Overclocking Approach in Speeding-up a PC Performance

By

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Dissertation submitted in partial fulfillment of
the requirements for the
Bachelor of Technology (Hons)
(Information System)

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CERTIFICATION OF APPROVAL

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Information System Programme
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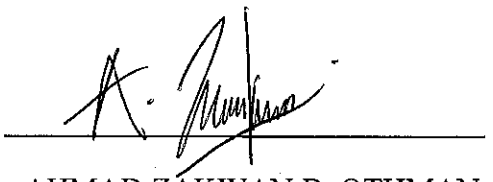
CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements and that the original work contained herein have not been undertaken or done by unspecified sources or persons.



AHMAD ZAKWAN B. OTHMAN

ABSTRACT

Overclocking can be defined as running a computer at a speed higher than the manufacturer intended. As technology evolves, the introduction of software-based overclocking solutions has widened the horizon of overclocking concept for all PC users. This concept originally designed to overcome money or price issues among the competing processor manufacturer. With this technology, user can achieve satisfaction as user will get boost on performance without spending a lot of money. This project called "Overclocking Approach in Speeding-up a PC Performance" will undermine all the relevant and important issues in developing a complete overclocked PC system with the right hardware and the right tools. This research discusses all the procedure needed in developing and testing the system stability within the capability of standard PC user using certain software. This research aim to achieve certain objectives that involve the procedures, legal issues, performance boost and skill development in overclocking concept as to ensure the topic are carefully chosen. For this project, the author is using the hybrid methodology of system development life cycle that include (Planning) Preliminary and feasibility study, Requirement specification, Design, Development and Testing. With this methodology, the author aim to develop a fully overclocked system in proving that overclocking approach can achieve higher overall performance result compare to standard system. Overclocking approach is designed for PC users to exploit the possibility of achieving higher system configuration and specification within the current hardware system with the help of some tweaking process and activities.

ACKNOWLEDGEMENT

Most grateful to God that I finally be able to complete my Final Year Project.

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ABBREVIATIONS AND NOMENCLATURES

FYP – Final Year Project

IT/IS – Information technology/ Information system

PC – Personal Computer Project

CPU – Central Processing Unit

OS – Operating System

SDLC- System Development Life Cycle

FSB- Front Side Bus

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND OF STUDY

At it simplest, overclocking is nothing more than running a computer at a speed higher than the manufacturer intended, and while it does require a bit of knowledge and familiarity with our computer.

Overclocking has a very long and storied history. As a matter of fact, overclocking probably first appeared in ancient Babylonia, when merchants would oil the slides on their abacus to enable faster calculations. Well, maybe not that long and storied, but it has indeed been around as long as there have been computers to overclock. In the early days, overclocking was a risky affair that often involved heavy physical modification to parts, and many times resulted in fried components. Since then, it is gotten steadily easier to overclock a system, but it really was not until the advent of Intel's venerable Celeron 300A that overclocking began to go mainstream.

Another development that helped increase the popularity of overclocking was the development of software-based overclocking solutions. Motherboard manufacturers began enabling overclocking features in the system BIOS rather than the tedious process of manual jumper or dipswitch settings. Combine this ease of use with the tremendous overhead available in many of today's modern processors, along with the ever-present lure of getting something for little or nothing, and it is easy to see why overclocking has become such a popular pastime.

1.2 PROBLEM STATEMENT

This project aim to solve some problems with current trend and technology in the computer world. The problem will be discussed with the significant of the project as to solve the problems.

1.2.1 Problem Identification

The author as end-user and myself as a student do not have enough money or resources to buy the latest high-end processor or PC that are very high in cost and price of getting the selected hardware. So, the easiest and understandable technique is to use the current or lower end PC and overclock it to match the high-end PC performance within minimal cost. As for this, the current problem would be the high price of desirable PC.

In another scenario, certain project or task in computer may face difficulty because of bottlenecks of certain hardware only. The solution to buy another PC or hardware can be described as irrelevant when we only need significantly small boost in performance. The concept of overclocking allows us to tweak the hardware to our satisfied target based on our need without spending much money in changing the hardware.

1.2.2 Significant of the Project

The latest technology allow novice user to play around with this overclocking concept without having knowing much about the architecture of the PC. The Artificial Intelligence concept has been introduced which the PC itself will overclock automatically upon request from user. This technology has become globally introduced to familiarize the concept of overclocking to all end-users.

The concept of overclocking allow us to explore the technology and architecture within the PC itself and this action will increase the understanding on how a complete PC is

working and how the certain hardware will differentiate the overall performance between one PC with another one.

Overclocking may appeal even to those who are not well versed in the intricacies of their PCs, but who are interested in hands-on learning. In fact, there are few performance tweaks that will cause users to learn more about their equipment and its limits than overclocking.

1.3 OBJECTIVE AND SCOPE OF STUDY

The objectives of doing research on this topic would be to:

1. discuss and implement procedures taken in building an overclocked system
2. discuss hardware and software used in developing an overclocked system
3. discuss legal issues resulting the concept of overclocking in a real word
4. proving the overclocked system performance is higher than standard system
5. show how overclocking can solve budget limitation in owning high-end PC

1.3.1 The Relevancy of the Project

Nowadays, this concept has been discussed widely in the internet and in the computer convention as manufacturers now have started competes with each other on delivering or producing hardware and software used for overclocking. Recently, Intel itself has introduced it own software called 'Intel Overclocking Desktop Center' that function as a standalone software that allow user overclocked the system from the window which opposite of current trend which is using the computer bios. This development marked the concept has been widely recognized and offer high demand of exploring the technology of computer itself.

1.3.2 Feasibility of the Project

With this available technology and widely discussed issues, the author will not have much problem on achieving the objective of the research and in the same time developing an overclocked PC system. The knowledge and skill has been developed throughout the research from the internet and trial and error method. The main motivation would be to achieve satisfaction as users have maximized the performance of our own PC without spending much money.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

The concept of overclocking is quite simple to understand. Many reviewers stated that overclocking is originally design within the product itself.

According to Ed Stroligo [1]
Imagine a factory making auto engines. This factory makes only 200 horsepower engines. It turns out there aren't enough buyers out there for 200 horsepower engines, but there are plenty of people who'll buy cheaper 150 horsepower engines. The factory will take the engines that they can't sell as 200 horsepower engines, and sell them as 150 horsepower engines rather than have them sit in the factory. This is what the CPU makers, whether it's Intel or AMD, basically do. They need at least some of the more powerful CPUs, but unlike most other areas, making a less powerful CPU doesn't cost them less. So they try to make all of them 200 horsepower, but sell most of them as 150. Overclocking is simply taking that 150 horsepower engine and running it at 200. It takes advantage of any difference between the stated and actual potential of a CPU.

This statement shows that overclocking originally is designed by manufacturer itself. They produce products that have the capability to be overclocked and as end-user, we should take this opportunity to maximize our machine performance in minimal cost condition.

According to John Crawley [2]

PCPlus UK version is very definite with the concept of overclocking: The power of your processor is directly related to the speed at which it's running. The concept behind overclocking is simple – increase the speed of the processor and it'll improve the overall performance of our machine. By fooling computer motherboard into thinking that we have a slightly faster processor, we can have all the benefits of that faster CPU without having to buy a new one.

According to Charles M. Kozierok [3]

In terms of a definition, *overclocking* is quite simple: it refers to changing the settings of a computer system so that the hardware runs at a faster speed than the manufacturer rated it for. Every piece of hardware in a computer system is tested and is supposed to be rated to run at a particular clock speed. When you overclock, you change the settings of the hardware so that it runs faster than what the manufacturer originally intended. Overclocking is also sometimes called *pushing* or *speed margining*.

As for the author, the term 'overclocking' is used to describe the process of running a piece of hardware at a clock and/or BUS speed that the hardware hasn't officially been specified for. Most commonly, that speed is usually higher from its default value.

In his article titled 'Overclocking: Drug of Performance Junkies', Joel Durham Jr. further explained the definition of overclocking: Overclocking generally refers to forcing a CPU, front-side bus, graphics chip, or graphics card memory to perform faster than it's supposed to perform. Done successfully, it can increase the performance of your system without new components. There's risk, of course--for instance, you can age your PC's components prematurely and void their warranties--but as with any worthwhile risk, there's plenty of reward. [4]

2.2 REASON TO OVERCLOCK

There are may reason that end user might take the initiation to understand the concept of overcloking and to explore the concept by doing or applied it to our own machine or PC. Some do it for the pleasure, some for the benefit and some because they have to do it in order to achieve certain performance level that allows them to finish their job.

According to Oystein W. Hoie [5]
Some don't find themselves happy with the performance of their computer, while others do it for fun. Overclocking is the new hobby in town, and by easy measures you can drastically increase the performance of both your processor and video card.

A professional overclocker, Bryan Bain once quotes that "But, why do we overclock our computers? Well, this brings us to the philosophy of overclocking. Different people have different reasons for overclocking. For some, it's to save money by maximizing their computer components. Gamers overclock in order to increase frame rates in their favorite 3D game. For others, it's a challenging hobby, not unlike hotrod ding a car. A few folks do it for bragging rights and to have a faster computer than their buddies. Personally, I do it for all of these reasons and much more. I get a great sense of pride when I say, "Yeah, I built this sweet machine all by myself (with a little advice from my Overclockers.com Forum friends), plus it benchmarks faster and cost much less than a store bought OEM computer!"

According to Paolo Corsini [6]
The reason it is possible to overclock most microchips are because the labeled speed of the chip is not necessarily the only speed attainable by it. When microchips come off of the factory line, they are not all equal. To prevent mass confusion and unnecessary complication, microchip producers find the best speed that those chips can operate effectively under at a given voltage and then clock all those chips at that default speed. Because of this, it is possible to increase the speed of most chips to a higher level (quite often without even increasing the voltage supplied to it). Of course, the overclocking capability of a CPU relies heavily on the quality of its core, or the "brain" of the CPU.

From this statement, the author can say that the very act of overclocking is embraced by the most passionate PC gearheads--the computer society equivalent of auto enthusiasts who craft holes in their hoods for modified engine blocks. As such, successfully overclocking a processor is sort of a cottage industry hobby to the world of PC power users. The rush and satisfaction that results from successfully pushing a processor beyond what should have been its very limits is often more rewarding than any performance gain.

In a simple word, if the PC is getting a bit old and we'd like to get a bit more performance out of it without having to invest a lot of money, overclocking may be able to hold us over till the next major upgrade. Other from that, if users have an older computer but cannot upgrade or buy a new system for any reason like not enough money, overclocking may breath new life into the PC.

2.3 WIDESPREAD PRACTICE

Since the first personal computers appeared on the market, people have invested large amounts of time in tweaking and customizing them. While most stay happy as long as it works, some are willing to spend their spare time and money looking for new ways to use their hardware and new ways to get that last drop of performance. Some time ago these efforts were reserved for the few, and only the most technically experienced and computer accustomed took any interest in such matters. In the mid-90's, however, things took another turn, as overclocking and tweaking were about to become a public interest and a major influence on the hardware industry. To further explain on how internet technology has support this concept popularity, an article by a popular author from major overclocking website will explain it.

