School of Computing

Faculty of Engineering

UNIVERSITI TEKNOLOGI MALAYSIA

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PROJECT TITLE: **Benchmarking Project: CPU & Hardware Performance**

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SECTION: **07**

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COMMENTS:

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1.0 Introduction

Benchmarking is an essential procedure to measure the quality and the performance of the products manufactured by each company. Then, the evaluation obtained will reflect the level of the products. In our project, the main target of our benchmarking is focusing on different model of personal computers. The benchmarking software are needed to test the performance of the personal computers especially in terms of CPU and GPU performance.

2.0 Objectives

1. To compare and analyse the difference in term of CPU performance between Intel i5 processors of different generations.
2. To compare and analyse the difference in term of CPU performance between Intel i5 processors with same generation.
3. To compare the results of using different benchmarking softwares in CPU benchmarking.
4. To compare and analyse the GPU performance of different model of graphic cards.
5. To determine the order of laptops in term of CPU and GPU performance.

3.0 Purpose of Project

The purpose of this project is to identify which laptop is the most suitable for learning purposes as students are the main target that we are focusing on in this project. In the project, we will determine the most suitable laptop for students by comparing the performance of laptops in term of CPU and GPU by using benchmarking softwares. Furthermore, the price factor is one of the factors that we will take into account as the price of laptops should be affordable for students.

4.0 Scope

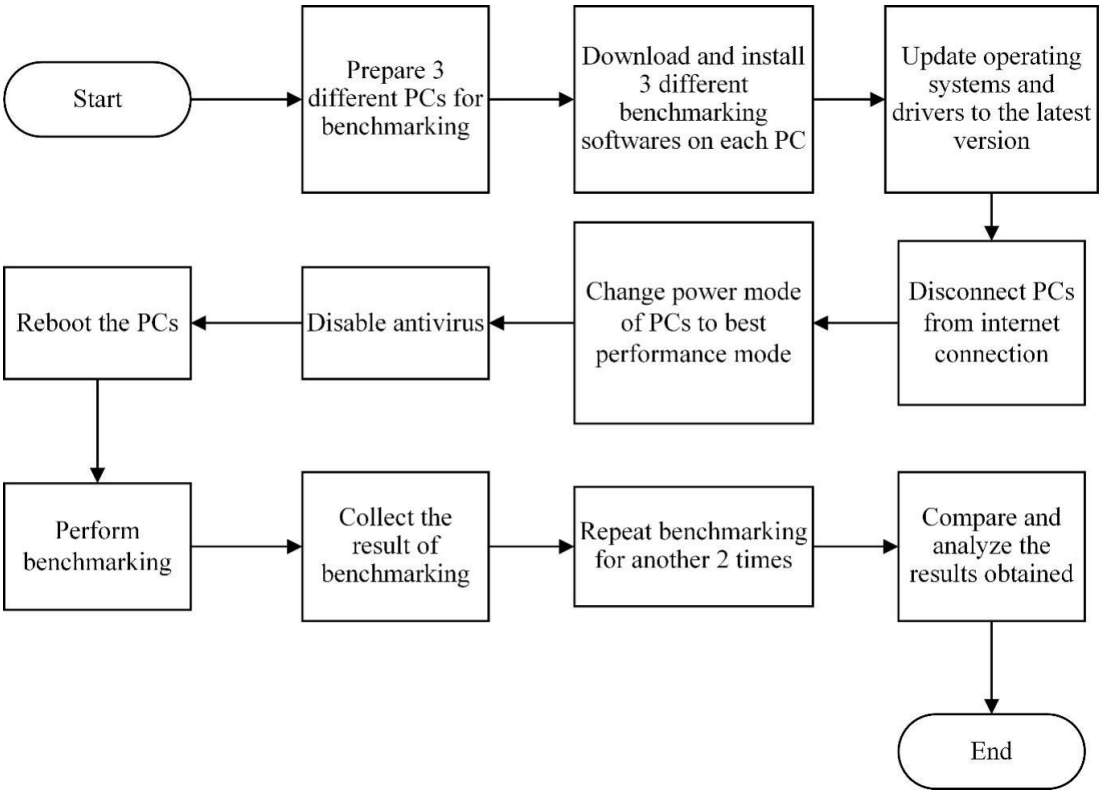
The scope of our project involves laptops that uses Intel i5 processors and also dedicated graphic cards of different brands and models at a maximum price of RM3000.

