`

Data Fields

- Npp64s re

  Real part.

- Npp64s im

  Imaginary part.

- Npp64f re

  Real part.

- Npp64f im

  Imaginary part.

8.1.1 Detailed Description

Complex Number This struct represents a long long complex number.

Complex Number This struct represents a double floating-point complex number.

8.1.2 Field Documentation

8.1.2.1 Npp64f NPP_ALIGN_16::im

Imaginary part.

8.1.2.2 Npp64s NPP_ALIGN_16::im

Imaginary part.

8.1.2.3 Npp64f NPP_ALIGN_16::re

Real part.

8.1.2.4 Npp64s NPP_ALIGN_16::re

Real part.

The documentation for this struct was generated from the following file:

- C:/src/sw/rel/gpgpu/toolkit/r8.0/NPP/npp/include/nppdefs.h

8.2 NPP_ALIGN_8 Struct Reference

Complex Number This struct represents an unsigned int complex number.

`#include <nppdefs.h>`

Data Fields

- Npp32u re

  Real part.

- Npp32u im

  Imaginary part.

- Npp32s re

  Real part.

- Npp32s im

  Imaginary part.

- Npp32f re

  Real part.

- Npp32f im

  Imaginary part.

8.2.1 Detailed Description

Complex Number This struct represents an unsigned int complex number.

Complex Number This struct represents a single floating-point complex number.

Complex Number This struct represents a signed int complex number.

8.2.2 Field Documentation

8.2.2.1 Npp32f NPP_ALIGN_8::im

Imaginary part.

8.2.2.2 Npp32s NPP_ALIGN_8::im

Imaginary part.

8.2.2.3 Npp32u NPP_ALIGN_8::im

Imaginary part.

8.2.2.4 Npp32f NPP_ALIGN_8::re

Real part.

8.2.2.5 Npp32s NPP_ALIGN_8::re

Real part.

8.2.2.6 Npp32u NPP_ALIGN_8::re

Real part.

The documentation for this struct was generated from the following file:

- C:/src/sw/rel/gpgpu/toolkit/r8.0/NPP/npp/include/nppdefs.h

8.3 NppiHaarBuffer Struct Reference

```
#include <nppdefs.h>
```

Data Fields

- int haarBufferSize

  size of the buffer

- Npp32s ∗ haarBuffer

  buffer

8.3.1 Field Documentation

8.3.1.1 Npp32s∗ NppiHaarBuffer::haarBuffer

buffer

8.3.1.2 int NppiHaarBuffer::haarBufferSize

size of the buffer

The documentation for this struct was generated from the following file:

- C:/src/sw/rel/gpgpu/toolkit/r8.0/NPP/npp/include/nppdefs.h

8.4 NppiHaarClassifier_32f Struct Reference

```
#include <nppdefs.h>
```

Data Fields

- int numClassifiers

  number of classifiers

- Npp32s ∗ classifiers

  packed classifier data 40 bytes each

- size_t classifierStep
- NppiSize classifierSize
- Npp32s ∗ counterDevice

8.4.1 Field Documentation

8.4.1.1 Npp32s∗ NppiHaarClassifier_32f::classifiers

packed classifier data 40 bytes each

8.4.1.2 NppiSize NppiHaarClassifier_32f::classifierSize

8.4.1.3 size_t NppiHaarClassifier_32f::classifierStep

8.4.1.4 Npp32s∗ NppiHaarClassifier_32f::counterDevice

8.4.1.5 int NppiHaarClassifier_32f::numClassifiers

number of classifiers

The documentation for this struct was generated from the following file:

- C:/src/sw/rel/gpgpu/toolkit/r8.0/NPP/npp/include/nppdefs.h

8.5 NppiPoint Struct Reference

2D Point

```
#include <nppdefs.h>
```

Data Fields

- int x

  x-coordinate.

- int y

  y-coordinate.

8.5.1 Detailed Description

2D Point

8.5.2 Field Documentation

8.5.2.1 int NppiPoint::x

x-coordinate.

8.5.2.2 int NppiPoint::y

y-coordinate.

The documentation for this struct was generated from the following file:

- C:/src/sw/rel/gpgpu/toolkit/r8.0/NPP/npp/include/nppdefs.h

8.6 NppiRect Struct Reference

2D Rectangle This struct contains position and size information of a rectangle in two space.

```
#include <nppdefs.h>
```

Data Fields

- int x

  x-coordinate of upper left corner (lowest memory address).

- int y

  y-coordinate of upper left corner (lowest memory address).

- int width

  Rectangle width.

- int height

  Rectangle height.

8.6.1 Detailed Description

2D Rectangle This struct contains position and size information of a rectangle in two space.

The rectangle's position is usually signified by the coordinate of its upper-left corner.

8.6.2 Field Documentation

8.6.2.1 int NppiRect::height

Rectangle height.

8.6.2.2 int NppiRect::width

Rectangle width.

8.6.2.3 int NppiRect::x

x-coordinate of upper left corner (lowest memory address).

8.6.2.4 int NppiRect::y

y-coordinate of upper left corner (lowest memory address).

The documentation for this struct was generated from the following file:

- C:/src/sw/rel/gpgpu/toolkit/r8.0/NPP/npp/include/nppdefs.h

8.7 NppiSize Struct Reference

2D Size This struct typically represents the size of a a rectangular region in two space.

```
#include <nppdefs.h>
```

Data Fields

- int width

  Rectangle width.

- int height

  Rectangle height.

8.7.1 Detailed Description

2D Size This struct typically represents the size of a a rectangular region in two space.

8.7.2 Field Documentation

8.7.2.1 int NppiSize::height

Rectangle height.

8.7.2.2 int NppiSize::width

Rectangle width.

The documentation for this struct was generated from the following file:

- C:/src/sw/rel/gpgpu/toolkit/r8.0/NPP/npp/include/nppdefs.h

8.8 NppLibraryVersion Struct Reference

```
#include <nppdefs.h>
```

Data Fields

- int major
  Major version number.
- int minor
  Minor version number.
- int build
  Build number.

8.8.1 Field Documentation

8.8.1.1 int NppLibraryVersion::build

Build number.

This reflects the nightly build this release was made from.

8.8.1.2 int NppLibraryVersion::major

Major version number.

8.8.1.3 int NppLibraryVersion::minor

Minor version number.

The documentation for this struct was generated from the following file:

- C:/src/sw/rel/gpgpu/toolkit/r8.0/NPP/npp/include/nppdefs.h

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