OpenCV CUDA for Video Preprocessing

No camera required. (Built on Jetson Nano.)

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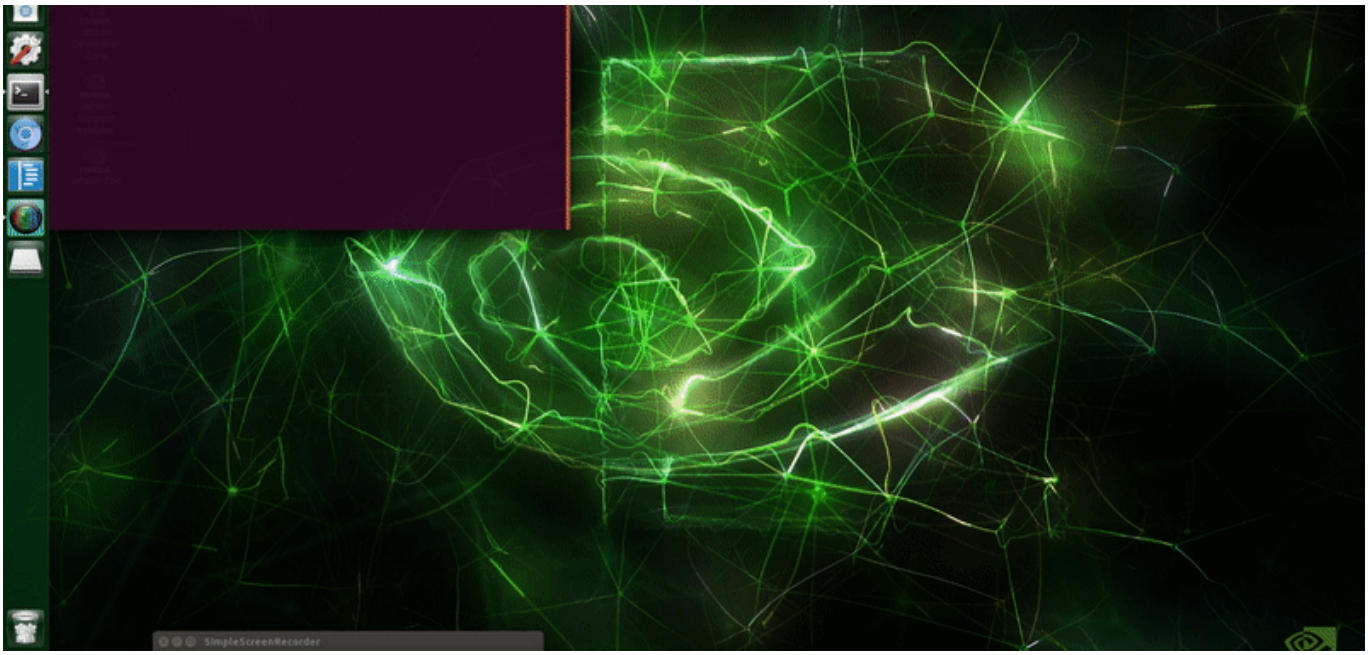
```python
import cv2 as cv

vod = cv.VideoCapture('media/corn.mp4')

ret, frame = vod.read()

gpu_frame = cv.cuda_GpuMat()

while ret:
    gpu_frame.upload(frame)

    frame = cv.cuda.resize(gpu_frame, (852, 480))
    frame.download()

    ret, frame = vod.read()
```

cold_cvcuda_vod.py hosted with ❤️ by GitHub view raw



Code to Reproduce this Display (original video source)

cv.cuda

OpenCV's CUDA python module is a lot of fun, but it's a work in progress.

For starters, we have to load in the video on CPU before passing it (frame-by-frame) to GPU. `cv.cuda.imread()` has not been built yet.