Table 4.1: Laptop Details

Model Name	ASUS A512FL	ASUS A556UF	HP NOTEBOOK
Price	RM2700	RM2299	RM1999
CPU	Intel Core i5-8265U 1.60 GHz	Intel Core i5-6200U 2.30 GHz	Intel Core i5-6200U 2.30 GHz
GPU	NVIDIA GeForce MX250	NVIDIA GeForce 930M	AMD Radeon ™ R5 M430

5.0 Methodology

5.1 Flowchart of Benchmarking



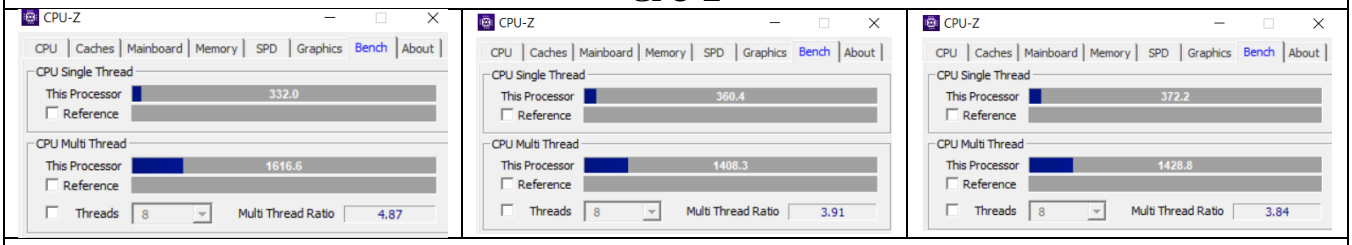
5.2 Benchmarking Softwares Used

1. CPU-Z
2. Novabench
3. Cinebench Release 20

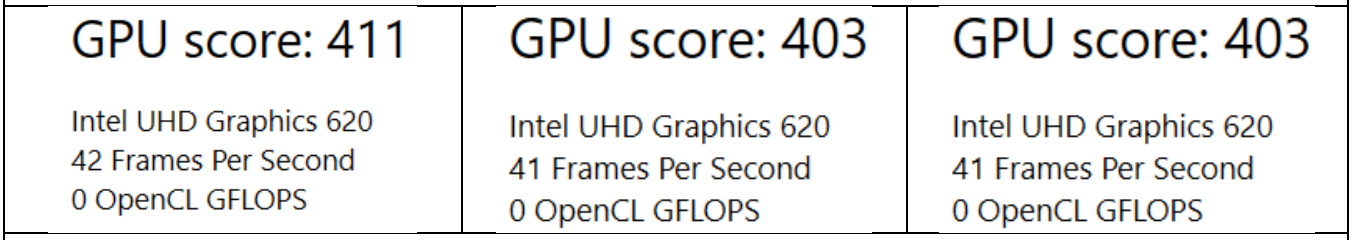
