$\mathbf{5}$

Benchmarking

William W.-Y. Hsu

Department of Computer Science and Engineering Department of Environmental Biology and Fisheries Science National Taiwan Ocean University

CONTENTS

5.1	Introdu	uction	33
5.2	Lab Pr	rocedures	33
	5.2.1	Super π (SuperPI)	34
	5.2.2	Novabench	34
	5.2.3	CPU-Z	35
	5.2.4	HWMonitor	36
	5.2.5	GPU-Z	38
	5.2.6	Geeks3D FurMark	39
	5.2.7	UserBenchmark	40
5.3	Lab Qu	uestions	43
5.4	Lab Re	eport	43

 \nobreak

5.1 Introduction

There are many tools that promise to optimize or speed up your Windows computer, but how can you make sure the software did what it promised? Confirmation bias can make it very, very hard to simply "eyeball" your computer's speed because you'll usually want to confirm that your efforts made an impact. This can be a problem as your computer ages. If you have no objective way of knowing how fast your computer is you won't be able to figure out which optimizations work and which don't.

That is where free benchmark testing software comes in. Downloading a free benchmark will give you a firm, objective way of judging the perform of your computer. As you make adjustments to your computer you can see just how much, or how little, your computer' s performance has changed.

Reference: http://www.makeuseof.com/tag/5-free-benchmark-programs/

5.2 Lab Procedures

\nobreak

5.2.1 Super π (SuperPI)

While your computer may pack more computing power than the rocket which sent men to the moon, it is still possible to choke a computer processor using simple math, and that is what the SuperPi free benchmark testing software does. SuperPi is capable of calculating Pi up to 32 million digits after the decimal point. This complex math significantly tasks your computer's processor, and SuperPi keeps track of how quickly it takes for your computer to complete the calculation.

SuperPi is focused on your processor's speed, not the speed of other components, so it only useful when judging changes to your computer's processors. For example, overclockers consider SuperPi to be one of the best free benchmarks around because it provides a processor-focused test which can help them judge how much extra performance their overclocking has gained them.

SuperPi can be obtained from http://www.superpi.net/Download/.

```
Calculate(C)
About..(A)
Help(H)
Stop(S)

1M
Calculation
Start.
19 iterations.

Real
memory
= -794624

Available
real
memory = -1800093696

Allocated
memory
= 8388648

Oh
00m
00.2675
The initial value finished

Oh
00m
01.0055
Loop 1
finished

Oh
00m
02.80484
Loop 2
finished

Oh
00m
02.80484
Loop 3
finished

Oh
00m
03.6775
Loop 4
finished

Oh
00m
05.4705
Loop 5
finished

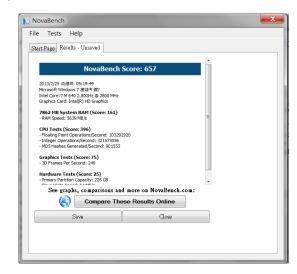
Oh
00m
06.3385
Loop 7
finished
```

5.2.2 Novabench

Novabench is a free benchmark testing software suite. Unlike many benchmark suites, Novabench isn' t a trial version or an older version released for free. The free version is the only version available, and it gauges multiple aspects of your computer' s performance.

The Novabench benchmark tests **processing speed**, **2D graphics performance** and **hard drive read/write performance**, making this a very well-rounded benchmark. It is particularly well suited for computers which are meant for a home office, as the hard drive read/write speed benchmark can help you find out if your productivity is being hurt by a hard drive which takes a long time to spin up and transfer data. Novabench also has a basic multimedia and graphics benchmark. It is less intensive than a dedicated graphics benchmark, like 3DMark06, but can give you a general idea of your computer' s graphics performance.

Novabench can be obtained from http://novabench.com/download.php.



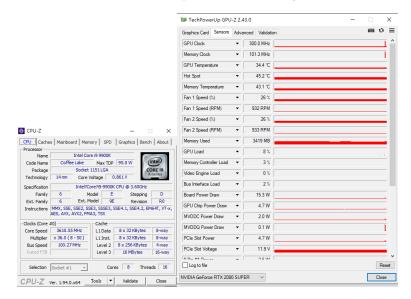
5.2.3 CPU-Z

CPU-Z is a freeware that gathers information on some of the main devices of your system :

- Processor name and number, codename, process, package, cache levels.
- Mainboard and chipset.
- Memory type, size, timings, and module specifications (SPD).
- Real time measurement of each core's internal frequency, memory frequency.