According to Christian "Catachan" D'Amico [7]
A few selected sites dedicated to the subject of hardware and overclocking were born - among these the renowned Tom's Hardware Guide. Tom Pabst, the page's creator and

editor, was among the first to describe computer hardware, the theories behind it and how to put it together. A growing trend of people putting together computer themselves, instead of purchasing them from an OEM, also appeared around this time. One of the first companies to take interest in this growing community was motherboard maker ABIT that revolutionized overclocking by its Soft Menu-invention. This allowed overclockers to control the speed of their system from inside the BIOS of the computer instead of using dip switches and jumpers on the motherboard itself.

Oystein W. Hoie further explained it with his statement that skipping forward to today, the overclocking and hardware enthusiasts community have grown exponentially. A wide selection of websites available in a range of languages provides reviews and guides related to computer hardware, and building your own computer has become a common thing for normal people. Hardware manufacturers are following up the trend by releasing components in delicate colors and intricate retail boxes, and Soft Menu-like options have become the standard on most motherboards. ABIT has seen a tremendous growth in popularity, and has become the motherboard manufacturer of choice for the growing community. [5]

2.4 LATEST TECHNOLOGY

New technology has been introduced to support this concept and biggest manufacturer start to market it product based on overclocking capability. Manufacturer like Asus and Intel has just introduced overclocking software that allow user to tweaking the PC performance in Windows mode.

According to Michael Singer [8]
Intel said it is preparing its next generation testing tool that lets you control the performance levels of desktop PC processors including the shunned practice of overclocking. Called the Intel Desktop Control Center, the software tool replaces the Intel Active Monitor to perform stress tests and measure the impact of system

configuration changes. The graphic interface on the console also displays various systems including temperature, speed, and usage percentages. After using the new, the company says an end user can verify system stability and check performance gains without rebooting into the BIOS. The settings can then be stored as presets to shift between "quiet operation" and "gaming mode".

In other article published on Asus website, a new technology has been introduced by Asus in his latest Motherboard model called Asus Artificial Intelligence. One of its functions is called AI-Overclocking that function as Intelligence CPU Frequency Tuner. It is a unique option in BIOS that enables quick overclocking up to 30% (depends on CPU and RAM). It automatically detects and optimizes every relevant parameter to provide both performance and stability. [9]

All of these examples prove that nowadays, overclocking concept is become very popular and with the advancement of this technology, the concept of overclocking can be applied by all end-users. This popularity can be proved as the practice of overclocking is becoming a mainstream business. Scores of Web sites like the Overclocking Store, and Extreme Overclocking offer tips and sell products that help computer users go beyond a chip's designated speed. Even internetnews.com sister sites Sharkey Extreme and SysOpt.com has pages devoted to teaching people how to boost a system's performance.

2.5 MINIMAL SETBACK

Basically, the biggest drawback of overclocking is the creation of more heat as heat is one of the biggest enemies of electronic components. Users are going to have to remove the additional heat if they want their system to run stable. If users do not, they are also reducing the life expectancy of the components.

Beside from this heat problem, the concept of overclocking also related to legal issues based on Void of warranty procedure in certain product.

Intel Tech Support in the warranty statement quotes that "Intel® processors are validated and supported only when they are operated at their factory rated settings. Operating a processor faster than it was designed (overclocking) can cause permanent damage to the processor, and possibly other system components including the motherboard. Other negative results are possible including the inability to boot or calculation errors. Operating a processor outside of specification will likely shorten the life of the processor, and can also void any available processor warranty. [10]

Although Intel has introduced its own overclocking software, they are still aware of the warranty issues. As for this matter, Intel spokesperson George Alfs told internetnews.com "Intel-based Company does not advocate overclocking because, "it may invalidate the warranty" but did say software utilities like this are fairly common in the industry. [10]

CHAPTER 3

METHODOLOGY / PROJECT WORK

3.1 METHODOLOGY

For developing a complete overclocked system, the main phase would be trial and error and it will involve many testing and benchmarking to ensure the system stability and performance. As for this, the author has chosen to use hybrid of existing SDLC model that only include phases that are relevant for my project.

This methodology so called Hybrid will include 5 main stages that aim to provide proper planning to testing phases through the development of this system. This methodology will focus on developing a systematic sequence or procedure to ensure the success of developing a system.

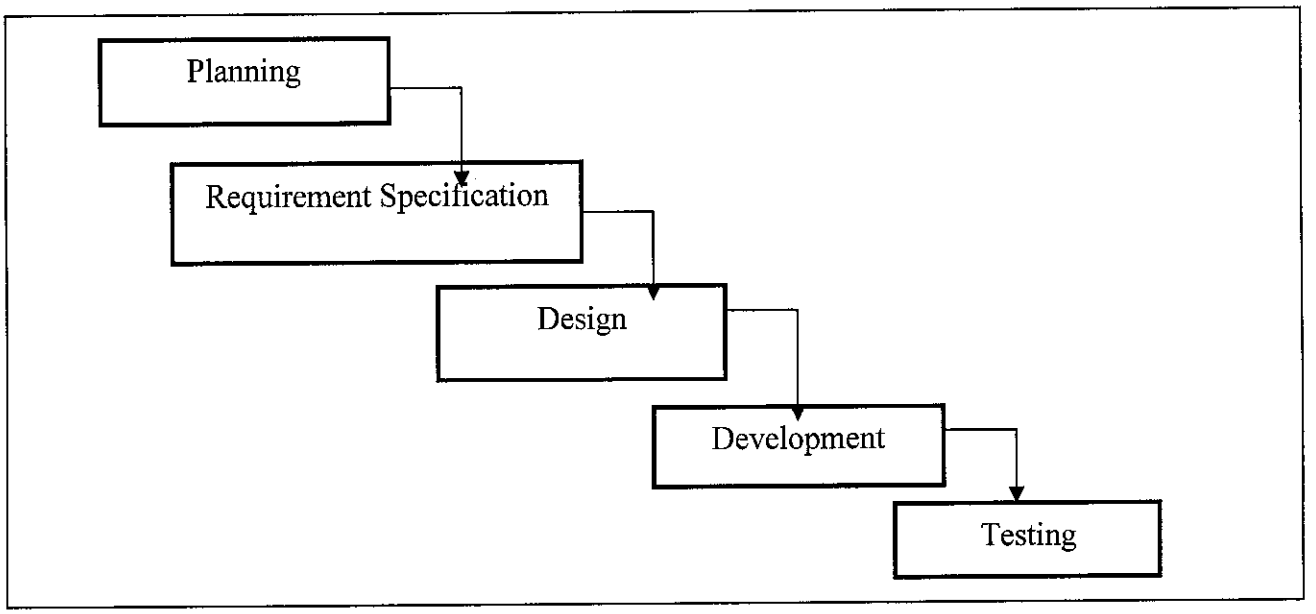

Figure 3.1: Hybrid Methodology used in this project

The first phases would be planning phases that will include the preliminary and feasibility study on selected hardware, software and concept that will be use throughout this project. This so called researching will identify the relevant material and information for this project. The main outputs for this phase are the development of the project Gantt chart and the documents that cover the concept of overclocking. The next phase is requirement specification that includes the list down of the most suitable hardware, software, tools and specification for the system. This phase is well known as project analysis and the author has prepared the problem analysis before completing the system requirement documentation.

The design phase mainly aim to properly arrange the combination of hardware and relevant testing for each hardware involved. The architecture design covers the combination of selected hardware with minimal testing in the area of compatibility and reliability. The detailed design will include the target and range to be achieved in system performance and the main activities that the author do is preparing and record the best configuration of the hardware and software that being used in this project. The next phase is the development phase which the author start to use trial and error method until target can be achieved. The testing phases may vary on certain performance review based on the selected hardware. The testing may involve many time as one proper testing sometimes need one daytime to be completed.

3.2 TOOLS

An overclocked system requires a specific hardware configuration and manufacturer to ensure system stability and compatibility. As for this matter, the author has narrowed down some specific model or hardware types that are commonly used for developing an overclocked system.

Table 3.1: Relevant hardware for developing an overclocked system

Specification	**Type**	**Brand**
Processor	2.4ghz or higher	Intel
Motherboard	i865PE chipset or higher	General
RAM	High Performance Ram	General
Graphic Card	GeForce 2 or higher	General
Fan and Heat sink	Stock or high performance	General
Cooling system	Casing with fan IDE Rounded Cable	General

Beside from this listed hardware, the right tools or software needed as for to testing and benchmarking the overclocked system performance to be compare with standard PC system. Some of the software included:

Table 3.2: Relevant software that will be used throughout developing the system

Specification	**Type**	**Licensing**	**Developer**
Overall torture test	Prime 95	Freeware	Prime
Overall system performance test	SiSoft Sandra	Shareware	SiSoft Utilities
Graphic Card test	3dmark 2001 se 3dMark 2003	Shareware	MadOnion
Graphic card overclocking software	PowerStrip Riva Turner	Shareware Shareware	Entechtaiwan Riva
Processor and Memory recognition	CPU-Z	Freeware	CPUID
Loop-timer testing program	Microsoft Visual C++	Full License	Microsoft Corporation

CHAPTER 4

RESULTS AND DISCUSSION

4.1 THE BASIC OF OVERCLOCKING

The main part of overclocking concept would be to overclock the processor itself. From the author point of view, before keep on continuing to overclock the CPU, there are some major considerations that need to be taken care of. The overclocking concept allows users to explore the possibility of increasing system performance prior to this certain consideration.

Before the author jump to the basic consideration in overclocking a CPU, it is for the best to explain a little bit on the term that will be used a lot in this discussion.

Front Side Bus (FSB) A bus is a stream of data between computer components. The Front Side Bus is the main bus of the computer. It determines how fast the information is carried between most of the components connected to the motherboard. A 133 megahertz (MHz) FSB means 133 million clock cycles per second (1 hertz = one clock cycle). That is how many "pieces" of data are being transferred every second. Adjusting the FSB affects any components in the computer that rely on this main bus.

Multiplier An internal variable of the CPU that helps determines the overall speed rating of the chip. The FSB is multiplied by this multiplier to get the final speed of the chip. Adjusting the multiplier only affects the speed of the chip, and nothing else in the computer. It does not affect the FSB speed at all.

4.1.1 CPU Information Analysis

When overclocking users often need to take stock of several factors that will affect the performance of our overclocked system. The human controllable ones such as multiplier and FSB help determine the final clock speed of the CPU. And many CPU databases refer to stepping and revision to let the users know which CPUs has been found to overclock to what frequencies.

The most popular program to report all this information and more was CPU-Z, used by many large websites to show everything from the CPU core (P4 Northwood, AMD Thoroughbred or Barton, etc) to the Bus and Front Side Bus(FSB) speeds. The ability of programs like CPUID and CPU-Z to detect the CPU and Bus information is really dependent on either information reported by the CPU, memory speed, and motherboard, or on clues that the software takes from those sources.

