Navistar Year 5 Hardware Analysis

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Hardware Process

Lenovo Y520:

- CPU: 7th Gen Intel Core i7-7700HQ Quad-Core Processor (2.80 GHz)
- RAM: 16GB DDR4
- OS: Windows 10
- Python Version: 3.9.2
- Testing Procedure: Ran on Windows 10 OS using Python 3.9.2.

Google Pixel 4:

- CPU: Qualcomm Snapdragon 855 octa-core processor
- RAM: 6GB
- OS: Android 13
- SDK Version: 32
- App Development: Developed in Kotlin 1.5.21
- Testing Procedure: Ran on Android 13 using TensorFlow tutorial on Android app development with SDK version 32 and Kotlin 1.5.21.

Raspberry Pi 3B+:

- CPU: Broadcom BCM2837B0 System on a Chip (SoC) with a 64-bit quad-core ARM Cortex-A53 CPU running at 1.4 GHz
- RAM: 1GB LPDDR2 SDRAM
- External Peripherals: 1080p USB EMEET C960 Webcam with Tripod, 128GB micro SD card (100 MB/s Read, 60 MB/s Write)
- OS: Debian Bullseye 64-bit
- Python Version: 3.9.2
- Testing Procedure: Ran on Debian Bullseye 64-bit OS using Python 3.9.2, with the addition of external peripherals for live video feed and operating system functionality.

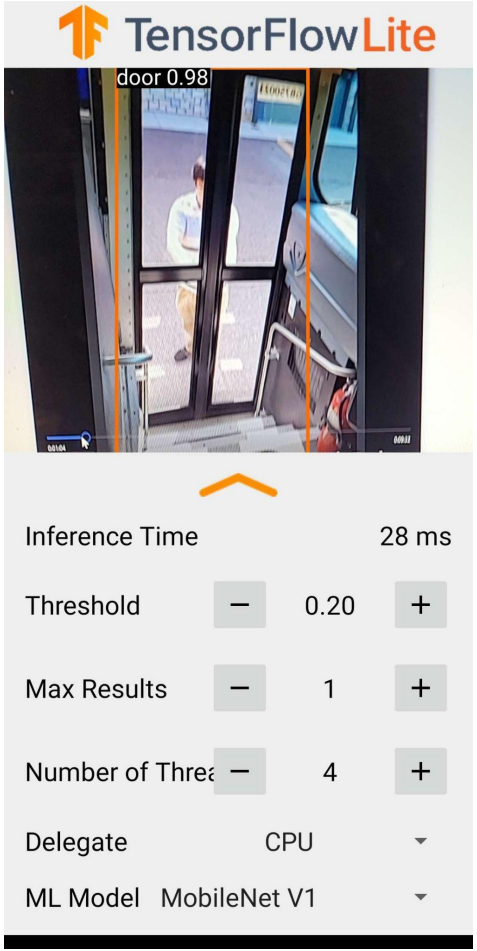
Hardware Analysis Procedure

Task 1: Batch Image Object Detection

- Raspberry Pi B3+
- PC (Lenovo Y520)