It is able to identify the parameters of your CPU, such as the processor name, the technology used and packaging, core voltage, supported instruction sets, core speed and core numbers, and cache sizes.

Introduction to Computers— Laboratory manual and exercises



Moreover, it can be used to identify the mainboard information and the BIOS brand. You can also check for the number of memory slots and how much memory is installed. The SPD information can also show you the vender information of your system memory.

CPU Caches Motherboard	s (Manboard	Memory SPD Graphic	s Bench	About	CPU C	aches Mainboard	(Picinory	ll ann Larabu	ics Bench Abo
	ASUSTEK COMF	TER INC			Туре	DDR4		Channel #	Dual
	PRIME Z390-A		Rev 1.x	<u> </u>	Size	32 GBytes		DC Mode	
Chipset	Intel	Coffee Lake	Rev.				Uno	ore Frequency	3308.9 MHz
Southbridge	Intel	Z390	Rev.		-Timings -				
LPCIO	Nuvoton	NCT6798D-R				DRAM Freq	uency	1604.4 MHz	
DPCIO	Nuvotori	WC10790D4K				FSB:	DRAM	1:24	
BIOS						CAS# Latenc	y (CL)	18.0 docks	
Brand	American Mega	trends Inc.			RA	S# to CAS# Delay (tRCD)	21 docks	
Version	0903					RAS# Precharge	(tRP)	21 docks	
Date	03/18/2019					Cyde Time (tRAS)	39 docks	
Graphic Interf					Row F	tefresh Cycle Time (tRFC)	560 docks	
	ace Version	PCI-Express				Command Rate	e (CR)	2T	
		(16 Max, Supporter	d x16			DRAM Idle	Timer		
Side Band Add		Max. Supporter	u x1	,		Total CAS# (tRE	RAM)		
Side Daliu Adu	resong 1					Row To Column (trcd)		

CPU-Z Ver. 1.94.0.x64 Tools Validate Close CPU-Z Ver. 1.94.0.x64 Tools Validate Close

CPU Caches M	ainboard Me	mory SPD	Graphics	Bench About
Memory Slot Select	ion			
Slot #1 💌	DDR4		Module Size	16 GBytes
Max Bandwidth	DDR4-3200	(1600 MHz)	SPD Ext.	XMP 2.0
Module Manuf.	King	ston	Week/Year	23 / 19
DRAM Manuf.	Micron Te	chnology	Ranks	Dual
Part Number	KHX3200C1	.8D4/16G	Correction	
Serial Number	0009	B465	Registered	
Timings Table	TEDEC #13	IEDEC #14	XMP-3200	XMP-2936
Frequency	1600 MHz	1600 MHz	1600 MHz	1468 MHz
CAS# Latency	21.0	22.0	18.0	17.0
RAS# to CAS#	21	21	21	19
RAS# Precharge	21	21	21	19
tRAS	39	39	39	39
tRC	74	74	74	68
Command Rate				
Voltage	1.20 V	1.20 V	1.200 V	1.200 V

CPU-Z can be obtained from https://www.cpuid.com/softwares/cpu-z.html.

5.2.4 HWMonitor

HWMonitor is a hardware monitoring program that reads PC systems main health sensors: voltages, temperatures, fans speed.

HWMonitor keeps track of your computer's vital statistics, including the temperature of various components and the current incoming voltages. With this information, you can ensure that your machine is not in danger of overheating or any other type of mechanical failure.