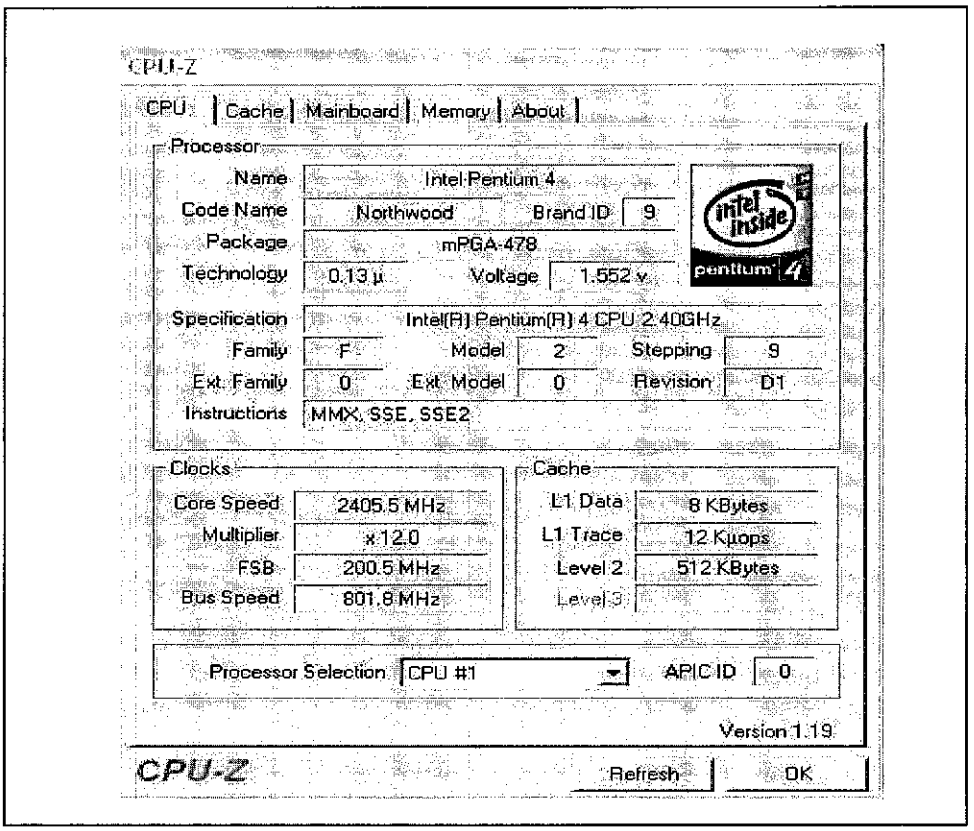

Figure 4.1: Software used to show basic information of CPU

4.1.2 Upgrading BIOS

Some BIOS's do not have overclock options or do not have good enough overclock options. The best way overcome this is to flash the BIOS. Basically the author need put a flashing utility and the new BIOS on a floppy disk, boot from it at startup, and install the bios. This too is risky because if anything goes wrong during a BIOS flash, users may ruin our original BIOS. If users have a dual BIOS motherboard, than users do not have to worry about anything. If users have just a single BIOS motherboard, then he or she will need to either get a new BIOS chip, or get a new motherboard.

As for this matter, it is aware that end-user should backup the original BIOS before continuing on flashing to the new BIOS. Beside from this way, users have to ensure that the original BIOS files are stored properly in the motherboard installation CD. If anything goes wrong, users always can use the older version of BIOS from the CD.

4.1.3 Cooling solutions

Having good cooling will give better overclock results. If the processor is in the 55°C range while it is idle, users going to need better cooling. Air cooling is the best so far in overclocking. Water cooling is the way to go if end-users are going to be doing heavy overclocks and they want to use the system while it is overclocked. Liquid Nitrogen is only for short term use. Once users get some good cooling then they can start doing some of the more extreme overclocking.

As for current situation based on this project, air cooling will be most suitable for the overclocked system. The basic thing would be to ensure enough airflow in the CPU casing. As for this, the author will use three inflow and one outflow fan to keep the casing cool. Beside from this, an upgrade in CPU heat sink may allow users to have better temperature reading as certain heat sink are tend to create less heat from the stock one.

Of course a good quality heat sink and fan on the CPU are important. And it's just as important to make sure the contact between heat sink and the processor is as good as possible. To do this, users need to have a good type of thermal grease which will help transfer heat between the CPU and the heat sink. It's also recommended that users get the surface of the heat sink as smooth as possible by sanding it (also called lapping) so that there is as much surface area of the heat sink touching the CPU as possible.

Not only is having a quality heat sink/fan on the CPU is necessary, but proper case cooling is just as important. Think on it for a second, if the ambient air in CPU case is hot, the fan on our CPU is just going to be blowing hot air onto the heat sink, which is already hot enough as it is. As for this matter, the solution is to get some fans in that case. Usually, an 80mm rear exhaust fan and a couple 80mm intake fans are enough (including the power supply fans). Some people prefer to use bigger fans if their case can support them because they can push a lot of air without having as many in their case, decreasing the noise of our computer. An aluminum case is also a nice thing to have because it disperses heat a lot better than steel. Also, round ATA and floppy cables versus the standard ribbon cables will help airflow in the case.

4.1.4 Voltage Increases

Increasing the voltage is dangerous without proper cooling. The processor will generate more heat at a higher voltage. Increasing the voltage will increase the system stability though and users can increase the FSB and Multiplier even higher. The author must be sure to monitor the temperatures to make sure anything is not frying.

Increasing the voltage supplied to a component may help stabilize it. Sometimes, however, it does not work and that could mean that users have hit the wall which mean users have reached the maximum potential for that chip. To increase the voltage, we have to do it so in the BIOS in 0.025v or 0.05v increments (little increment).

As for this matter, the main hardware that the author should look for would be power supply. Overclockers need a good quality power supply for overclocking, because bumping up the CPU core voltage, using multiple fans and other stuff like that requires lots of extra wattage. The good one may cost a little more but the functionality and stability are far better than the standard one as it allow end-user to use as many power cable needed for certain devices.

4.2 THE PROCUDURES IN OVERCLOCKING

CPU Speed = CPU Multiplier * Front Side Bus (FSB) Speed

The clock frequency of a processor is the product of two factors: the front side bus (FSB) frequency and the multiplier. FSB frequency indicates how fast the components of your computer are working, while the multiplier indicates how fast the processor is compared to this value. By adjusting these two factors, users can change the clock frequency of the processor. A good rule of thumb is to increase total processor speed a few MHz at a time, spend some time playing or benchmarking it to detect any system instabilities, for then increasing it further and further until the author see any sign of instability

The concept of overclocking a computer is straightforward, but actually doing so is not. CPU speed is determined by the following equation: CPU speed = CPU multiplier x Front Side Bus (FSB) speed. Overclocking is changing the CPU multiplier and/or the FSB speed to increase the CPU speed. Modifying the CPU multiplier is difficult as most CPU multipliers are locked. The FSB is where most speed tweaking happens. Depending on motherboard age, the FSB speed is adjusted by either jumpers on the motherboard or a menu in the BIOS. Either way, the right thing to start is to not immediately jump to the fastest speed possible instead, try to increase the CPU speed

slowly. To test the stability in early phase, users should run our system for some time at each new speed level to make sure the system is stable and does not crash. Once users get to a speed where the system is no longer stable, set the system to the last stable speed.

Overclocking generates more heat in our computer system than normal. More case fans and a bigger heat-sink /fan unit for the CPU may be needed to keep the heat in check. There are tricks that may defeat system instability, pushing the speed a little higher, and certain FSB speeds are more unstable than others, but this information is beyond the scope of a basic overview of overclocking. Then again, users may not be able to overclock our system at all.

Some users on commercial systems will not be able to access FSB and Multiplier settings. Users with locked Multipliers on their processors will only be able to rely on the FSB to overclock. This trend has become universal as nowadays manufacturer has locked their processor multiplier. As for this matter, overclockers only will have one ways to overclock their system by playing and tweaking the FSB speed until achieves certain target.

4.3 STABILITY TEST

To test the stability of an overclocked processor, users should use a program that will stress the CPU continuously. This will generally bring the core temperatures up very high and the end user should ensure that adequate cooling is available on the processor to avoid damage. Some good programs to stress the CPU include DivX encoding and Prime95. Generally the author are likely to stick to torture test inside Prime95 because not only does it bring the temperatures up very high but it also does self checks on the answers to see the results obtained are correct. This will ensure that an overclocked processor is functioning within the same parameters as a non-overclocked CPU. DivX is

also very stressful and overclocked processors that are not completely stable tend to fail in the middle of encoding.

Other programs such as Folding@Home and Seti@Home will bring temperatures up to very high levels but in the past Seti has stated that overclocked processors have introduced slight rounding errors in the results produced. There is no way to verify the computational accuracy of Seti and Folding@Home which is why Prime95 is the best since they can compare to answers to pre computed results. Generally stress tests should be run for a minimum of a few hours to ensure stability and accuracy.

Temperature monitoring is paramount to processor stability. A good temperature in the current crop of processors is the under 45° C range under load. 45°-55° is getting on the high side while higher than 55° may adversely affect stability and reduce the lifetime of the processor. The temperature of CPU has become a major resource to monitor system stability.

4.4 HARDWARE SELECTION

An Overclocker's life, be it frugal or expensive, inventive or acquisitive, will always center on buying new parts. The first step must always be to select the right part. To the beginner having perhaps read an article or two, a review or three, this may seem an easy mark to hit on selecting the right hardware. It's far different with the overclockers' procedure or view on the hardware. Systems are just that, an integral unit - a complete integration. This is simply not possible to achieve in a random manner.

For a beginner, an entire month spent in the overclocking forum before spending a dime is not too long nor a waste of time. If users just burning to begin, then consider going to the overclocking forum and asking about commercial systems built by overclockers for overclockers who are in a hurry or who have limited time to spend in achieving their goals.

Overclocking can save PC users a bundled, but a single bad purchase can wipe out those savings and cash in a flash as well as delay users' next upgrade. This is an approach that must show care in the little things - attention to detail and detailed attention.

