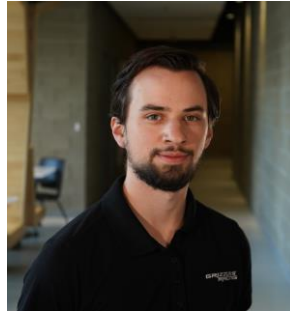


Multi Threaded BLOB Analysis for Video Processing



Professor: Daniel Llamocca
ECE 4900: Embedded Systems Design
Matthew Hait

Core Idea

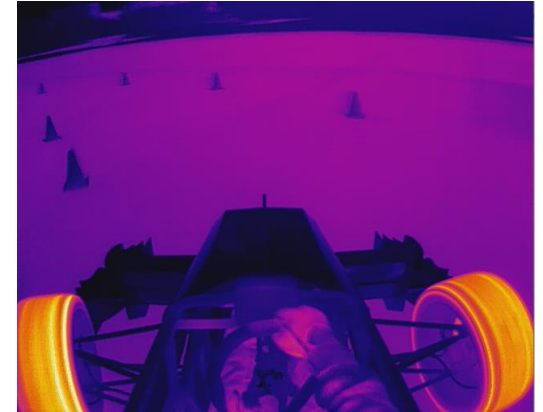
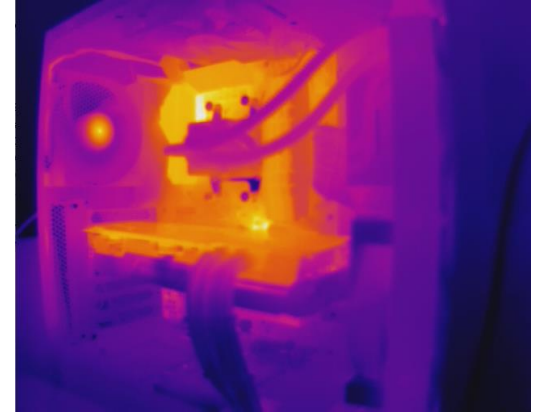
Find and evaluate heat sources in thermal imaging.

Evaluate:

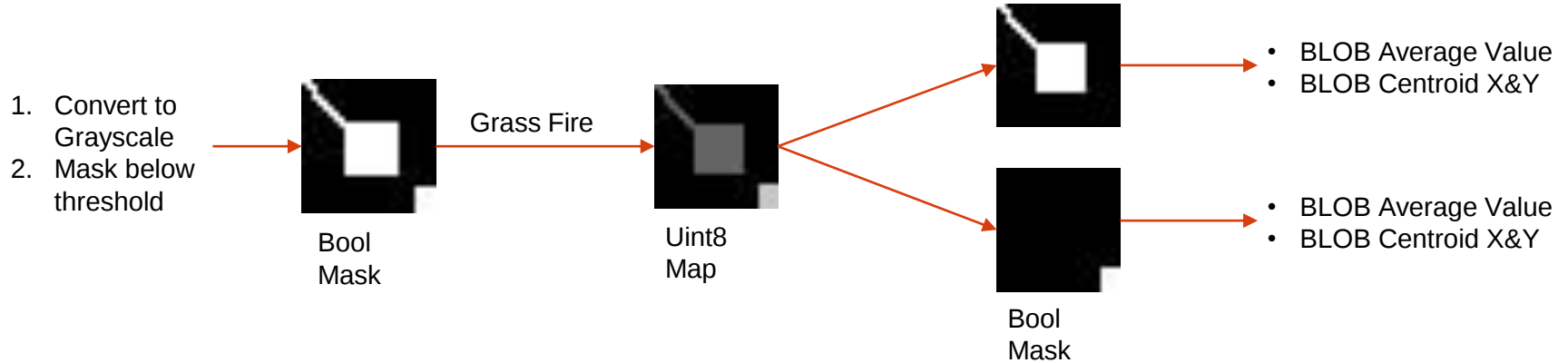
- BLOB Centroid Location
- BLOB Average Value

Design Requirements:

- Image processing time < frame time



Program Flow



Benchmark

- Generate 100 white images
- 76x43 to 4320

```
/home/mhait/Documents/ECE-4900/ece-4900_final_m_hait/cmake/./bin/ECE-4900_FINAL_M_Hait -b
Testing 100 levels from 76x43 to 7680x4320. All Units [us]
-----
Res      S.Mask  P.Mask  P.RGF   S.RGF   S.BAVG  P.BAVG  P.BAVG2  S.BCNT  P.BCNT  P.BCNT2
-----
77x43,   59, 6911, 2653, 161,   8738, 5283, 30096, 8618, 4563, 29970,
154x86,  182,   415,  10429, 524,   26984, 13906, 37104, 26882, 17537, 47865,
231x129, 358,   839,  23056, 1110,  36843, 25473, 34938, 33434, 17108, 32961,
308x172, 622,   881,  40593, 2095,  140454, 71461, 118321, 137613, 69589, 117668,
385x215, 1028,  1287, 63593, 3189,  77887, 39914, 62006, 77913, 39848, 62452,
462x258, 1516,  1702, 90965, 4844, 200491, 103466, 151311, 199807, 103973, 151716,
539x301, 2180,  2120, 124318, 6199, 334746, ^C
```

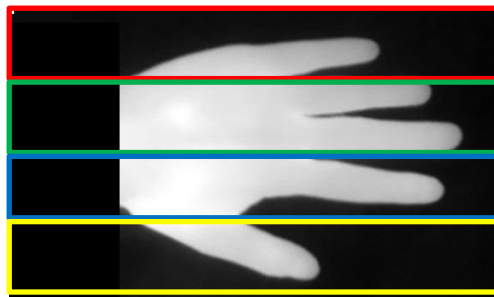
Photo Mask



uint8_t

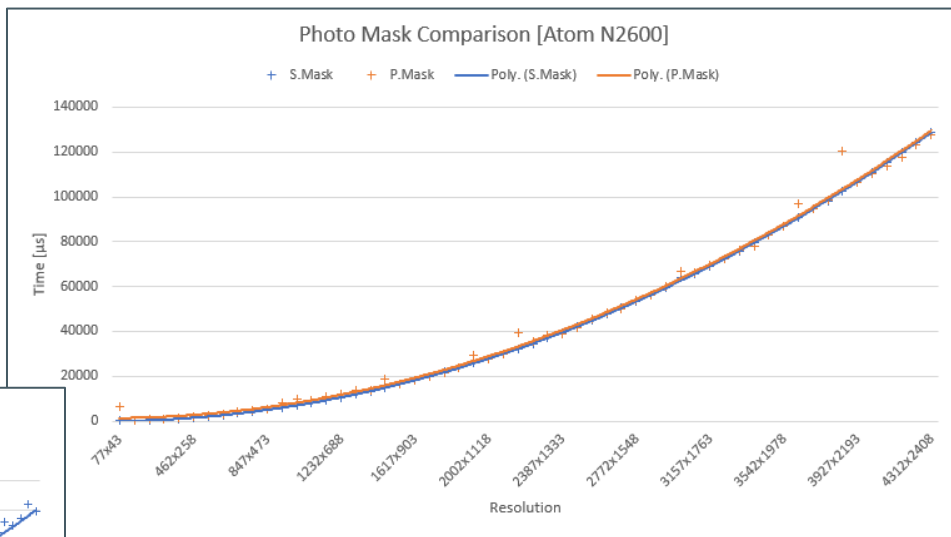
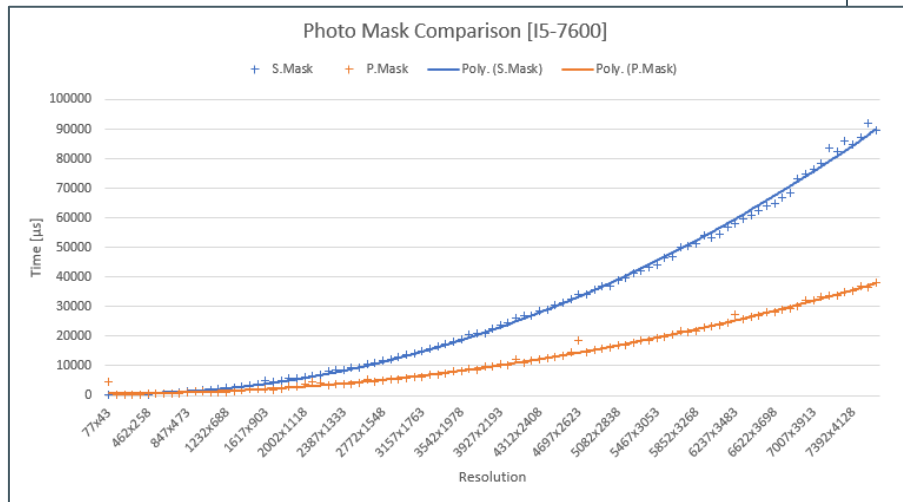


bool



TBB: Parallel For

Photo Mask Results



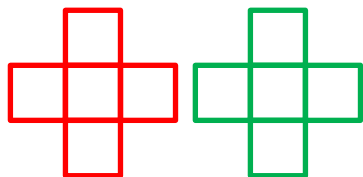
Recursive Grass Fire (RGF)



