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Histogram Equalization

* **Problem statement:** Histogram Equalization

complete implementation of Histogram equalization on your face image with 1024 * 1024 size 8bit grayscale img.

○ **Parallelizing Histogram using Cuda**

Histogram equalization enhances image contrast be redistributing pixel intensities in a sequential CPU implementation, computing the histogram. Cumulative distribution function. (CDF)

① computing Histogram
② Computing CDF
③ Transforming image histogram

Challenges:

1) Atomic operations - since multiple thread update same bin

2) Global Memory latency - accessing global memory frequently slows down the execution,

3) Parallel prefix sum - sequential computation limits GPU.

Observation:

① GPU was slower than CPU.

despite parallel execution, atomic operations and memory overhead led to increased exe time, unlike CPU's which handle sequential tasks efficiently. GPU struggle when thread must frequently synchronize.

Speed up factor!

$$Speedup = \frac{CPU\ time}{GPU\ time} = \frac{16\ ms}{1650\ ms} \approx 0.0097 \text{ ✗}$$

since speedup is less than 1, The GPU performed worse due to memory overhead and inefficient processing.