Table 4.1: Summarize information on hardware selection strategy

Type	Criteria / Alternatives	Selection
Casing	1. Modded case (generic cheap case, cut and hack holes into it, and then mount a host of fans) 2. Good case with all the cooling stuff already built into it 3. The main feature that needs to be considered would be to get a case big enough where nothing overhangs the motherboard and also there is enough space to add extra fan for the casing	A ready-made casing with three intakes fan and one exhaust fan that are enough to provide the air cooling for the system
Power supply	1. Good quality power supply for overclocking, because increasing the CPU core voltage, using multiple fans and other stuff like that requires lots of extra wattage 2. The minimum standard for power supply is 400 watt	A medium class power supply unit 450 watt with I-cute brand are enough to support this project
Motherboard	1. The motherboard is considered as the heart of the machine. It will	Asus P4P800 Deluxe as this motherboard provides

	serve as the master equation and determining feature of any system it inhabits. 2. Motherboards must be equipped with the latest features in overclocking world and it must provides higher certainty in increasing the speed of the system 3. High quality BIOS feature such as lots of FSB and voltage adjustment that can be easily changed in the BIOS	a good feature is overclocking and also well known in high performance and reliability.
CPU/ Processor	1. Only certain type of processor really performs best in overclocking mode. Thus, careful consideration, researching and selection are vital in buying the right processor. 2. The main consideration would be in selecting a processor would be its quality, speed, batch type and its overclocking capability. 3. Heat factor can be a consideration too as certain processor produce more heat and this will affect the overall stability of the system.	Intel Pentium4 2.4c with Hyper Trading technology enabled. This processor is considered as the king or champion of CPU overclocking
RAM Memory	1. Aim for quality and high reliability RAM. The other feature would its overclocking capability.	Kingston HyperX RAM PC3200 which is a high performance RAM that is

	2. Standard RAM is being used by normal end users and its capability is very reliable and good for the use of default or standard system. 3. High Performance Ram that is specially designed for the use in overclocking and to increase system performance.	suit and compatible with the motherboard of the system.
Graphic Card	1. Most of the newer AGP 3D video cards seem quite tolerant to overclocking 2. The best alternatives would be to choose high-end card from the certain brand of graphic card product or family	Geforce4 Ti4200 as it is considered as the big brother in GeForce4 family of products
Hard drives/ Hard disc	1. High quality and high speed hard disc can help improve the result of benchmark 2. It is optional to use small hard disc or bigger hard disc as the performance relies on the speed and the quality of the hard disc.	80 GB Maxtor with 7200 rpm and 8MB buffer that can be describe as the fastest hard disk in its range
Other components	1. Overclocking usually causes the PCI bus to run faster than normal, so, overclockers need to buy good and quality components that will run well when overclocked	High quality CD-ROM, sound card

4.5 OVERCLOCKING WITH 2.4 C CPU

Before the author move on to the overclocking discussion, let the author remind about the CPU or processor that will be used in this process

1. Pentium 4 2.4C is intended for work with 800MHz bus. It means that it requires main boards supporting 200MHz FSB. Such main boards are those based on the new i875 and i865 chipsets and also – overclockers main boards based on the old and time-tested i845PE. Thus, Pentium 4 2.4C has a fixed multiplier = 12x.
2. Pentium 4 2.4C supports Hyper-Threading, which once was available only in top-end Pentium 4 CPUs. For your information, Hyper-Threading refers to a virtual multiprocessor system. One physical CPU is recognized by the system as two logical CPUs: it helps to load the processor's computational units to the full and, as a result, to achieve a certain performance gain.

Intel Pentium 4 2.4c
Asus p4p800 deluxe (i865PE chipset)
Kingston HyperX pc3200 256*2 dual channel enabled
Nvidia MSI Geforce4 Ti4200 8x 128mb
80 gig Maxtor 7200rpm 8mb + 40 gig Quantum
Liteon dvd-rom + Sony 24x cdrw
Creative Soundblaster Live 5.1 (DE)
Coolermaster Cool drive 4
Coolermaster rounded IDE and Floppy cable

Figure 4.2: The final system combination use in Overclocking Project

4.5.1 Tweaking BIOS setting in overclocking

The process of overclocking can be done after all the equipments and hardware is properly installed in the system. The first step would be to enter the system BIOS which can be done by pressing the "del" or "F1" key on startup when the student turns on the PC or system. From the main BIOS screen, the author has to select the option where the author can adjust the processor voltage, multipliers and so on. As for this motherboard BIOS, it would be to set the AI Overclock Tuner to manual. For the next step or procedure, the author has to ensure that certain configuration must be fixed before moving on in increasing the processor speed. The basic steps would be:

1. Set the Fixed AGP/PCI Frequency to 66/33MHz.
   This is also very important to keep the AGP/PCI clocks running within specification (66/33MHz) when overclocking. If the AGP/PCI clocks are too far out of specification when overclocking, i.e. 90/45MHz, the computer might crash, and many bad things like hard disk data corruption may occur

2. Increase the DDR SDRAM voltage to at least 2.70v. This is just a precaution to make sure that the RAM is stable. Such a small voltage increase will not hurt the memory or RAM.

3. Set the AGP Voltage option to 1.6v. The author need to test out the different settings from 1.50v to 1.65v to see which one gives the most stable setting.

4. When we are running or using DDR400 RAM, the author needs to change the DRAM Ratio option to 5:4 which mean (DDR333 on ASUS boards). This means that the RAM will run at 4/5 or 80% of the FSB speed. This procedure is important to ensure that the RAM is not limiting the CPU in overclocking.

If all of these basic steps are taken care of, the author now can move on to the real overclocking procedure and process that will definitely increase the processor speed. Before to move on, let the author recall the concept of the processor speed. The default FSB (sometimes called External Clock in the BIOS) for the P4C chips is 200MHz. Remember that the final clock speed of the CPU is the result of the FSB speed*CPU multiplier. For the P4 2.4C, the multiplier is 12, for 2.6C, it is 13, and so on with other type of processor. The main steps and procedure in increasing the speed of a CPU would be:

1. Increase the External Clock or FSB by 10MHz. The default is 200/66/33, so after the increment it should read 210/66/33. Save the settings and exit the BIOS.

2. The computer or system should boot up flawlessly. So, the author should get into windows and run the Prime95 torture test for at 20-30 minutes. (The higher users increase the speed, the longer users should run Prime95 to ensure that the system is stable).

3. The next step would be to repeat steps 1, 2, and 3 until the author get errors in the Prime95 torture test. This means the system is somewhat unstable. As for this reason, there is two available alternatives or options to choose from:

    a) Decrease the FSB (Ext Clock) by 5 MHz then run Prime95 torture test for a few hours (the best option is 3 to 4 hours) to make sure it is stable. If it is still not stable, the author can either reduce it some more or refer to option (b) below
    b) Increase the CPU Core voltage by one step (0.025v). This is usually the better option as long as the voltage is still below 1.65v. As a precaution, the author should not increase the voltage beyond 1.70v as this might kill or burn the CPU. The author must run Prime95 torture test for a few hours (the best option is 3 to 4 hours) to make

sure the system is stable. If still unstable, the option would be to increase it some more, or if it is already high (1.65v and above), overclockers should refer to option (a) above.

4. If users increase the voltage a few times and the system is still unstable, it is a sign that we might have reached the limit of the processor. The author should refer to step 3. (a) and reduce the FSB by 5 MHz before torture testing again.

5. Within this procedure of increasing the FSB value, the author must keep in mind the configuration of the memory or RAM. As the author is running DDR400 RAM, we have to change the DRAM Ratio to 3:2 once the FSB exceeds around 250 MHz. This step is required in order to ensure that the RAM stays within specification and will not limit the CPU in overclocking.

6. Once the author has found the sweet spot between FSB speed and core voltage, the author need to run Prime95 torture test for at least 5 hours just to make sure it is completely stable. If it is not stable after a few hours, the solution would be to reduce the FSB by 5 MHz and to try again.

The author has able to reach the 3.2 GHz but there is some problem occurs when running with that speed. Using this configuration, the author run Prime95 software for the stability test and it failed within one minute. This show instability in the system that running at that speed. The solution would be to increase the Vcore or voltage and it has been done but the result are still the same. With extra research, the author has identified that the voltage cannot be fixed as it tend to fluctuate time to time. The problem may come form the motherboard or the author need better power supply unit to reach more than 3.2 GHz

Because of this problem, the author has tried to reduce the FSB value from 267 to 260 which mean the processor is running at 3.1 GHZ. At this point, Prime 95 program has

been run for about 5-6 hours and the result would be that the system is stable at this speed.

4.5.2 Benchmarking

Benchmarks exist to determine how a particular piece of hardware performs in relation to itself, and to others. This benchmark will show comparison of the current CPU compare with others.

CPU-Z functions as the program that show the core speed and FSB speed after the overclocking process being done in BIOS. The other function would be it gives information on the voltage that the system is using.

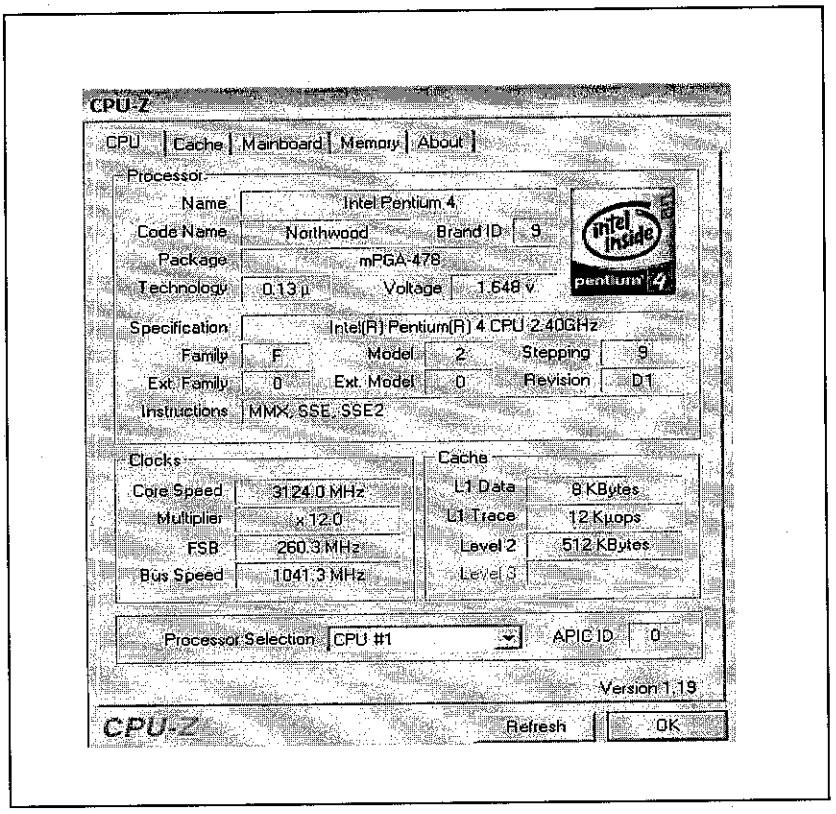

Figure 4.3: CPU-Z result at P4 3.1 GHz 260 FSB

For stability testing, the best benchmarking or testing program would be the Prime95 program that functions to torture the CPU hardware and capability to its limit. Below are the results of the testing that show that the CPU is stable and reliable when it run at 3.1 GHz speed and having some problem (based on the problem stated above) to run at 3.2 GHz.