It has straightforward presentation: All of the data that this program records is presented in one clear chart. And in addition to the current readings for all of your systems, you can also see the recommended maximums and minimums for each category to give you a frame of reference. It also includes Real-time updates: This program updates all of the data readings it displays in real time. That means you can just glance over now and then to see how your computer's doing rather than having to switch over to the program and refresh the feed.

ile Vi	iew I	Vetwork To	ools Ri	egister	Help			
ensor				Value		Min	Max	
- D	ESKTO	P-30QELB	/ (192					
ė- P	ASU	STeK COMP	UTER					
Ē	· 💉 /	/oltages						
		VIN7		0.392 V	r -	0.392 V	0.392 V	
		VIN8		1.456 V	r -	1.424 V	1.480 V	
		VIN9		0.976 \	(0.976 V	0.984 V	
		VIN10		[TRIAL]		[TRIAL]	[TRIAL]	
		VIN11		[TRIAL]		[TRIAL]	[TRIAL]	
		VIN12		[TRIAL]		[TRIAL]	[TRIAL]	
		VIN13		[TRIAL]		[TRIAL]	[TRIAL]	
		VIN14		0.488 V	r -	0.480 V	0.488 V	
		VIN15		1.640 V	1	1.640 V	1.640 V	
		VIN16		0.992 V	r	0.992 V	0.992 V	
		VIN17		0.784 \	r -	0.784 V	0.792 V	
		VIN18		0.784 V	1	0.784 V	0.792 V	
		+5V		4.960 V	r -	4.920 V	4.960 V	
		+3.3V		[TRIAL]		[TRIAL]	[TRIAL]	
		+12V		[TRIAL]		[TRIAL]	[TRIAL]	
		VIN3		[TRIAL]		[TRIAL]	[TRIAL]	
		VIN4		[TRIAL]		[TRIAL]	[TRIAL]	
		VCORE		1.448 V	r	1.416 V	1.480 V	
		VIN6		1.024 V	(1.024 V	1.032 V	
		VIN7		1.952 V	r -	1.952 V	1.968 V	
Ē	- 🖌 1	emperature	s					
	- T	SYSTIN		38.0 °C		37.0 °C	38.0 °C	
		CPUTIN		[TRIAL]		[TRIAL]	[TRIAL]	
		TMPIN5		[TRIAL]		[TRIAL]	[TRIAL]	
		TMPIN6		38.0 °C		37.0 °C	38.0 °C	
		TMPIN8		27.0 °C		27.0 °C	27.0 °C	
		TMPIN7		55.0 °C		52.0 °C	63.0 °C	
		Mainboa	rd	38.0 °C		37.0 °C	38.0 °C	
		CPU		55.0 °C		52.0 °C	63.0 °C	
		TMPIN2		38.0 °C		37.0 °C	38.0 °C	
		TMPIN3		37.0 °C		37.0 °C	38.0 °C	
		TMPIN4		27.0 °C		27.0 °C	27.0 °C	
		TMPIN5		38.0 °C		37.0 °C	38.0 °C	
		TMPIN6		27.0 °C		27.0 °C	27.0 °C	
		TMPIN8		55.0 °C		52.0 °C	63.0 °C	
	-53 F	ans						
	1	CPUFANI	N	1258 R	PM	1208 RPM	1324 RPM	
		AUXFANI		1829 R		1804 RPM	1834 RPM	
		CPU		1258 R		1208 RPM	1324 RPM	
		Chassis #	5	1829 R		1804 RPM	1834 RPM	
			g Status:			0 connectio		