6.0 Screenshot of Test

ASUS A512FL

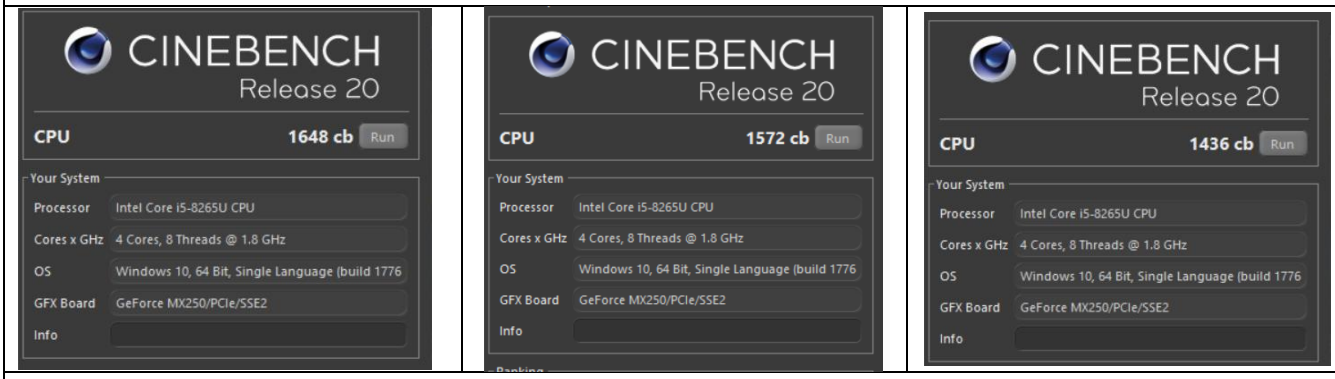
CPU-Z



Novabench

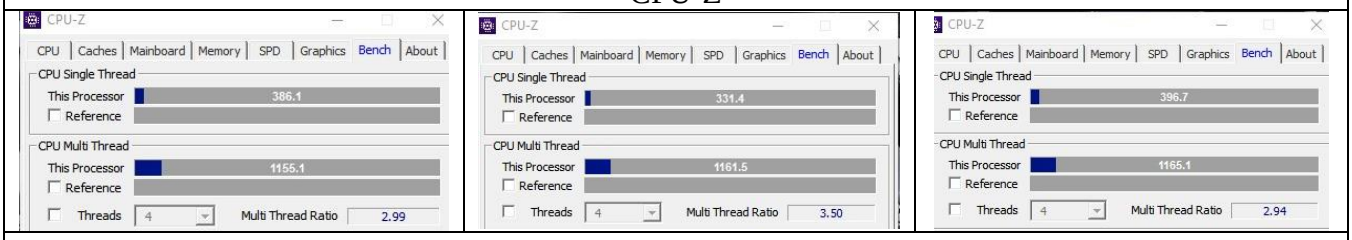


Cinebench Release 20



ASUS A556UF

CPU-Z



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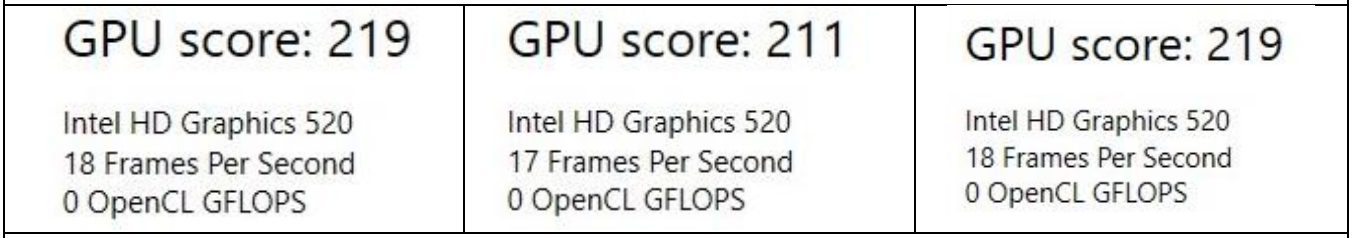
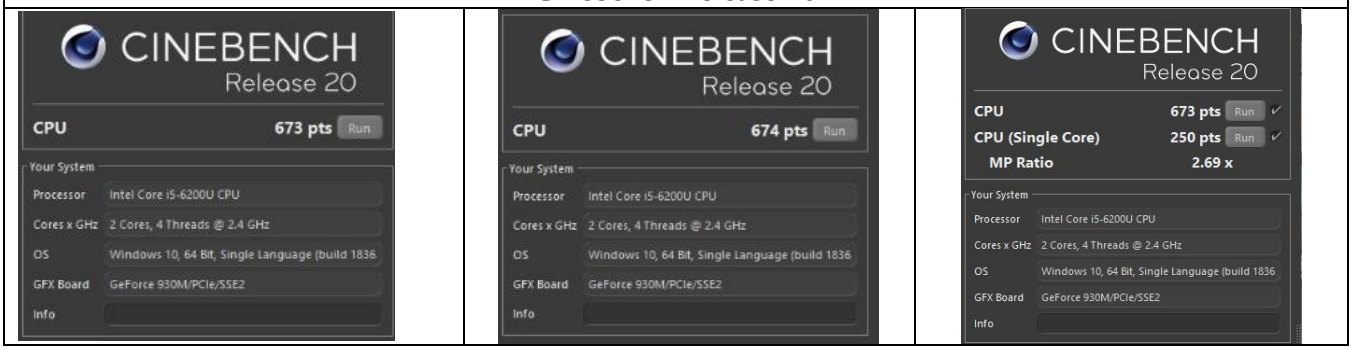
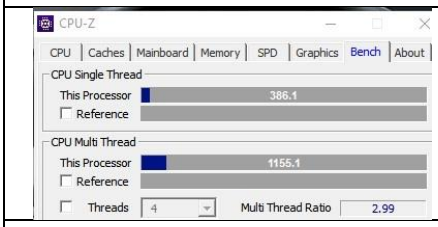
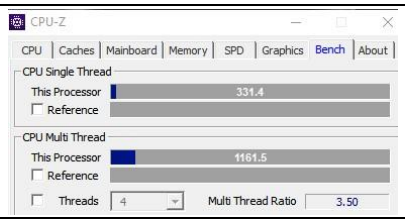
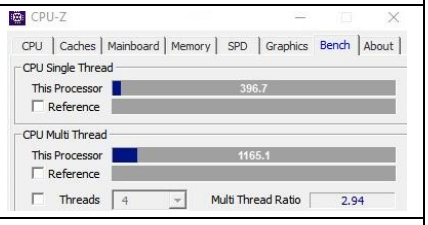