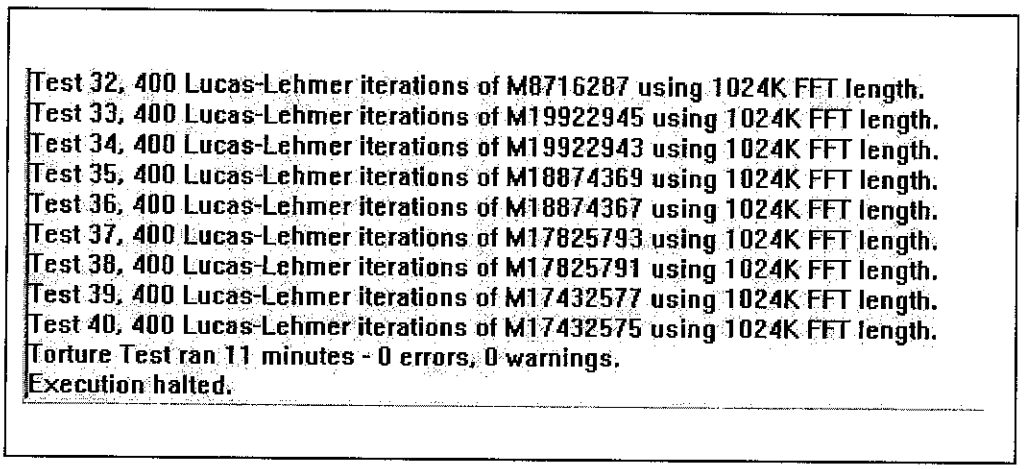

Figure 4.4: Prime95 Torture Test Pass at P4 3.1GHz 260 FSB

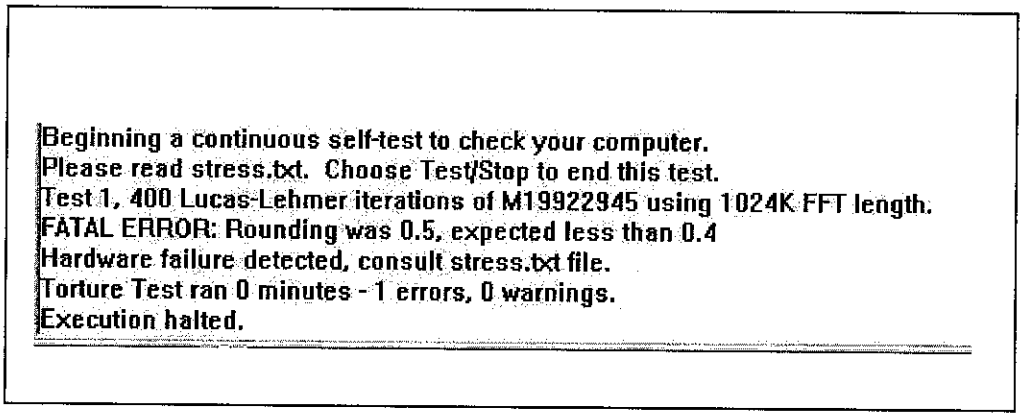

Figure 4.5: Prime95 Torture Test Fail at P4 3.2GHz 267 FSB

For benchmark purpose, the author has use SiSoftware Sandra as the primary tool or software to prove on the theory that an overclocked processor surely gives higher performance score than the default system. This result below will further show the performance increase for CPU overall performance. The benchmark has been done in two modes which is in default speed of the system and in its overclocking mode.

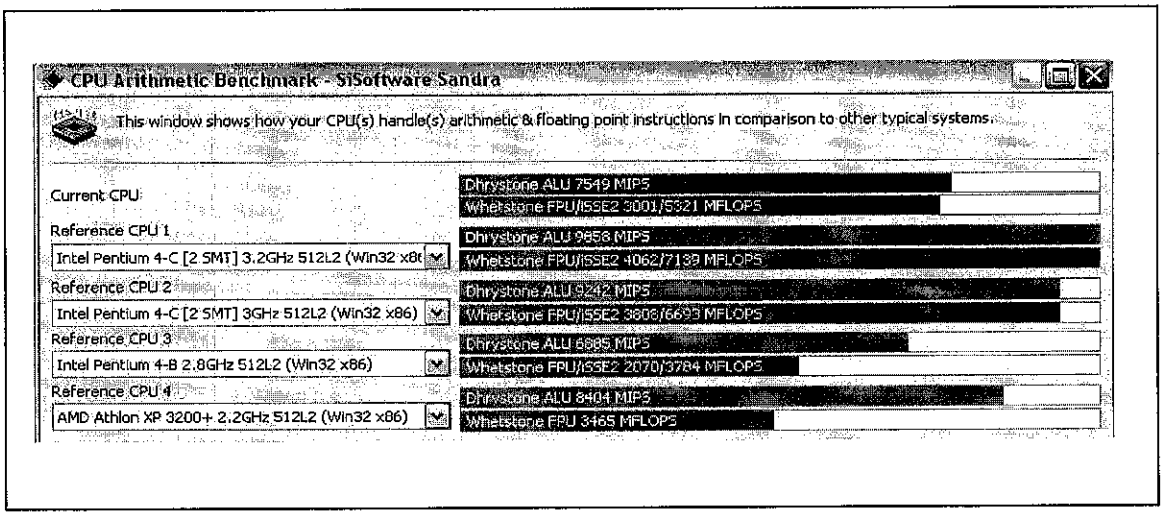

Figure 4.6: CPU Arithmetic Benchmark P4 2.4GHz at 200MHz FSB

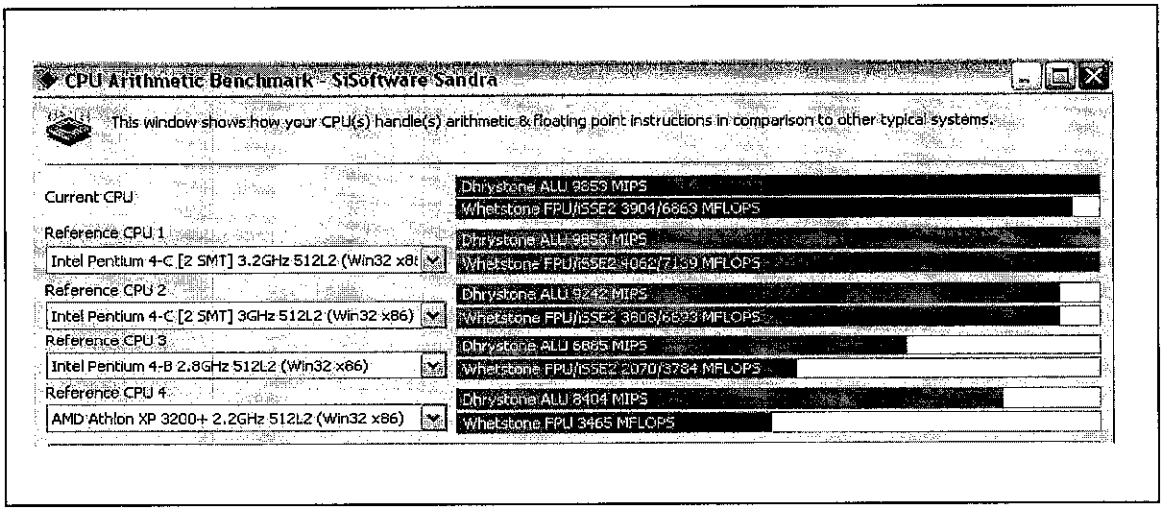

Figure 4.7: CPU Arithmetic Benchmark P4 2.4GHz @ 3.1GHz 260MHz FSB

This benchmark purpose would be to test the performance of the CPU when it handles multiple multimedia programs at one time. For this benchmark, video card performance is taken it consideration as this hardware are backbone for the CPU in handling multimedia program.

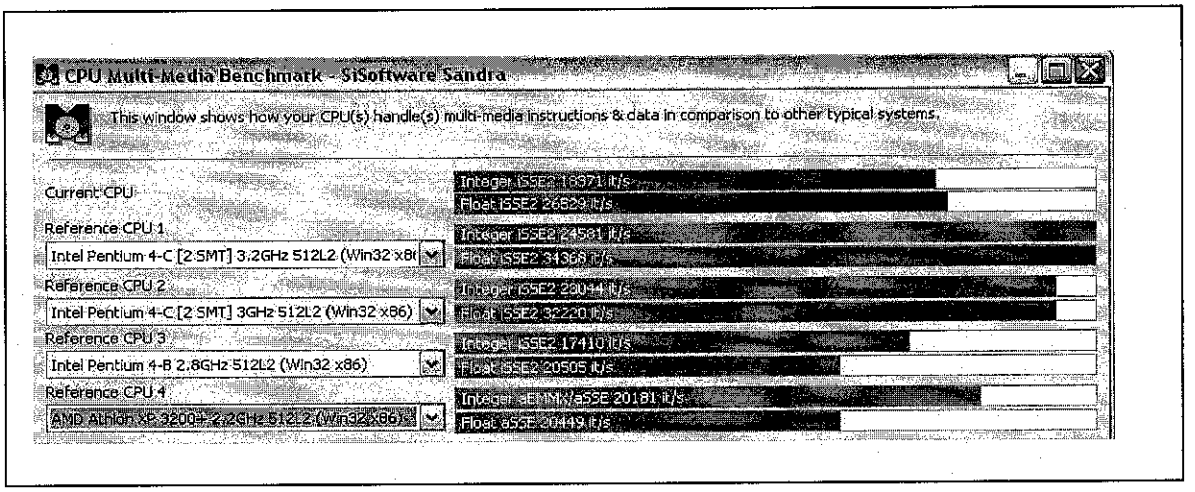

Figure 4.8: CPU Multimedia Benchmark P4 2.4GHz 200MHz FSB

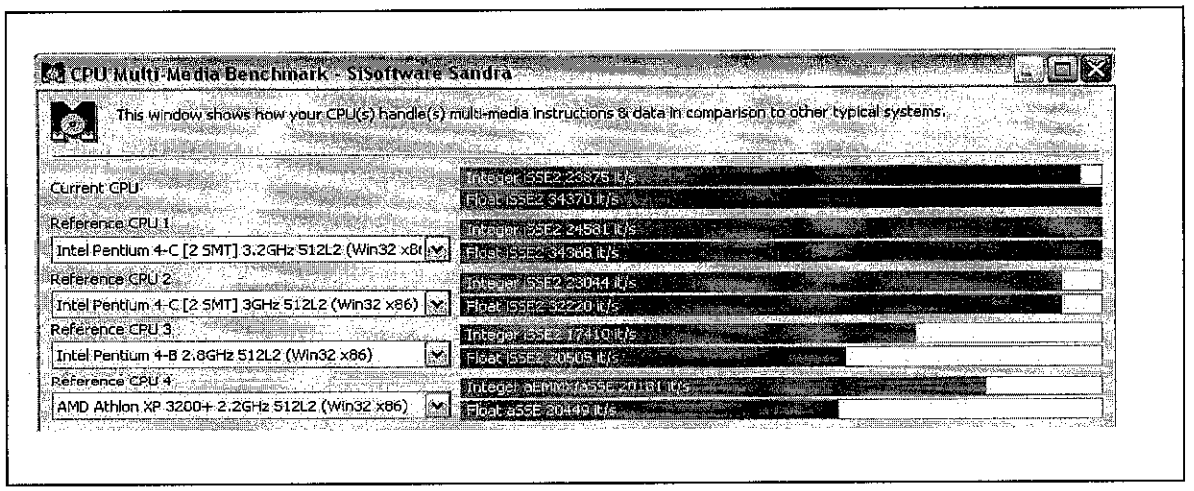

Figure 4.9: CPU Multimedia Benchmark P4 2.4GHz @ 3.1GHz 260MHz FSB

As the author has explained above, memory or RAM has big influence or factor in increasing the overclocking capability of a system. For this benchmark, the author doesn't tweak the configuration of the RAM in order to prove that when the author is running the overclocked system, the RAM performance will also increase. Below are the benchmark results for this concept.