Introduction to Computers— Laboratory manual and exercises

+ (CPUID H	lardware M	lonitor F	RO		- 🗆	
_	View	Network	Tools	Register Hel			_
ens			_	Value	Min	Max	
	1		5	[TRIAL]	[TRIAL]	[TRIAL]	
	P.~?	Currents		TOIAL	(70)411	(70)411	
				[TRIAL]	[TRIAL]	[TRIAL]	
	- 4	Temperat		57.0.00	52.8 °C	63.3 °C	
	1		ge (Ivoa	e 57.8 °C	52.8 °C	03.3 %	
		Powers Packad		99.93 W	67.56 W	103.29 W	
				4.22 W	1.64 W	6.83 W	
				4.22 VV	2.91 W	10.12 W	
				5.28 W	2.91 W	9.97 W	
				2.51 W	1.21 W	5.44 W	
				3.02 W	1.21 W	6.11 W	
				3.34 W	1.73 W	6.64 W	
				3.34 VV 3.57 W	1.73 W	6.14 W	
		Core #		3.02 W	1.64 W	6.38 W	
				2.66 W	0.92 W	5.27 W	
				2.81 W	1.06 W	5.46 W	
	-			2.08 W	0.33 W	5.43 W	
	-			7.86 W	2.08 W	12.60 W	
	-			2.04 W	0.52 W	5.01 W	
	-	0010		2.25 W	0.97 W	5.58 W	
	-			1.62 W	0.58 W	5.34 W	
	-		15	2.71 W	0.64 W	5.83 W	
	-	Cores		56.12 W	28.52 W	92.77 W	
	-	Utilization					
	-	Proces		17 %	4 %	17 %	
	-			28 %	0 %	54 %	
	-	0.0		3 %	0 %	12 %	
				43 %	0 %	98 %	
	-			48 %	0 %	100 %	
	-			39 %	0 %	100 %	
	-			56 %	0 %	100 %	
	-			4 %	0 %	12 %	
	-			0 %	0 %	15 %	
	-			1 %	0 %	7 %	
	-			20 %	0 %	20 %	
	-			9 %	0 %	26 %	
	-			6 %	0 %	10 %	
	-			40 %	0 %	45 %	
	-	0.0.		3 %	0 %	9 %	
	-			6 %	0.96	28 %	
	-	CPU #		4 %	0 %	15 %	
		CPU #	16	3 %	0 %	10 %	

5.2.5 GPU-Z

GPUZ can list all the internal factors of your GPU (like the CPUZ software, which lists the details of your CPU). It also monitors the current status of or GPU, including the power usage, fan speed, memory usage, and temperature.

		TechPowerUp GPU-Z 2		(i)	0	
			anced Validation			
		GPU Clock 👻	300.0 MHz			Ĺ,
		Memory Clock 🔹	101.3 MHz		1	Ĺ
		GPU Temperature 💌	34.4 °C		_	1
TechPowe	rUp GPU-Z 2.43.0 - X	Hot Spot 💌	45.2 °C			1
raphics Card	Sensors Advanced Validation	Memory Temperature -	43.1 °C			1
		Fan 1 Speed (%) 💌	26 %			Ì
Name	NVIDIA GeForce RTX 2080 SUPER Lookup	Fan 1 Speed (RPM) 🔻	932 RPM			
GPU	TU104 Revision A1	Fan 2 Speed (%)	26 %			÷
echnology	12 nm Die Size 545 mm ²	Fan 2 Speed (RPM) -	933 RPM			1
ease Date	Jul 2, 2019 Transistors 13600M NVIDIA				_	i
OS Version	90.04.7A.40.33	Memory Used 👻	3419 MB		-	•
Subvendor	ASUS Device ID 10DE 1E81 - 1043 8711	GPU Load 👻	8 %			
OPs/TMUs	64 / 192 Bus Interface PCIe x16 3.0 @ x16 1.1 ?	Memory Controller Load 🔹	3 %			
Shaders	3072 Unified DirectX Support 12 (12_2)	Video Engine Load 🔹	0 %			
Pixel Fillrate	119.0 GPtxel/s Texture Fillrate 357.1 GTexel/s	Bus Interface Load 🔹	2 %			i
emory Type	GDDR6 (Samsung) Bus Width 256 bit	Board Power Draw	15.3 W			
lemory Size	8192 MB Bandwidth 496.1 GB/s		4.7W			İ
ver Version	27.21.14.5671 (NVIDIA 456.71) DCH / Win 10 64	GPU Chip Power Draw -			_	
Driver Date	Sep 30, 2020 Digital Signature WHQL	MVDDC Power Draw -	2.0 W			L
GPU Clock	1650 MHz Memory 1938 MHz Boost 1860 MHz	MVDDQ Power Draw 🔹	0.1 W		1	Í
efault Clock	1650 MHz Memory 1938 MHz Boost 1860 MHz	PCIe Slot Power -	4.7 W			ĺ
NVIDIA SLI	Disabled Resizable BAR Disabled	PCIe Slot Voltage 🔹	11.9 V			i
Computing	OpenCL CUDA DirectCompute DirectML	0 R. #1 R	2 5 147			
	Vulkan Ray Tracing PhysX OpenGL 4.6	Log to file			Res	s

GPUZ can be downloaded from https://www.techpowerup.com/download/techpowerup-gpu-z/.