Cinebench Release 20



HP NOTEBOOK		
CPU-Z		
		
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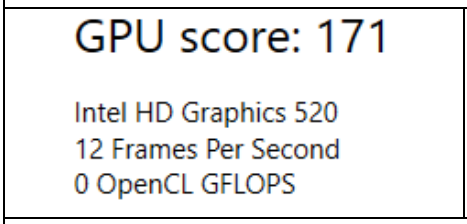	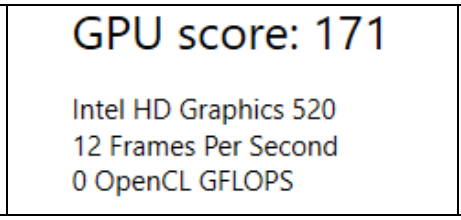	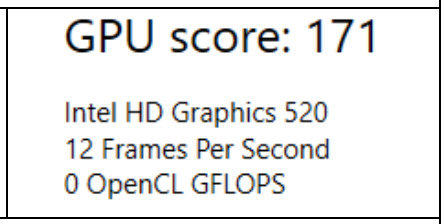
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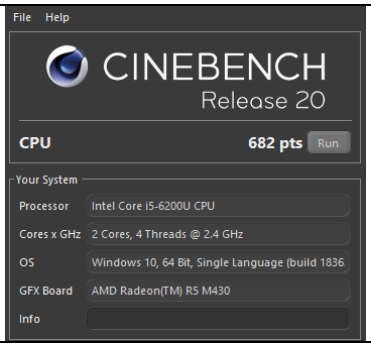	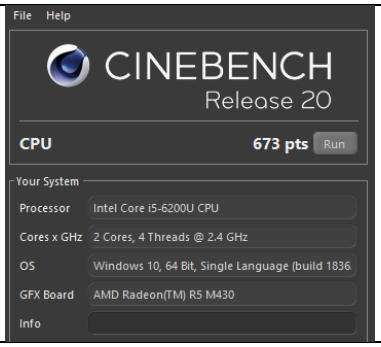	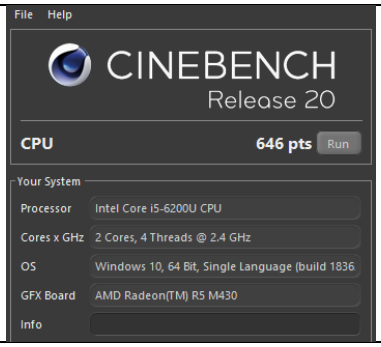

7.0 Results

CPU-Z

Table 7.1: CPU Single Thread

Trial	Intel Core i5-8265U 1.60 GHz	Intel Core i5-6200U 2.30 GHz	Intel Core i5-6200U 2.30 GHz
1	332.0	386.1	375.2
2	360.4	331.4	368.3
3	372.2	396.7	369.1
Average	354.9	371.4	370.87

Table 7.2: CPU Multi Thread

Trial	Intel Core i5-8265U 1.60 GHz	Intel Core i5-6200U 2.30 GHz	Intel Core i5-6200U 2.30 GHz
1	1616.6	1155.1	1172.0
2	1408.3	1161.5	1163.8
3	1428.8	1165.1	1139.7
Average	1484.6	1160.6	1158.5

Table 7.3: CPU Multi Thread Ratio

Trial	Intel Core i5-8265U 1.60 GHz	Intel Core i5-6200U 2.30 GHz	Intel Core i5-6200U 2.30 GHz
1	4.87	2.99	3.12
2	3.91	3.50	3.16
3	3.84	2.94	3.09
Average	4.21	3.14	3.12

Based on the table 7.1, Intel Core it-6200U has higher score than Intel Core i5-8265U in CPU single thread test, whereas Intel Core i5-8265U has higher score than Intel Core i5-6200U in both CPU multi thread and multi thread ratio tests. Besides, the average scores obtained by the two intel Core i5-6200U processors in the three tests are approximately the same and this tell us that they have the same CPU performance.