Task 2: Live Video Object Detection

- Raspberry Pi B3+
- Google Pixel 4

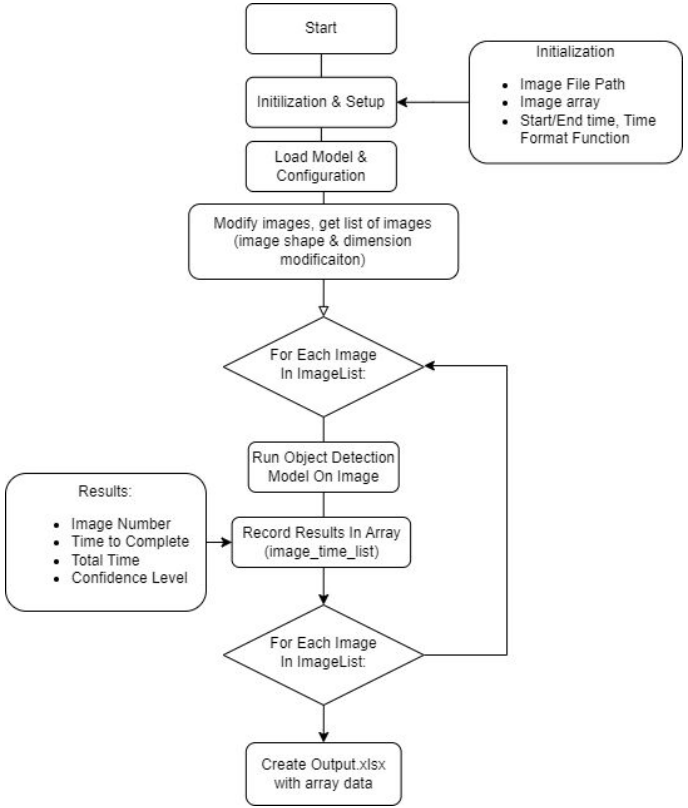


Software Procedure - Batch Image Object Detection

Task 1: Batch Image Object Detection

- Raspberry Pi B3+
- PC (Lenovo Y520)

Both Devices used Python 3.9.2



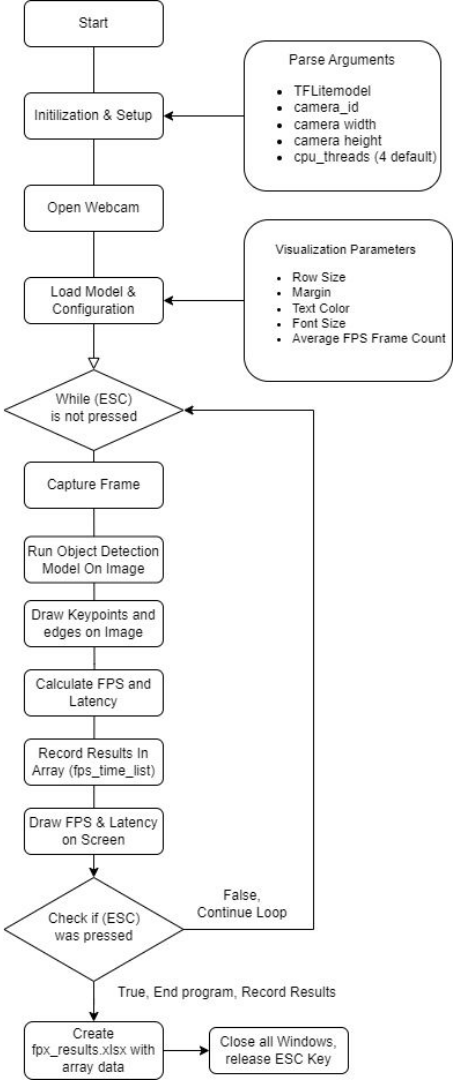
Software Procedure - Video Object Detection

Task 2: Video Object Detection

- Raspberry Pi B3+
- Google Pixel 4

Raspberry Pi B3+ used Python 3.9.2

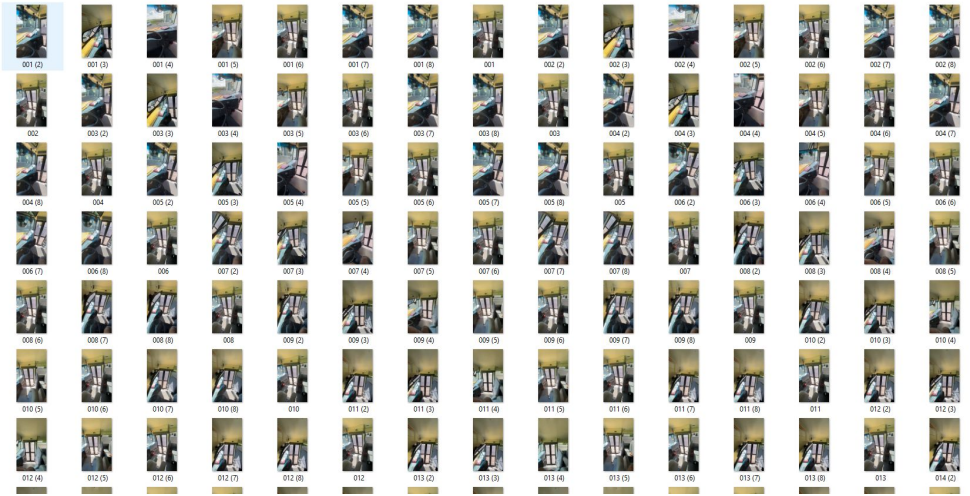
Google Pixel 4 Ran on Android 13 using TensorFlow tutorial on Android app