5.2.6 Geeks3D FurMark

It is a VGA stress test and GPU burn-in test as well as an OpenGL Benchmark. It is a lightweight but very intensive graphics card / GPU stress test on Windows platform. It's a quick OpenGL benchmark as well. It is simple to use and is free. FurMark is a popular VGA stress test (graphics card burn-in test) as well as an OpenGL benchmark.

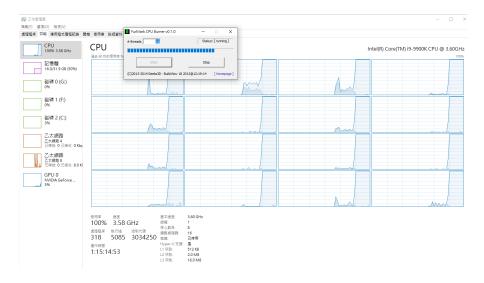


GPU Shark will get all the parameters your graphics card is capable of. The most important features are the **core speed**, **texel rates**, **memory speed**, **memory bandwidth**, and the **TFLOPS**. You can also use this software to monitor the power usage of your GPU.

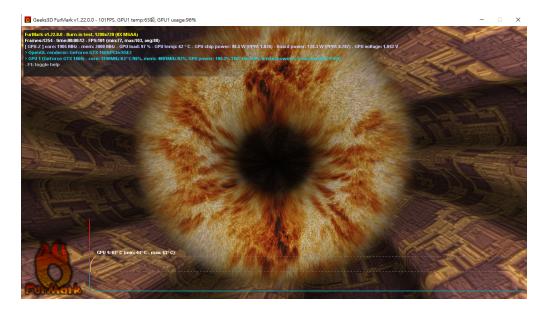


The $CPU\ Burn$ test will try to eat up all your CPU resource as shown in the next image.

Introduction to Computers— Laboratory manual and exercises



Finally, it is the GPU stress test. The stress test puts 100% loading onto your GPU (please use at your own risk and ensure proper cooling). You can use this to test if your system is able to supply enough power to the GPU (if not, your system will become unstable), and to monitor the internal temperature to see if you have proper cooling (to protect your GPU).



FurMark can be downloaded from https://geeks3d.com/furmark/downloads/.

40

5.2.7 UserBenchmark

UserBenchmark is a free all-in-one benchmarking application. Benchmark your CPU, GPU, SSD, HDD and USB Drives then compare results with other users and see which parts you can upgrade together with the expected performance improvements. *CPU benchmarks bias toward Intel.* (See Google results, https://www.ptt.cc/bbs/PC_Shopping/M.1564077327.A. E48.html)

How it works:

- Download and run UserBenchMark.
- CPU tests include: integer, floating and string.
- GPU tests include: six 3D game simulations.
- Drive tests include: read, write, sustained write and mixed IO.
- RAM tests include: single/multi core bandwidth and latency.
- SkillBench (space shooter) tests user input accuracy.
- Reports are generated and presented on userbenchmark.com
- Identify the strongest components in your PC.
- See speed test results from other users.
- Compare your components to the current market leaders.
- Compare your in-game FPS to other users with your hardware.

Run the benchmark to obtain the first results, which evaluates the suitability of your PC for different environnemts: Gaming, desktop, and workstation.

	RIME X570-PRO rformance R	esults		16	ADD TO PC BUILD	TEST YOUR PC
Ô	Gaming 133%		esktop 96% Juclear submarine 💿	No. 1	Workstation	169%
R	Save results	Copy results	User guide	Φ	f	y
PC Status Processor	components, 62 performed b the benchmark sections of th With an outstanding single or apps and audio/video playba	below expectations (38th percentile). This means tha etter. The overall PC percentile is the average of each is report to identify problem rares. are score, this CPU is the cat's whiskers: It demolshe ck. Additionally this processor can handle interative w ing score of PL, which CPU suitability for 3D gam	r of its individual components. Use the charts in everyday tasks such as web browsing, office orkstation, and even full-fledged server	Motherboard Memory Display OS BIOS Date	Asus PRIME X570-P 56.4 GB free of 64 (1920 x 1080 - 32 B/ Windows 10 20210809	58 @ 2.4 GHz
Graphics Boot Drive	detail levels. 225% is an exceptional SSD s	ore, it's the bee's knees. This GPU can handle almost core. This drive is suitable for heavy workstation use, t transfers of multiggabyte files.		Uptime Run Date Run Duration Run User	0 Days Oct 31 '21 at 15:19 178 Seconds TWN-User	
Memory OS Version	64GB is enough RAM to run a large file and system caches,	ny version of Windows and it's far more than any cu virtual machine hosting, software development, vide It version of Windows, and the best to date in our op	editing and batch multimedia processing.	Background CPU	3%	