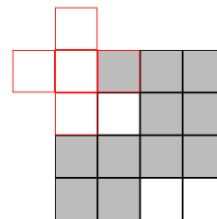
bool



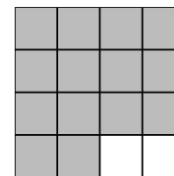
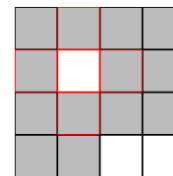
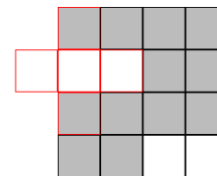
uint8_t
*7x7 Contact Kernel Used



TBB: Task Group
(Spawn threads in recursion)



RGF Algorithm

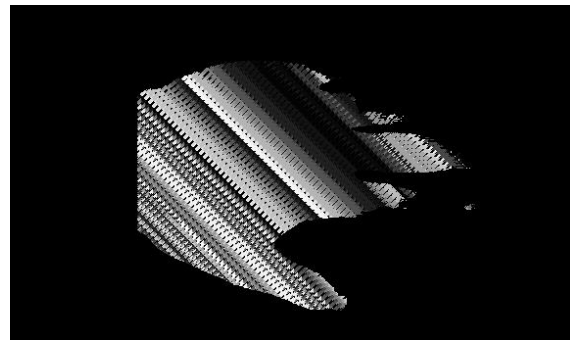


Recursion Aside

Recursion is BAD!

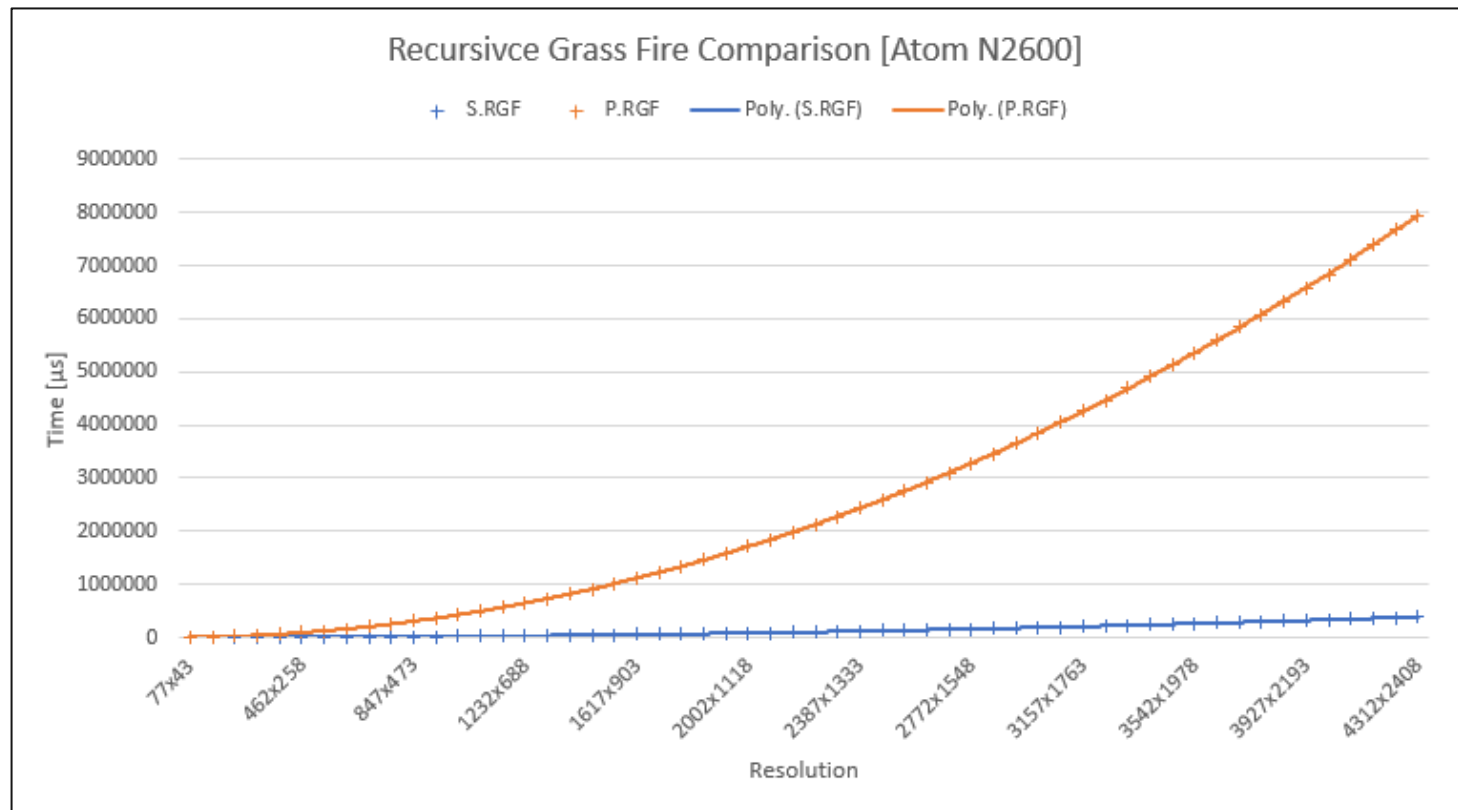
Solutions for deep recursion:

1. Translate to iterative
2. Translate to tail recursion
3. Trampoline
4. Use little to no vars and prevent over recursion
5. Enlarge the stack and prevent over recursion
6. Relocate stack pointer onto heap



Multithread error from no mutex

RGF Results



BLOB Average



BLOB Map



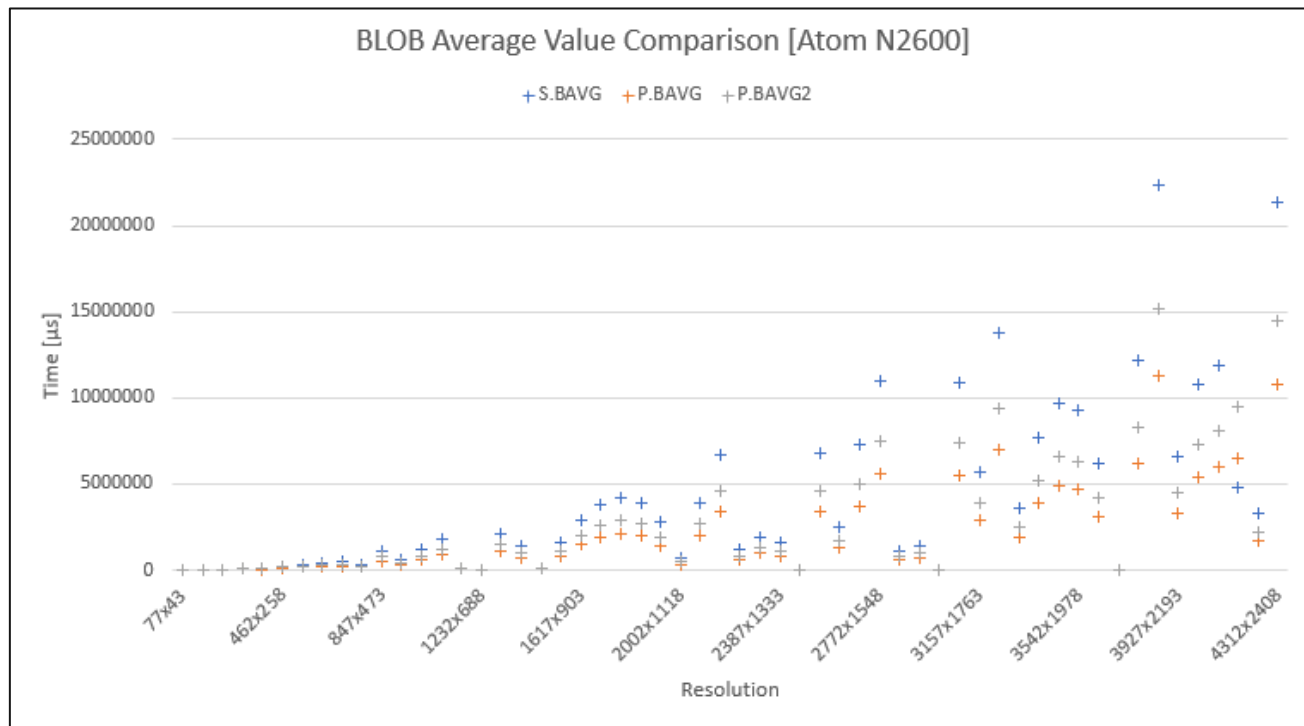
Original Greyscale

BLOB Average Value

TBB Methods:

1. Parallel For: BLOB IDs
2. 2.A. Parallel For: BLOB IDs
2.B. TBB Reduce Average

BLOB Average Results



BLOB Centroid



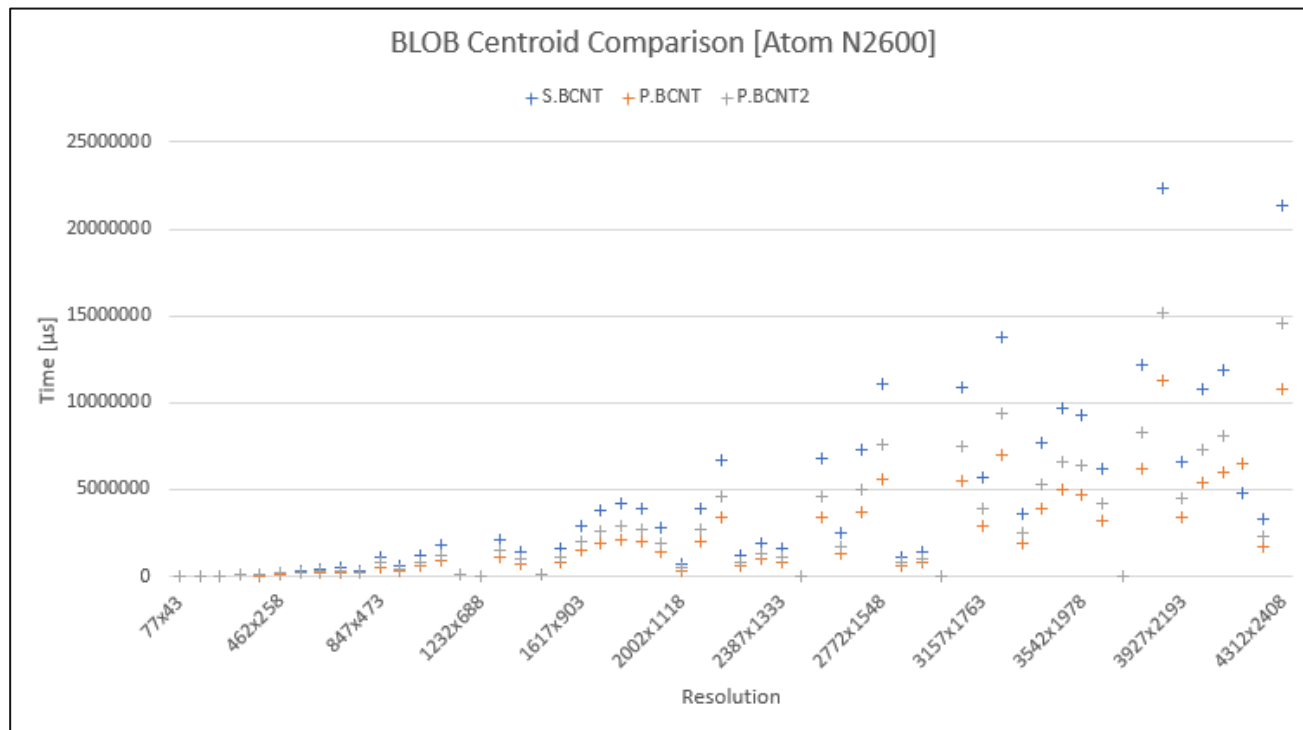
BLOB Map

- BLOB average X value
- BLOB average Y value

TBB Methods:

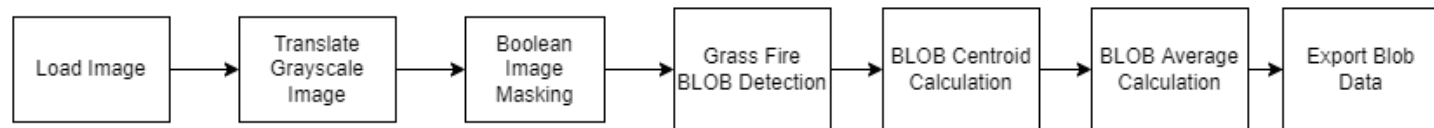
1. Parallel For: BLOB IDs
2. 2.A. Parallel For: BLOB IDs
2.B. TBB Reduce X&Y Average