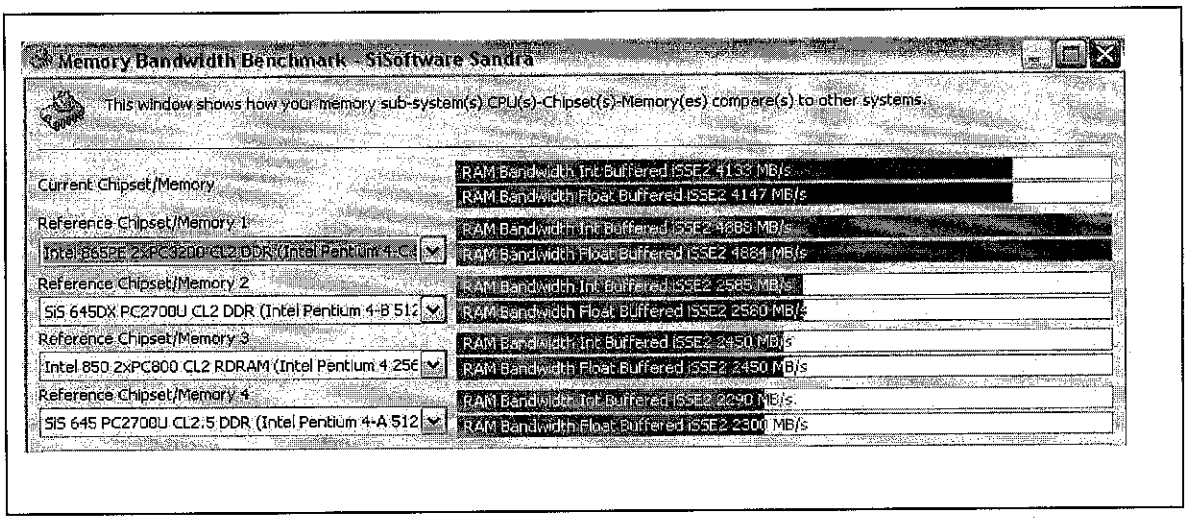

Figure 4.10: Memory Bandwidth Benchmark P4 2.4GHz 200MHz FSB

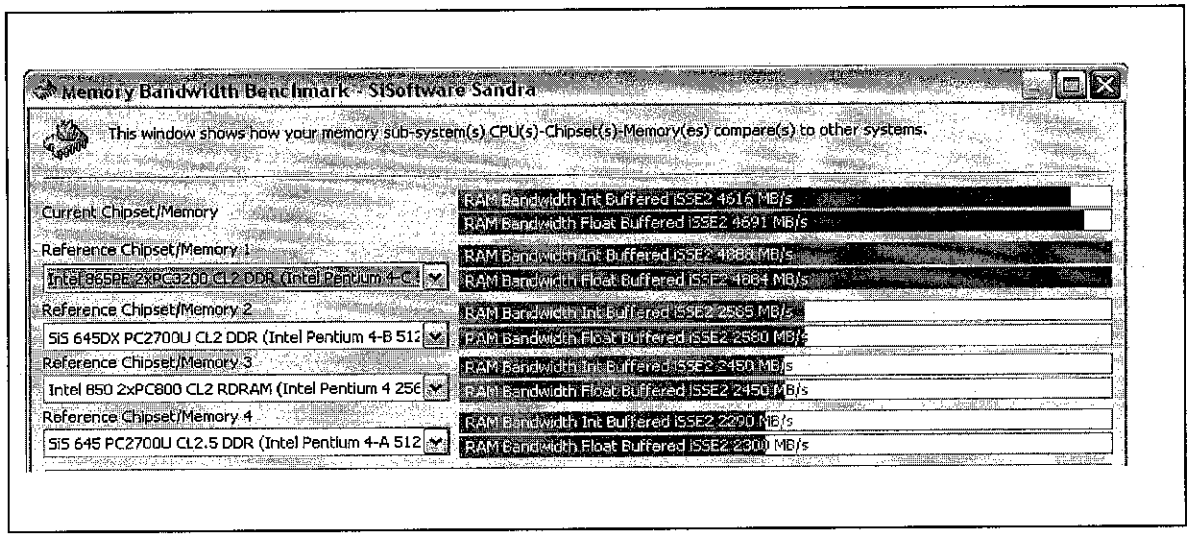

Figure 4.11: Memory Bandwidth Benchmark P4 2.4GHz @ 3.1GHz 260MHz FSB

Testing phase is vital in proving that overclocking can increase the performance of the system. As for this reason, the author has develop a testing tools based on arithmetic function of the CPU. This program is called loop-timer and its main functionality would be to calculate the processing time of CPU in handling simple looping structure. The target to achieve is that the processing time of an overclocked system must be lower from the standard or default system. The testing is divided into three main categories based on the looping structure which is easy, medium and hard. The result of the testing may vary based on this certain level as higher level of testing include more looping structure and increase the CPU handling and processing time.

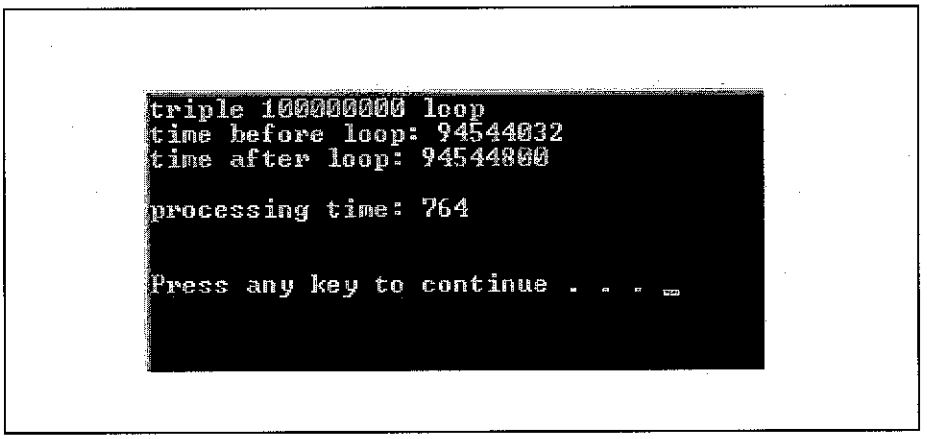

Figure 4.12: Processing time on 2.4 GHz system with highest level of testing

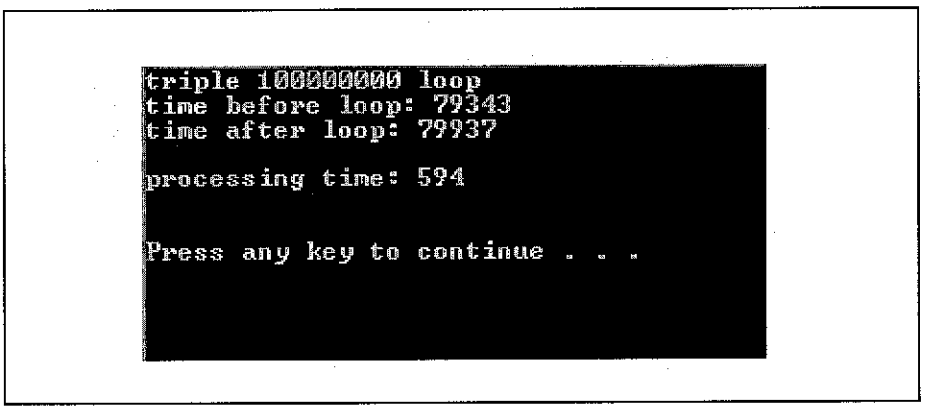

Figure 4.13: Processing time on 3.1 GHz system with highest level of testing

4.5.3 Benchmarking result

Table 4.2: Summary of benchmarking result using SiSoft Sandra Program

Type of benchmark	Score at 2.4 GHz	Score at 3.1 GHz
CPU Arithmetic	7549/ 5321	9853/ 6863
CPU Multimedia	18271/ 26529	23875/ 34370
Memory Bandwidth	4133/ 4147	4616/ 4691

4.5.3.1 CPU Arithmetic and Multimedia benchmark

Based on the result shown in the table 4.2, overclocking produces better or higher score result in benchmarking software. The score increments are quite high as it surpasses the 1000 score for each type of testing. Based on the figure above, the performance of overclocked process are higher than 3.0 GHz processor and almost the same with Intel Pentium 4 highest line of processor product which is 3.2c. This result show that an overclocked processor will certainly increase the performance of its current speed but also has the capability to achieve higher performance compare to higher default processor speed such as 3.2 C. The reason or factor that allows an overclocked processor to surpass its target performance would be the high value of FSB compares to default speed processor. It is certain that an overclocked processor that run at 3.1 GHz can perform better that default processor that run at 3.1 GHz too.

4.5.3.2 Memory Bandwidth benchmark

This benchmark is performed to prove that when we are running an overclocked processor, the score or the performance will be increase without needing to overclock

the memory itself. Based on the result above, it is certain that RAM also benefit from higher speed of processor as the score still increase although only with small margin.

4.5.3.3 CPU processing time testing

Table 4.3: Summary of testing result using loop-timer

Testing Level	Score at 2.4	Score at 2.6	Score at 2.8	Score at 3.1
Easy	250	234	219	203
Medium	516	484	437	406
Hard	764	718	656	594

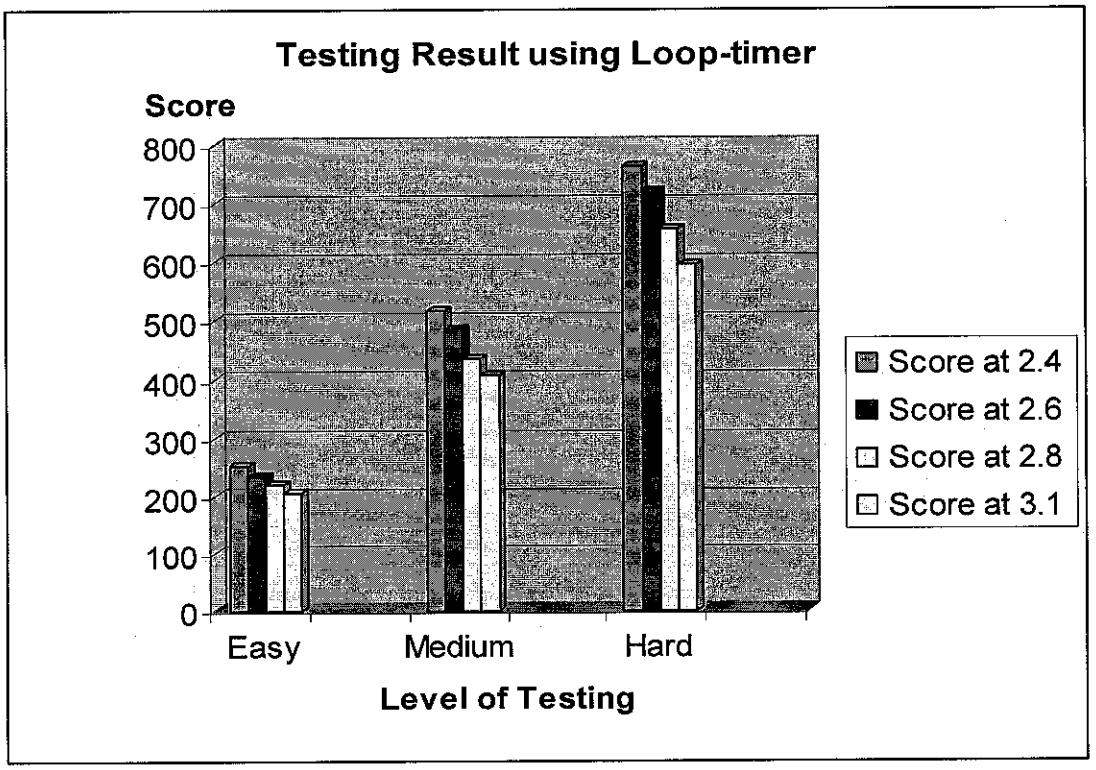

Figure 4.14: The overall score in loop-timer testing sequence

From Table 4.3 and Figure 4.14, the testing result of the loop-timer program show that when the author overclocks the processor, the processing time would decrease. As for this, it shows that system performance is increase as CPU can handle arithmetic function faster than before. The use of multiple level of testing is to ensure that the result may vary as the higher level of testing give the CPU more workload compare to easier level. Although the test result are fluctuate, the author is able to record the average time for every testing level The results are consistent as each increment in the system speed resulting to decrement in processing time. From this data, it is certain that overclocking is a way or approach that can be taken by PC end-user in increasing the overall system performance without spending much money on that.