Step 1 — `.upload()`

`cv.VideoCapture()` can be used to load and iterate through video frames on CPU. Let's read the `corn.mp4` file with it;

```
import cv2 as cv

# load .mp4 video
vod = cv.VideoCapture('media/corn.mp4')

# grab 1st frame (ret is bool)
ret, frame = vod.read()
```

load_video_cpu.py hosted with ❤ by GitHub view raw

After `.read()` ing the 1st image, we're ready to make a GPU matrix (picture frame) so that image can be `.upload()` ed to our GPU.

```
import cv2 as cv

vod = cv.VideoCapture('media/corn.mp4')

ret, frame = vod.read()

# create a frame on GPU for images
gpu_frame = cv.cuda_GpuMat()

# send 1st frame to GPU
gpu_frame.upload(frame)
```

cpu_to_gpu_video_cv.py hosted with ❤️ by GitHub view raw

Great! But what about the 2nd image?

Well, you probably noticed `.read()` output 2 variables, `ret` and `frame`; `ret` is a boolean value that's `True` if `frame` is a valid frame and `False` if it's not.

So we can simply introduce a `while` loop and, by grabbing the next frame at the bottom, it'll break when the video's completed (i.e. `ret!=True`).

```
import cv2 as cv

vod = cv.VideoCapture('media/corn.mp4')

ret, frame = vod.read()

gpu_frame = cv.cuda_GpuMat()

# as long as the last frame was successfully read
while ret:

  # send current frame to GPU
  gpu_frame.upload(frame)

  # grab next frame with CPU
  ret, frame = vod.read()
```

cpu_to_gpu_video_loop_cv.py hosted with ❤️ by GitHub view raw

Setp 2 — Have Fun

Once frames start hitting GPU memory, the fun begins.

We've already seen `cv.cuda.resize()`, so let's toss in `cv.cuda.cvtColor()` and apply some filters to the resized frames.

```
import cv2 as cv

vod = cv.VideoCapture('media/corn.mp4')

ret, frame = vod.read()

# set scale of resized image
scale = 0.5

gpu_frame = cv.cuda_GpuMat()

while ret:

    gpu_frame.upload(frame)

    # resize image (numpy.ndarray -> cv2.cuda_GpuMat)
    resized = cv.cuda.resize(gpu_frame, (int(1280 * scale), int(720 * scale)))

    # apply luv, hsv, and grayscale filters to resized image
    luv = cv.cuda.cvtColor(resized, cv.COLOR_BGR2LUV)
    hsv = cv.cuda.cvtColor(resized, cv.COLOR_BGR2HSV)
    gray = cv.cuda.cvtColor(resized, cv.COLOR_BGR2GRAY)

    ret, frame = vod.read()
```

multi_cvcuda.py hosted with ❤ by GitHub view raw

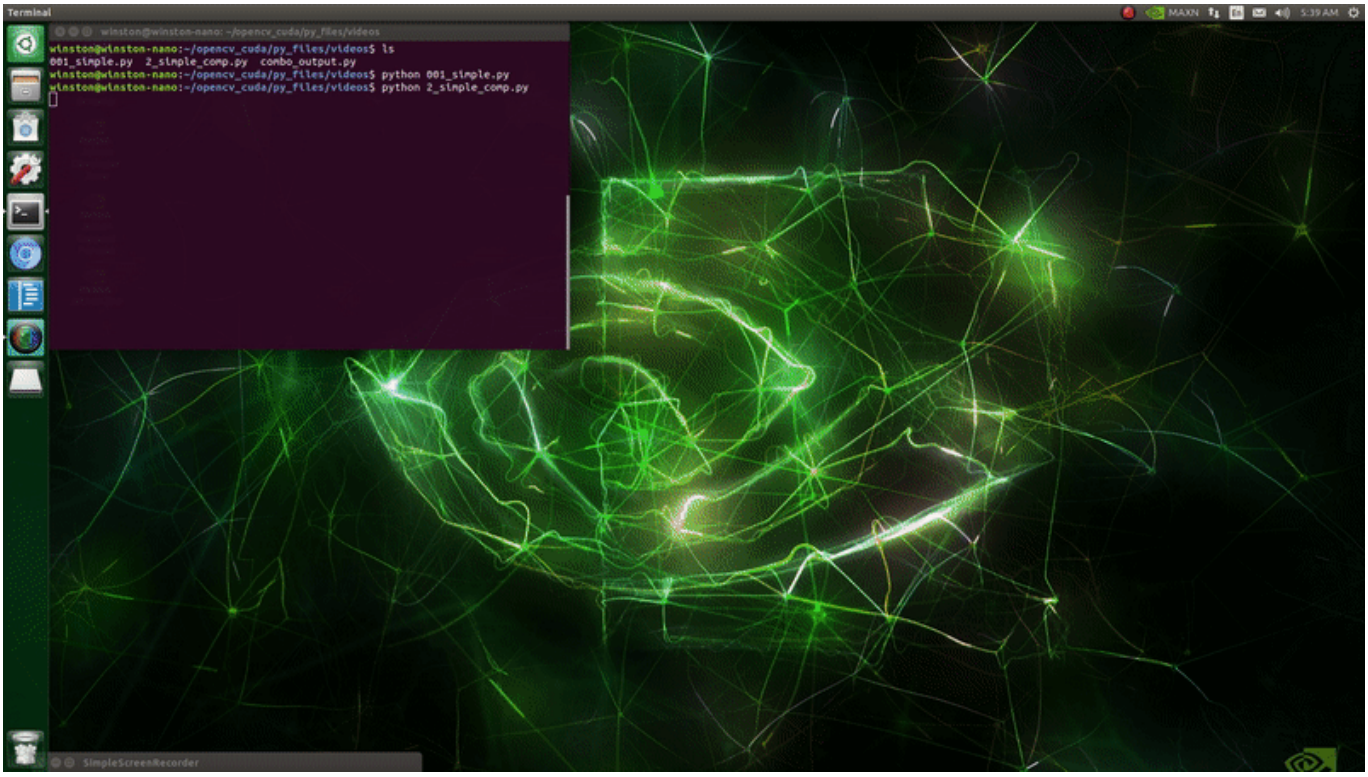
You'll also note `scale`, this is for quickly adjusting the scale of the resize.