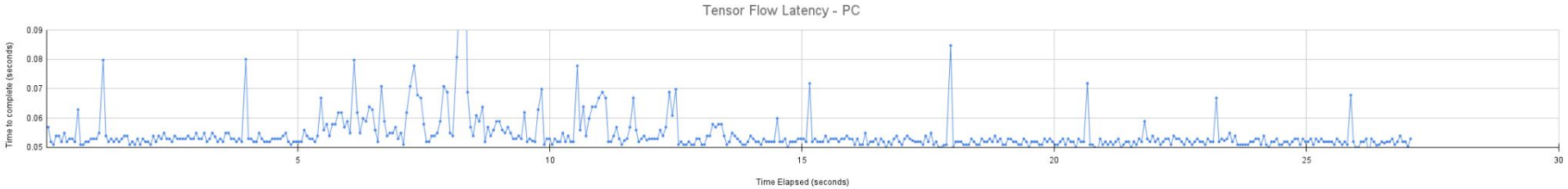
Task 1: Batch Image Object Detection

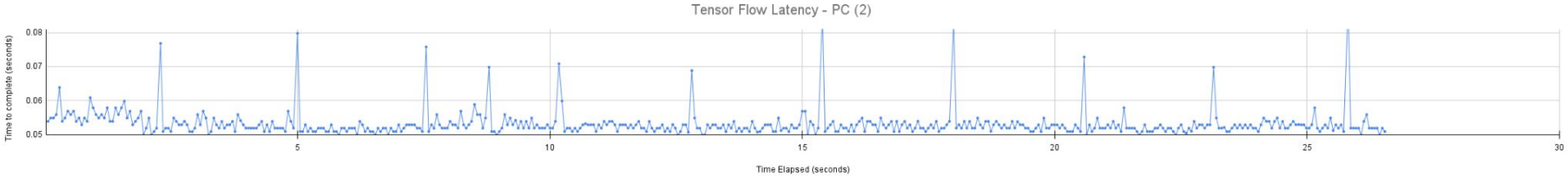
- 500 Images featuring Bus Doors
- 0.05s, vs 0.4s taken to modify and organize images
- Monitored the first batches without confidence
- Second batch provided an output of the Max confidence value from the 26 provided

Image No.	Time To Comple	Total Time	Max_Confidence
Image #1	0.4275043011	0.4275043011	0.984375
Image #2	0.3628153801	0.7903196812	0.8984375
Image #3	0.3524258137	1.142745495	0.8984375
Image #4	0.351277113	1.494022608	0.921875
Image #5	0.3575844765	1.851607084	0.9765625
Image #6	0.3535366058	2.20514369	0.828125
Image #7	0.3535969257	2.558740616	0.87890625
Image #8	0.3517613411	2.910501957	0.97265625
Image #9	0.3505222797	3.261024237	0.8984375
Image #10	0.3508515358	3.611875772	0.93359375
Image #11	0.3513207436	3.963196516	0.828125
Image #12	0.3524513245	4.31564784	0.94140625
Image #13	0.363073349	4.678721189	0.97265625
Image #14	0.3521716595	5.030892849	0.984375
Image #15	0.352227211	5.38312006	0.83984375
Image #16	0.3519883156	5.735108376	0.94921875
Image #17	0.35394907	6.089057446	0.9765625
Image #18	0.3523240089	6.441381454	0.921875
Image #19	0.3527209759	6.79410243	0.83984375
Image #20	0.3513424397	7.14544487	0.93359375
Image #21	0.3516931534	7.497138023	0.83984375
Image #22	0.3543097973	7.851447821	0.96875
Image #23	0.3536534309	8.205101252	0.64453125
Image #24	0.3520202637	8.557121515	0.953125
Image #25	0.3517332077	8.908854723	0.97265625
Image #26	0.3508853912	9.259740114	0.88671875
Image #27	0.3528232574	9.612563372	0.95703125
Image #28	0.3510222435	9.963585615	0.8671875