4.6 OVERCLOCKING THE GRAPHIC CARD (GeForce4 Ti 4200)

All modern graphics cards have a Graphics Processing Unit (GPU) chip which performs graphics calculations, and memory which the GPU uses to perform these calculations. Each of these has a default clock speed determined by the manufacturer. The performance of a graphics card can be boosted by increasing the clock speeds beyond the manufacturer's default settings. This is what we call overclocking.

Before the author explains on graphic card overclocking method, there is some term that needs to be classified first. Two important variables in graphic card are:

a) Core clock - the clock speed at which the GPU (also known as graphics chip) operates. It is measured in MHz, just like a CPU.
b) Memory clock- the clock speed at which the graphics card's memory operates. It is also measured in MHz. All modern graphics cards use DDR (double data rate) memory, which explains why some people may refer to the same memory speed as 350MHz or 700MHz

4.6.1 Tweaking Core and Memory Clock

The best software to use in overclocking graphic card would be a program called Riva Turner that supports both NVIDIA and ATI cards. The function would be simple as it only display needed value in the software such as core and memory clock of graphic card. As for this project, the author are using MSI GeForce 4 Ti 4200 and with this hardware come a manufacturer made driver that allow student to overclock using it owns driver. This feature allows the overclocking process being done without the third party software.

The first value to tweak would be the memory clock as we have to find the most stable overclock for memory clock and then move on to find the maximum stable clock for core speed. The author needs to increase the value of this two clock by move the pointer

to the right and if the author want to decrease its value, the action would be to move it to the left. The basic steps in tweaking the memory clock would be:

1. Increase the Memory clock by 5MHz at a time. After each increase, the author have to run 3DMark01 once and must alert or monitor any weird rendering errors, artifacts, or glitches.

2. If the author notices some slight graphical anomalies, the action would be to reduce the speed by 10MHz and run 3DMark once more. If there are no more anomalies, then it is recommended to run 3DMark at least 4 times more and watch every run carefully for any weird glitches.

3. When the author are not sure, the author just need to lower the clock speeds back to normal and run 3DMark again to see if that little something that the author might noticed was an error due to instability, or just something normal.

4. As if everything is fine and running stable, it is recommended that users or me as the author start playing some high graphic games or do some video editing.

5. After doing some test, if we still see some glitches/errors, the action would be to reduce the Memory clock by about 5MHz and try again. The author will keep doing this until the maximum stable speed is found.

The next step would be to record the highest possible value for the memory core speed that student can overclocked and then, student would reduce the value to its default once again. After this action is finished taken care of, the author will move on to the next step in overclocking graphic which is to tweak the core speed clock of the graphic card. The method uses are similar with above and these 5 steps are repeated once again in tweaking the core speed. After all of these steps have been done, it is time to test the combination of two values with best possible values. If anything weird happened, student would decrease the value or speed of that two clock speed.

4.6.2 Benchmarking result

The score above are taken after and before the overclocking graphic card take place. The score difference prove that the performance of the graphic increase when student overclock it. This shows that the graphic card has the capability to be overclock based on student or end-user need. The graphic card performance mean very much to video editor and for hardcore gamers as they use the graphic card for their search of better performance on their activities.

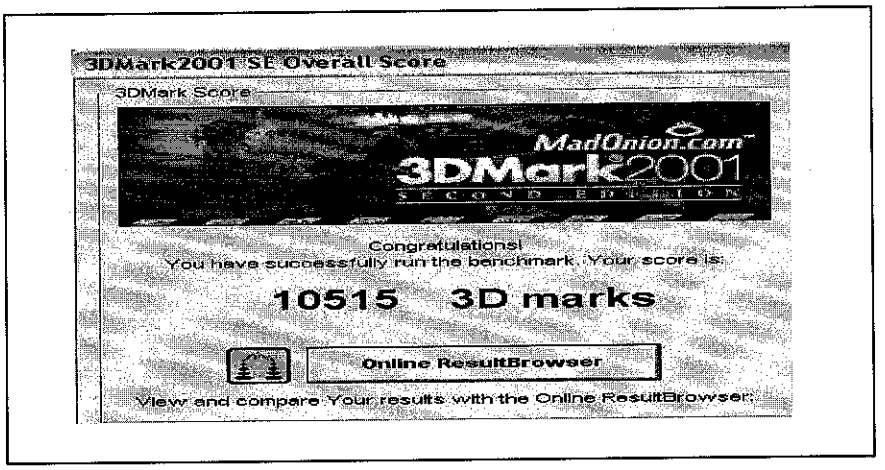

Figure 4.15: 3DMark result for default configuration at 513/250 clock speed

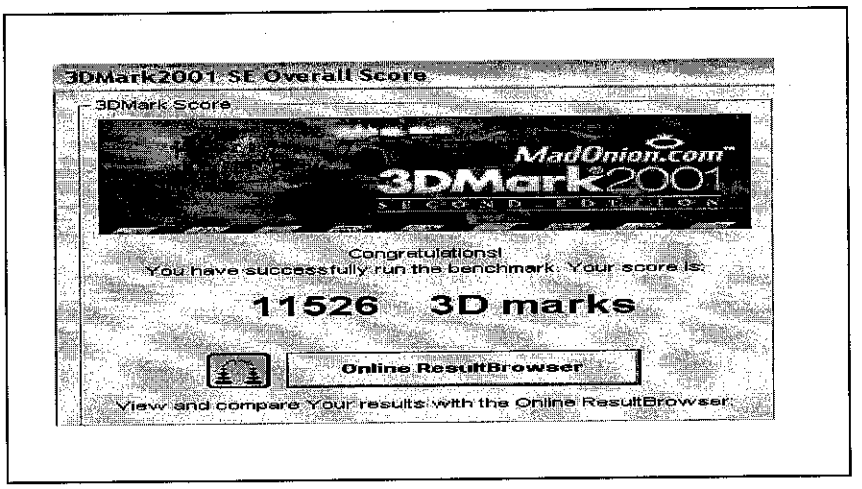

Figure 4.16: 3DMark result for overclocked configuration at 530/265 clock speed

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

Overclocking is a new branch of technology in Computer and Information age area. The introduction of this technology allows certain method and concept being applied by normal users of personal computer or PC. Using this research, the author has explained on the basic concept of this technology and demonstrates it through the experimenting and developing prototype upon completion of this project.

The basic problem of PC users which is lack of money and desire for better performance can be solve by applying this concept. This research has fulfilled or achieves its objective by proving how end-user can achieve certain performance satisfaction using overclocking approach and procedure.

The stability of prototype has been tested in order to ensure that the result of performance test is vertically the same with the reliability of the system. The testing phase allows the author to prove how performance of the system increases and effecting overall performance of the system.

The main result of this research would be that the author is certain about the benefits of developing an overclocked system. The first one would be the speed element which the CPU will perform more operations per second and also RAM when the author increase the FSB of the system. This ensures that the performance will increase and will speed up almost all operation in overall system. The next benefit is the money issues which the author has prove that the author can increase the performance with minimum cost by

overclocking 2.4 GHz processor to 3.1 GHz processor that cost or price double from the 2.4 GHz.

This research certainly educates the author on the vast areas of computer architecture. Trouble-shooting activities strengthen the author problem solving and critical thinking skills. The knowledge gain throughout this project is invaluable as it allow the author to explore new technology possibilities and challenges.

5.2 RECOMMENDATION

This overclocked system is developed as a working prototype resulting from the research of the project; therefore this prototype can be improve in term of its reliability, stability as well as performance. The main enhancements focused on the higher level of overclocking experiment or project and some recommendation being made to improve the research element of this project.

With proper budget and research, the experiment of this prototype can achieved higher level of PC technology that will integrate with the concept of physic and chemical element. The use of chemical like liquid nitrogen has been introduces as the primary cooling solution that enable the system to run 100 percent more that default speed. This technology proved that overclocking approach is been widely discussed and experimented by professional user. Beside from this, the author would recommend that proper testing and benchmark has to be done time by time and ongoing research to be made on review of certain hardware that will help in determining the right combination of hardware for a complete overclocked system. This activities are vital as its will effect overall performance of the overclocked system.

The author has developed a testing tool in proving that an overclocked system processing time would be much smaller than the default one. This prototype only uses arithmetic function in CPU processing time. For further enhancement, the author

recommends that the functionality of the tools to be added some new feature such as multimedia benchmark test and certain performance comparison value.

As for the research element, the author recommends that further explanation can be made on the procedure of overclocking for different kind of hardware. In this project, the author only covers two types of hardware which is the processor and the video card and the continuation can be made on other hardware such as the memory, the sound card and also certain CDR-W. With all of this hardware, the testing result can be enhanced through the use of multiple software tools that designed to be as benchmarking tools. Beside from this, a discussion should be made on how this technology is affecting the current computer trend and how it will affect normal end-user like the author himself.