Cinebench Release 20

Table 7.4: CPU Score

Trial	Processor		
	Intel Core i5-8265U	Intel Core i5-6200U	Intel Core i5-6200U
	CPU Score	CPU Score	CPU Score
1	1648	673	682
2	1572	674	673
3	1436	673	646
Average	1552	673.33	667

Based on the table 7.4, Intel Core i5-8265U has better CPU performance than Intel Core i5-6200U and the average scores for the two Intel Core i5-6200U processors are approximately the same.

Novabench

Remark: Although the graphic card indicated is Intel graphics, but in fact the dedicated graphic cards are used during the test.

Table 7.5: GPU scores of graphic cards

Trial	GPU Score		
	NVIDIA GeForce MX250	NVIDIA GeForce 930M	AMD Radeon ™ R5 M430
1	411	219	171
2	403	211	171
3	403	219	171
Average	405.67	216.33	171

Order of GPU scores:

NVIDIA GeForce MX250 > NVIDIA GeForce 930M > AMD Radeon ™ R5 M430

Thus, NVIDIA GeForce MX250 has the best GPU performance among the three graphic cards.

8.0 Discussions of Result

CPU PERFORMANCE

Table 8.1: Specifications of processors

Specifications	Processor		
	Intel Core i5-8265U 1.60 GHz	Intel Core i5-6200U 2.30 GHz	Intel Core i5-6200U 2.30 GHz
Generation	8th generation	6th generation	6th generation
Clock Speed	1.6 GHz	2.3 GHz	2.3 GHz
Number of cores	Quad core	Dual core	Dual core

In fact, we can estimate rank of processors based on the specifications of the processors in table 8.1 without performing CPU benchmarking. In term of processor's generation, i5-8265U have higher generation compared to i5-6200U. Theoretically, the higher the generation of the processor, the better the performance of the processor. Next, the clock speed of a processor indicates how fast the processor can transmit the data in short time. Faster clock speed indicates that better performance in performing general tasks such as gaming, video editing etc. Therefore, in this aspect i5-6200U is more advanced than i5-8265U. Next, CPU with multiple cores have more power to run multiple programs at the same time. Both clock speed and number of cores really matter as if clock speed is fast enough but the processor has not enough cores to support it, then transmission of data also would not be advanced. In this case, since i5-8265U have quad core while i5-6200U only have dual core, therefore i5-8265U have more power to process multiple programs compared to i5-6200U.

i. CPU-Z

Based on the results of CPU-Z, we can know that i5-6200U has better performance than i5-8265U in term of CPU single thread. For your information, CPU single thread is whereby test only runs one instruction executed at one time rather than multiple parallel streams per core. Therefore, the result is logical as i5-8265U has lower clock speed compared to i5-6200U. Therefore, in term of amount of work completed that runs as a single stream of instructions in a certain amount of time, i5-6200U performs better than i5-8265U.

After that, in term of CPU multi thread, it is clearly to see that i5-8265U processor has better performance than i5-6200U processor. This is because with the higher number of cores in i5-8265U, the performance in executing multiple tasks at the same time will be more advanced compared to i5-6200U. Hence, processor i5-8265U is more suitable to process the execution of multiple parts of a program at the same time with the lightweight processes available within the process.

The multi thread ratio test in CPU-Z measures the efficiency of processor and it is calculated by dividing the data of CPU multi thread with CPU single thread. The higher the multi thread ratio, the more efficient the processor work. Therefore, based on the result in table 7.3, it shows that i5-8265U is more efficient than i5-6200U as it has higher score than i5-6200U.

ii. Cinebench Release 20

Cinebench is a real-world cross-platform test suite that evaluates computer's hardware capabilities in term of CPU performance as well as Cinema 4D's 3D modeling, animation, motion graphic and rendering performance on multiple CPU cores. Besides that, Cinebench R20 also tests CPU whether it can run stable on a high-CPU load at its full potential and also handle demanding real-life 3D tasks.

Based on the result of this test, we can know that the average scores of Intel Core i5-8265U is almost 2.3 times of the average score of Intel Core i5-6200U as the former and this tells us that Intel Core i5-8265U has better performance in handling tasks involving multiple cores. This matches with the theoretical assumption. By comparing the CPU scores of the 2 Intel Core i5-6200U processors, their scores are approximately the same and the slightly difference of the 2 processors in CPU scores is probably due to the temperature of the processors and the background process of the laptops when performing the CPU benchmarking.

iii. *Conclusion*

Based on the results obtained from CPU-Z and Cinebench, both software produces the same result about the performance of the two processors which is Intel Core i5-8265U has better CPU performance than Intel Core i5-6200U. And these results match the result of the comparison between these two processors as advertised by the Intel manufacturer.