Task 1: PC Results

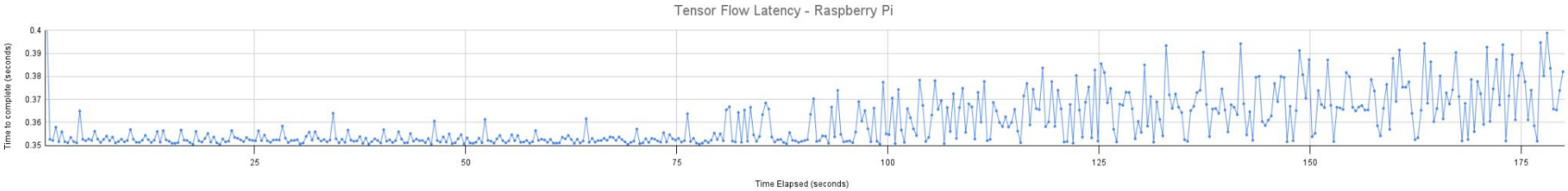


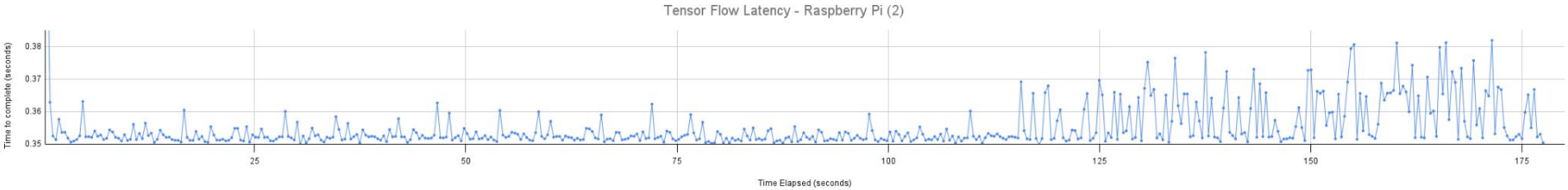


Average Time: 0.054s

Total Time: 27.066s

Task 1: Raspberry Pi B3+ Results





Average Time: 0.360s

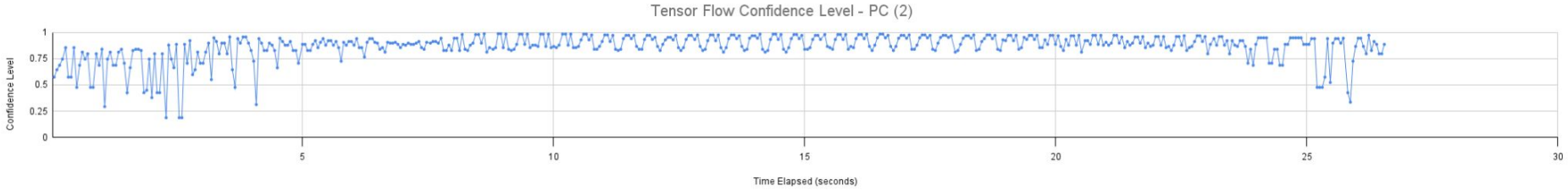
Total Time: 179.910s (almost 3m)

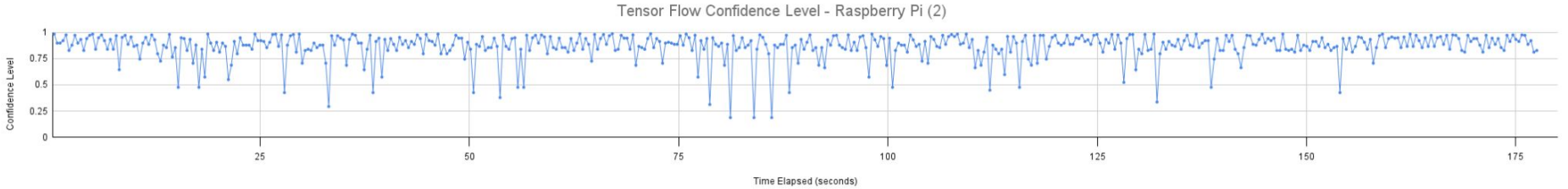
#1 Staggered around 80s

#2 Staggered around 115s

Low: 0.35, High: 0.38

Task 1: Confidence Level Results





Average Confidence: 0.867

Task 1 Total Results

Tensor Flow Object Detection on Images Latency Results						
	Average Time	Total Time	Max Time	Min Time	Start Time	End Time
PC Test #1	0.054	27.066	0.146	0.048	0.048	27.066
PC Test #2	0.053	26.545	0.089	0.050	0.054	26.545
PI Test #1	0.360	179.910	0.407	0.350	0.407	179.910
PI Test #2	0.355	177.499	0.428	0.350	0.428	177.499