BLOB Centroid Results

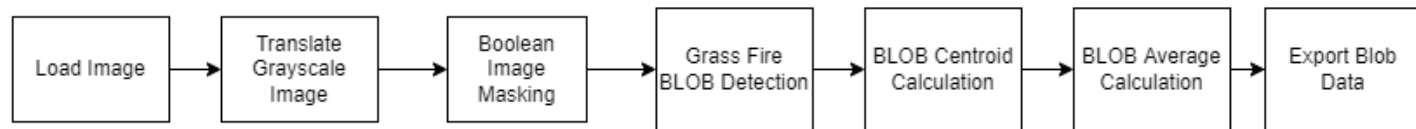


TBB Parallel Pipeline

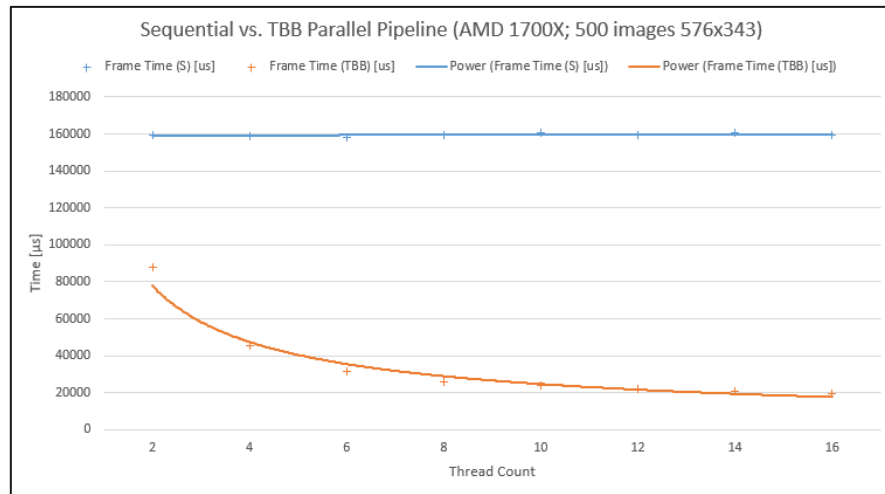
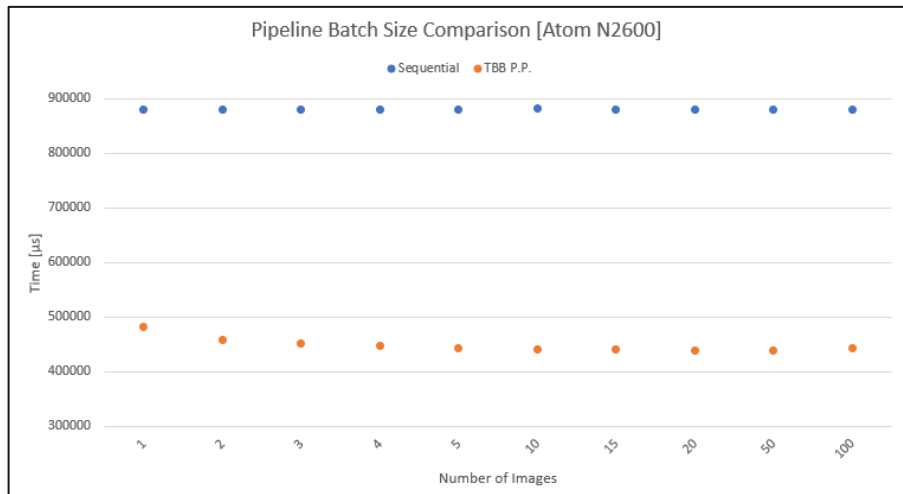
Frame 1:



Frame 2:



TBB Parallel Pipeline Results



```
mhait@DE2I:~/Documents/ECE-4900/ece-4900_final_m_hait/bin$ sudo ./ECE-4900_FINAL_M_Hait -ci ../input_files/batch_load/
Loaded 5 images with a width of 576px, a height of 343px. The original images had 3 channels.
Running sequential... Comp. Time:          4402772 [us],    AVG. Frame Time: 880554 [us].
Running parallel pipeline... Comp. Time:    2213348 [us],    AVG. Frame Time: 442669 [us].
-----
Total savings: 49.728310%
mhait@DE2I:~/Documents/ECE-4900/ece-4900_final_m_hait/bin$
```