The following results shows the percentile ranking of components.

$Introduction\ to\ Computers-Laboratory\ manual\ and\ exercises$

Processor		Bench 💮	Normal 💮	Heavy 💮	Server 💮
S950X RyzEN 9	AND types 1 5000-8749 31.042 Determination exercises intend 10010 accesses of A1 of United A1 Set (upp) A Ferforming way latter expectations (12 th precenting ()) A Ferforming way latter expectations (12 th precenting ()) For the latter A1 of	91.2% Outstanding	Memory 73.6 1-Care 158 2-Care 306 98% 179 Pts	4-Core 582 8-Core 1,148 107% 865 Pes	64-Care 2,802 188% 2,802 Ptt
Graphics Card		Bench 🕢	3D DX9 😡	3D DX10 🚱	3D DX11 @
00	Notes In 70, 2000 (Speer, 577) 11, 441 (Speer, 127) 11, 441 (Speer, 127) 11, 441 (Speer, 128) 11, 441 (Speer, 128) 11, 441 (Speer, 128) 11, 441 (Speer, 128) 12, 441 (Speer, 128) 14, 441 (Sp	147% Outstanding	Lighning 187 Reflection 187 Parallax 190 15196 188 fps	MRender 207 Gravity 171 Splatning 138 14210 172 fps	
Drives		Bench 🕜	Sequential 😡	Random 4k 🔞	Deep queue 4k (
390	XPG SPECTRIX S40G 1TB 9.142 User benchmarks, average banch 224% 30068 free (System dink) Primaser VIA21037 «Winter & Sto Interval: 44.272 268 304 253 254 MB/s « Performing as expected (41 ⁴⁶ percentit) 	225% Outstanding	Read 2338 Write 1,183 Mixed 109 SusWrite 299 216% 905 ME/s	4K Read 57.4 4K Write 134 4K Mooed 78.9 239% 90.2 MB/s	DQ Read 1,242 DQ Write 240 DQ Mood 485 42296 656 MB/s

Play the game to measure results using real application.

O System Memory Latency Ladder O UX2X-CVC ucht end Pran memory (DMM) access latences in navo seconds.

The program can generate a simple report of your PC ranking.



5.3 Lab Questions

Finish the attached form and turn it to the TA. Repeat 3 times for all experiments.

- For Super PI, compute PI to 32 million digits. Record the time results for 24 iterations.
- For Novabench, record the results acquired from the program.
- For CPUZ, record the following parameters of your system:
 - CPU Name, technology used (nano meter), core speed, number of cores.
 - The cache of your CPU.
 - The mainboard vender of your system and the chipset.
 - The amount of memory installed and the core frequency of your memory chips. What does the Channel # mean?
 - For each of the memory banks, record the vender, bandwidth, and the size of the module.
 - Benchmark the performance of this (or your) CPU against the best CPU currently in our department: Intel core i9-7980XE CPU 2.6GHz 18C/36T. What is the relative speed of your CPU against the reference (both single thread and multi thread). The formula is the benchmark score divided by the reference score.
- For FurMark, record the following parameters of your GPU:
 - GPU Name, technology used (nano meter) and die size, approximate transistors, and vendor.
 - Show idle mode power consumption (at a percentage of TDP).
 - Find the maximum (boosted) parameters of your GPU, including (core speed, FP operations, memory speed, texture fill rate, pixel fill rates).
 - $-\,$ Conduct a burn on your GPU for a moment, and record its stable temperature.
- For UserBenchMark obtain the following results for your PC.

5.4 Lab Report

Your lab report is due before the next class.