Tensor Flow Object Detection on Images Confidences			
	Min Confidence	Max Confidence	Average Confidence
PC Test	0.1875	0.9883	0.867
PI Test	0.1875	0.9883	0.867

Task 1 Results

Tensor Flow Object Detection on Images Latency Results						
	Average Time	Total Time	Max Time	Min Time	Start Time	End Time
PC Test #1	0.054	27.066	0.146	0.048	0.048	27.066
PC Test #2	0.053	26.545	0.089	0.050	0.054	26.545
PI Test #1	0.360	179.910	0.407	0.350	0.407	179.910
PI Test #2	0.355	177.499	0.428	0.350	0.428	177.499

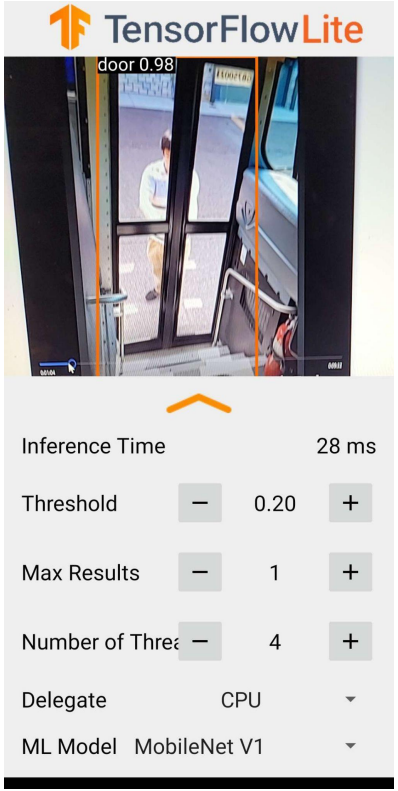
Tensor Flow Object Detection on Images Confidences			
	Min Confidence	Max Confidence	Average Confidence
PC Test	0.1875	0.9883	0.867
PI Test	0.1875	0.9883	0.867

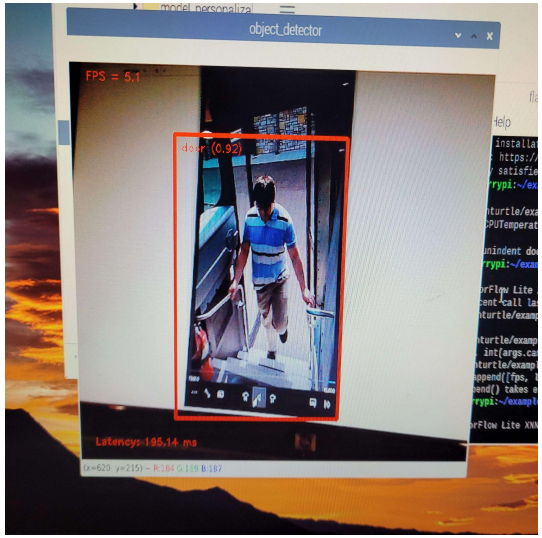
Task 2: Video Object Detection

- Devices Ran for 30-40m
- Devices had CPU 4 threads enabled
- Max results for detection was 1