Step 3 — .download()

To see the images, we need to bring each back from GPU memory (`cv2.cuda_GpuMat`) to CPU memory (`numpy.ndarray`).

We can put this in right before loading the next frame;

And here's how they came out;



Code to Reproduce this Display

cv.cuda + cv

Not all OpenCV methods have been translated to CUDA python bindings.

If, for example, you want to do `.Canny()` edge detection, you'll either need to `.download()` (move that image from GPU to CPU) or run `cv.Canny()` before `.upload()` ing the video to GPU.

The `.download()` route made more sense to me;

To compare with the canny results, let's run in a threshold on the grayscale as well. `.threshold()` is CUDA capable.

So if we only wanted to output the GPU threshold (`thresh`) and CPU Canny edge (`canny`), the script could look something like;

By scaling down the output image size (from `scale=0.5` to `scale=0.25`), however, my Jetson Nano was able to display all 5 edits (`gray` , `luv` , `thresh` , `hsv` , `canny`) and the resized original (`resized`) side-by-side in real time.

So I did that;

Code to Reproduce this Display

> *Note: displaying single channel images (* `gray`, `thresh`, `canny` *) next to triple channel images (* `resize`, `luv`, `hsv` *) can be achieved with* `cv.cvtColor(img, cv.COLOR_GRAY2BGR)`

Fin

Thanks for reading. Please feel free to respond with any questions.

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github.com

You can help build OpenCV CUDA in opencv/opencv_contrib or in opencv/opencv.

Continued Reading

GPU Module Introduction — General Information

> *The OpenCV GPU module is a set of classes and functions to utilize GPU computational capabilities. It is implemented using NVIDIA CUDA Runtime API and supports only NVIDIA GPUs.*
>
> *The OpenCV GPU module includes utility functions, low-level vision primitives, and high-level algorithms.*
>
> *The utility functions and low-level primitives provide a powerful infrastructure for developing fast vision algorithms taking advantage of GPU whereas the high-level functionality includes some state-of-the-art algorithms (such as stereo correspondence, face and people detectors, and others) ready to be used by the application developers. (cont…)*

References

"CUDA." *OpenCV*, OpenCV Team, 2020, opencv.org/platforms/cuda.

Pulli, Kari; Baksheev, Anatoly; Kornyakov, Kirill; Eruhimov, Victor. "Realtime Computer Vision with OpenCV." *Realtime Computer Vision with OpenCV — ACM Queue*, Association for Computing Machinery, 22 Apr. 2012, queue.acm.org/detail.cfm?id=2206309.

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