GPU PERFORMANCE

Table 8.2: Specifications of graphic cards

Specifications	NVIDIA GeForce MX250	NVIDIA GeForce 930M	AMD Radeon ™ R5 M430
Core speed (MHz)	1518-1582	928-941	955
Memory speed (MHz)	7000	1800	1746
Maximum amount of memory (MB)	4096	2048	2048
Memory bus width (Bit)	64	64	64

The GPU tests of Novabench are designated to run on most graphic cards and integrated graphics such as AMD, NVIDIA and Intel graphics cards. Besides that, the GPU tests of Novabench can be divided into two different tests which are graphics test and compute test. The graphics test renders a 3D scene and

measure frame drawing performance at a fixed 1280 × 720 resolution, while the compute test is based on OpenCL and is used to evaluate the GPU's single-precision performance in general-purpose computing which compute tasks including video rendering, machine learning, and various scientific applications.

Based on the Table 8.2, NVIDIA GeForce MX250 has the highest core speed and memory speed and the largest amount of memory among the three graphic cards, while AMD Radeon™ R5 M430 has slightly faster core speed than NVIDIA GeForce 930M, but the memory speed of NVIDIA GeForce 930M is slightly faster than AMD Radeon™ R5 M430 provided that both of them have the same maximum amount of memory. Theoretically, the performances of NVIDIA GeForce 930M and AMD Radeon ™ R5 M430 should be almost the same.

Based on the result of this test, we can know that NVIDIA GeForce MX250 has the best performance in rendering 3D scene at a 1280 × 720 resolution and computing general-purpose tasks among the 3 graphic cards. Besides that, the average GPU score of NVIDIA GeForce 930M surpasses AMD Radeon™ R5 M430 by 42.67 and this implies that the former performs better than the later in rendering 3D scene and computing general-purpose tasks. The better performance of NVIDIA GeForce 930M over AMD Radeon ™ R5 M430 in the GPU tests also indirectly imply that the memory speed of a graphic card plays a more important role than the core speed in rendering 3D scene and computing general-purpose tasks.

ORDER OF LAPTOPS IN TERM OF CPU AND GPU PERFORMANCE

CPU Performance

ASUS A512FL > ASUS A556UF = HP NOTEBOOK

GPU Performance

ASUS A512FL > ASUS A556UF > HP NOTEBOOK

9.0 Conclusion

Benchmarking is important to both users and developers because benchmarking can provide an independent perspective about the performance of a hardware at a certain condition to users and developers. For example, benchmarking enables a computer user for gaming purpose to know how well is the computer components when running a high-loaded video game such as Farcry. Besides that, benchmarking on a certain hardware can also provide useful information to hardware developers as they get to know what are weakness of their products, so that they can further improve their products and provide a better product that can fulfil the needs of their clients. Moreover, benchmarking can also defend the right of consumers from being exploited by the developers through the hype of their products, because because consumers can verify the performance of the hardware on their own whether the performance of the hardware is the same as being advertised or not.

Throughout this project, we get to learn new knowledge and skills that will be useful for our further studies and even for our future career. By conducting this project, we have learned about what is benchmarking,

how to perform benchmarking and also have better understanding about CPU and GPU. Besides that, we also get to learn how to organize and divide tasks of this project among the group members and how to work together and communicate with other members. Because of the project, we get to learn team-working and communication skills as these skills are vital for us to be successful in our studies and also in our life. Moreover, we also learn the skill of report writing as we divide the tasks of writing report equally among the members so that everyone can take part in this project and also learn how to write a report. This skill is really important as it is inevitable for us to write reports and thesis in the rest of our university life at UTM.

When conducting the project, we did face some challenges and the first challenge is the lack of experience in using benchmarking software. When we wanted to benchmark our laptops using CPU-Z, we cannot differentiate the difference between benchmark CPU and stress CPU, but with our determination and accessibility to internet, we found a tutorial video of using CPU-Z at YouTube and then successfully benchmark the laptops. After that, we also faced challenge when the difference between the CPU scores obtained for each trial using Cinebench is abnormally big and we figured out that the deviation of the scores was probably due to the overheating of computers. Therefore, we took a measure to solve this problem by cooling the computer for 20 minutes after each benchmarking.

10.0 References

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