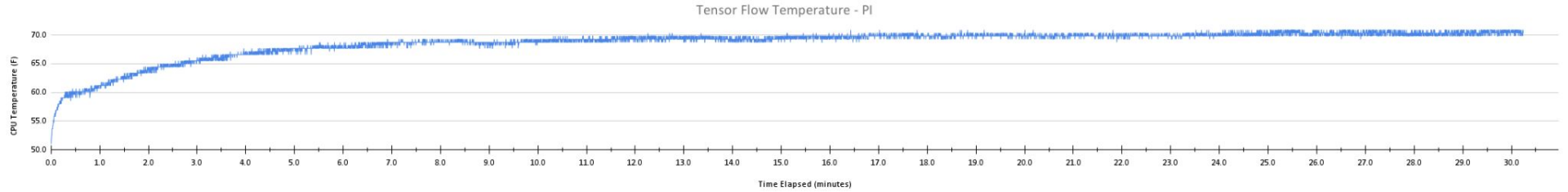
FPS	Latency (ms)	Time	Temperature	Minutes
3.218385678	300.8224087	1.925231218	51.002	0.0
4.118385678	242.8224087	2.168053627	51.54	0.0
5.66885935	176.4111519	2.344464779	52.078	0.0
5.946288801	168.1814194	2.512646198	52.078	0.0
6.030189016	165.8391953	2.678485394	52.616	0.0
6.091343193	164.1745567	2.84265995	52.616	0.0
5.813415904	172.0240116	3.014683962	53.154	0.1
5.623499537	177.8347492	3.192518711	53.692	0.1
5.946255081	168.184042	3.360702753	53.692	0.1
6.094821811	164.0806198	3.524783373	53.692	0.1
5.929367326	168.6594486	3.693442822	53.692	0.1
6.070783037	164.7322178	3.858175039	53.692	0.1

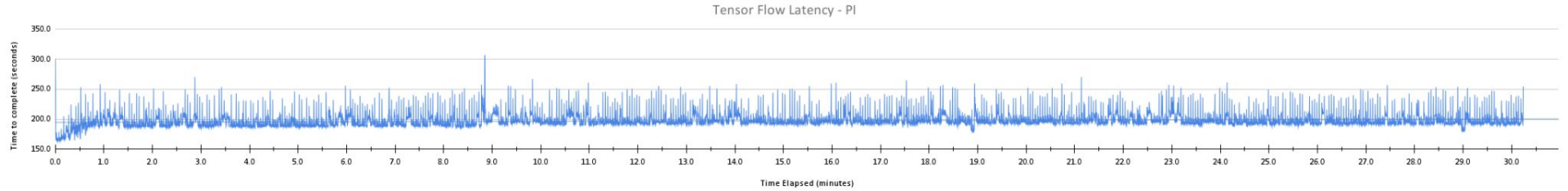
Latency (ms)	Battery %	Minutes
40-50	100	0
45-50	100	1
45-55	100	2
45-55	100	3
45-55	99	4
45-55	99	5
45-55	98	6
45-55	97	7

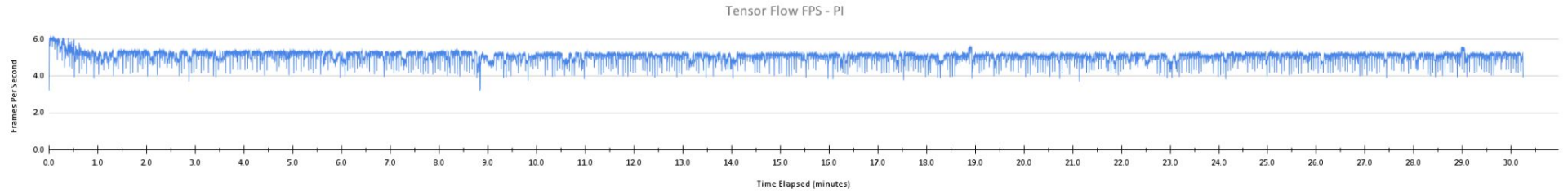




Task 2: Raspberry Pi B3+ Results





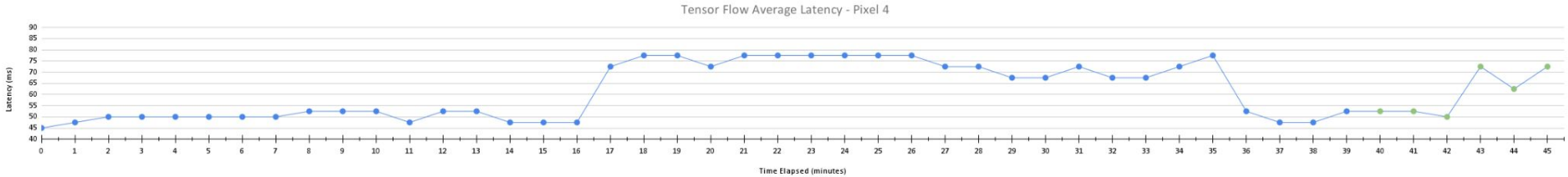


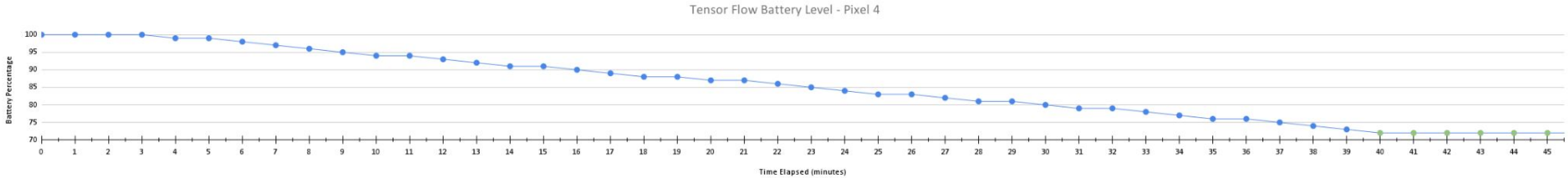
Task 2: Raspberry Pi B3+ Results

Tensor Flow Object Detection Test On Rasberry Pi			
	Frames Per Second	Latency (Ms)	Temperature
MAX	6.105	306.955	70.908
MIN	3.218	163.815	51.002
AVERAGE	5.083	197.386	68.622

- Max Potential of PI B3+ Was capped around 1 minute

Task 2:Google Pixel 4 Results





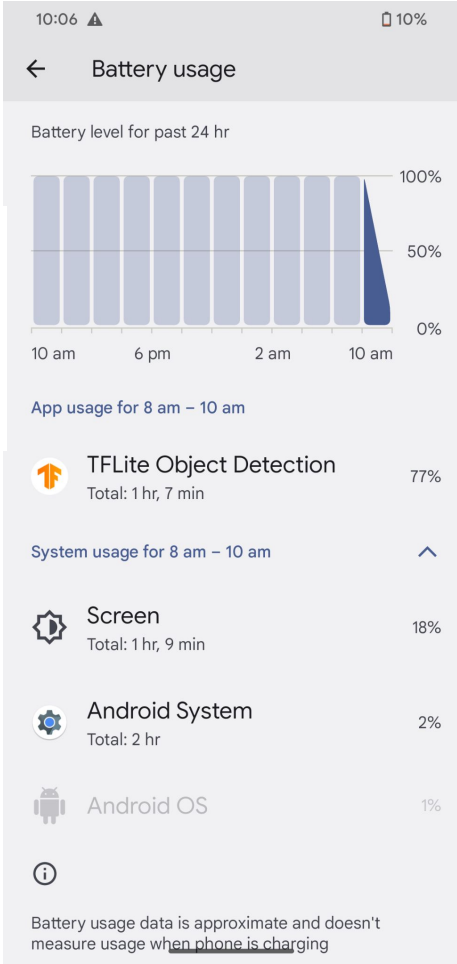
Task 2: Google Pixel 4 Results

- 100% -> 76% Battery
  - 2800 mAh Capacity
  - 0.28 * 2800 mAh = 784 mAh
- 784 mAh * 3.85 V / 1000
  - Total Energy Consumed (Wh) ≈ 3.02 Wh

- Watt-hours used by TensorFlow app = 3.02 Wh * 0.77 ≈ 2.32 Wh

Tensor Flow Object Detection Test On Google Pixel 4	
	Latency (Ms)
MAX	77.500
MIN	45.000
AVERAGE	60.968

- On average, the Raspberry Pi 3B+ consumes around 2.5 - 5 watts.
- An external battery can be purchased for around $27 containing 26000mAH (74-130 Wh)



Task 2: Comparing Results

- Speed difference = (198.386 - 61.087) / 61.087
  - Pi was ≈ 2.251x slower
- Efficiency difference = 61.087 / 198.386
  - Pi Efficiency ≈ 0.3073 = 31%

Tensor Flow Object Detection Test On Rasberry Pi			
	Frames Per Second	Latency (Ms)	Temperature
MAX	6.105	306.955	70.908
MIN	3.218	163.815	51.002
AVERAGE	5.083	197.386	68.622

Tensor Flow Object Detection Test On Google Pixel 4	
	Latency (Ms)
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