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URL:http://www.intel.com/products/desktop/processors/pentium4/index.htm?iid=ipp_desk+proc_p4ht&

[11] Abdellatif Benzzine "System Development Methodologies a framework for comparison"
URL http://www.umsl.edu/~ab189/mis488paper.html#methodologydef (MSIS 488 - Information Systems Analysis - fall, 2002)

[12] Howard Weitzel May 2003 "Overclocking with nForce2"
URL: http://www.systemcooling.com

[13] Ilya Gavrichenkov, July 2003 "Intel Pentium 4 2.4C overclocking"
URL: http://www.xbitlabs.com

[14] Bill Hillman, 2001 "A brief overview of overclocking"
URL: http://www.viperlair.com

[15] "Overclocking basic training" 2001
URL: http://www.overclockers.com

[16] Colin Sun, May 23, 2003 "The art of overclocking"
URL: http://www.pcstats.com

APPENDICES

APPENDIX 1

COOLING SOLUTIONS

1. Current cooling solutions

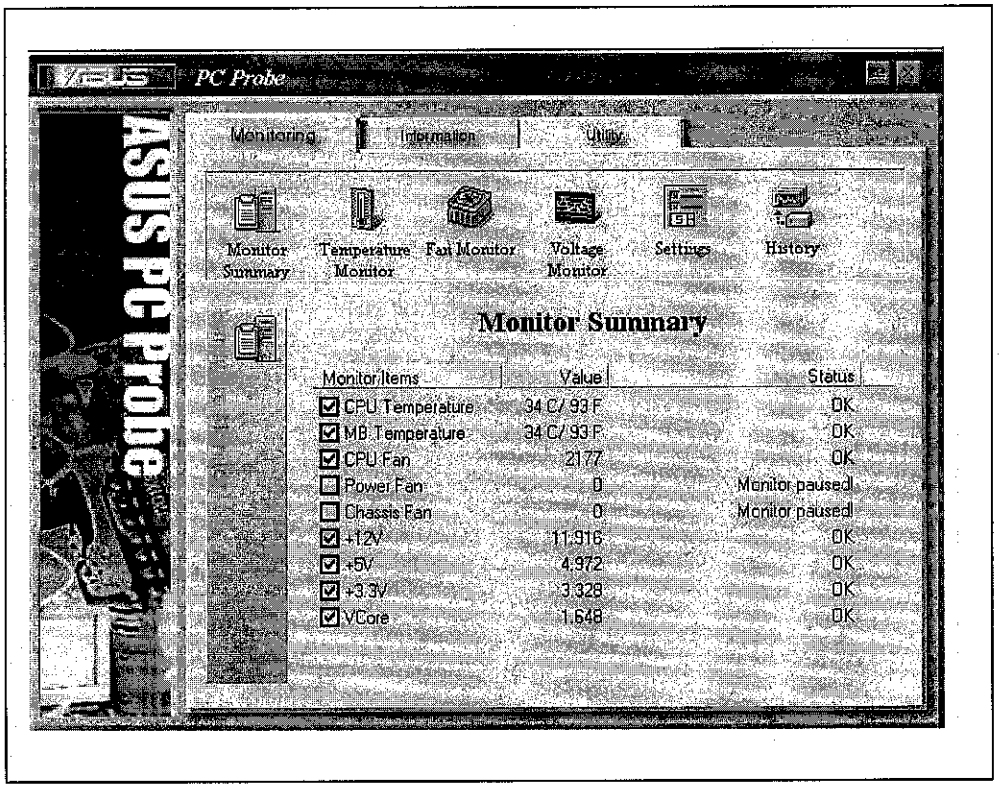

Figure 6.1: Sufficient cooling solution when overclock 2.4 to 3.1 GHz

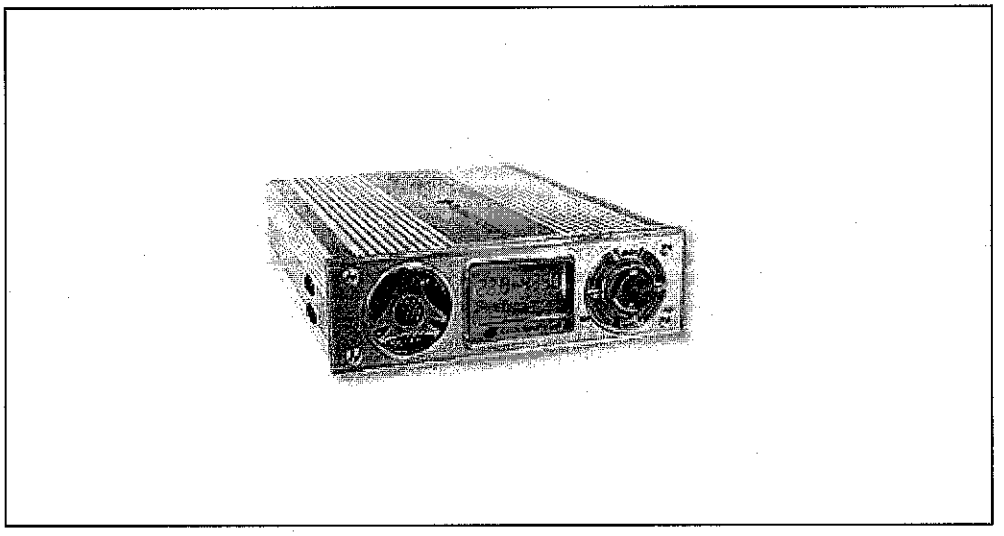

Figure 6.2: Hardware use to monitor CPU temperatures

APPENDIX 2

MEMORY SETTING

2. Memory Capability setting

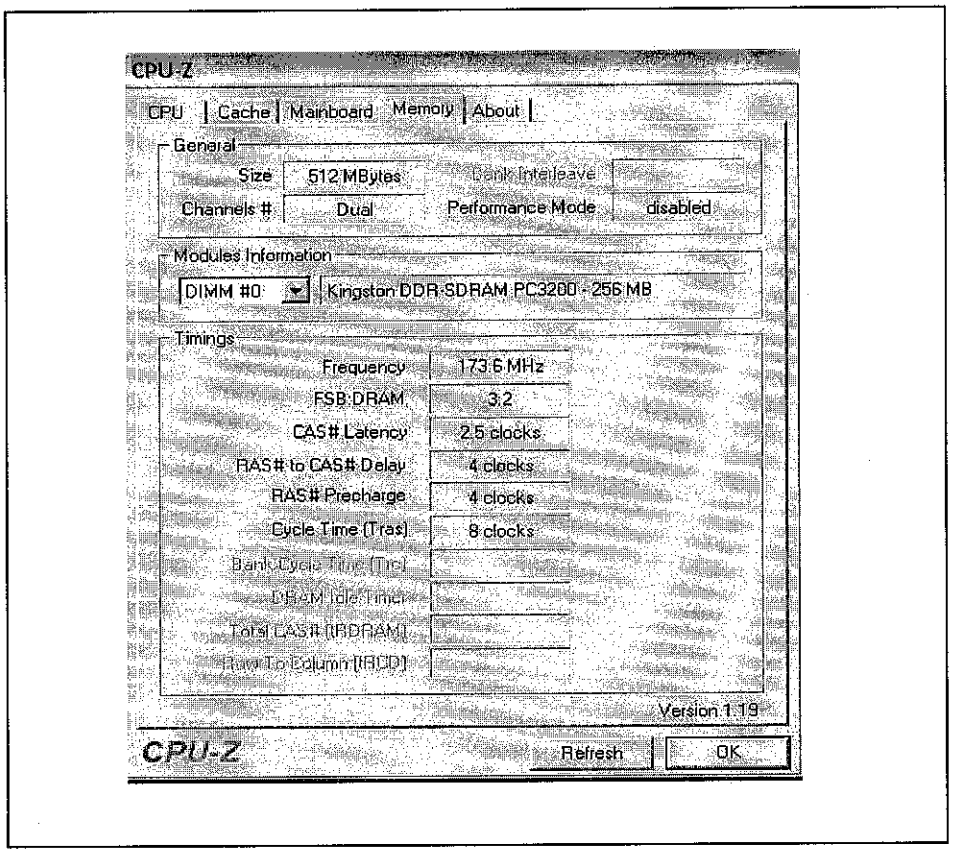

Figure 6.3: Memory setting to achieve 3.1 GHz overclocked processor

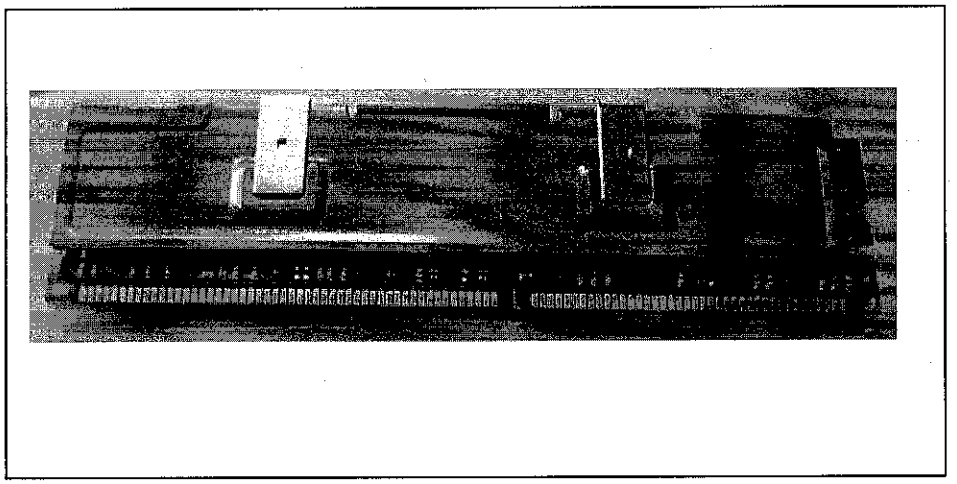

Figure 6.4: High Performance RAM with additional heat sink

APPENDIX 3

LATEST TECHNOLOGY

3. Latest software and technology in overclocking

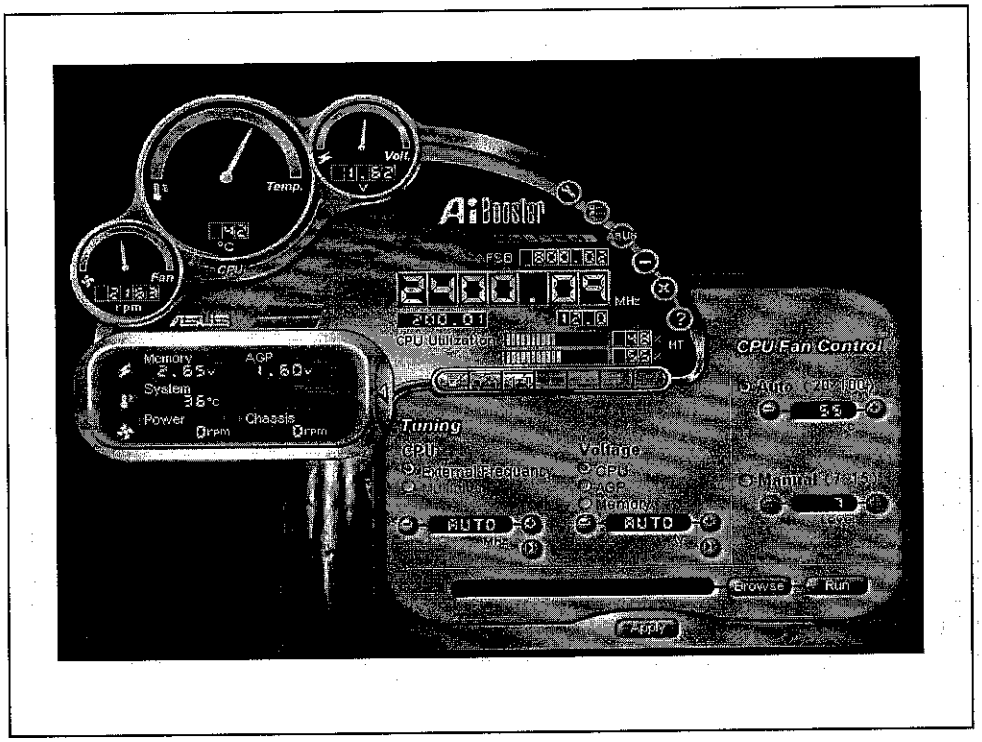

Figure 6.5: Overclocking software designed for high-end Asus motherboard owner

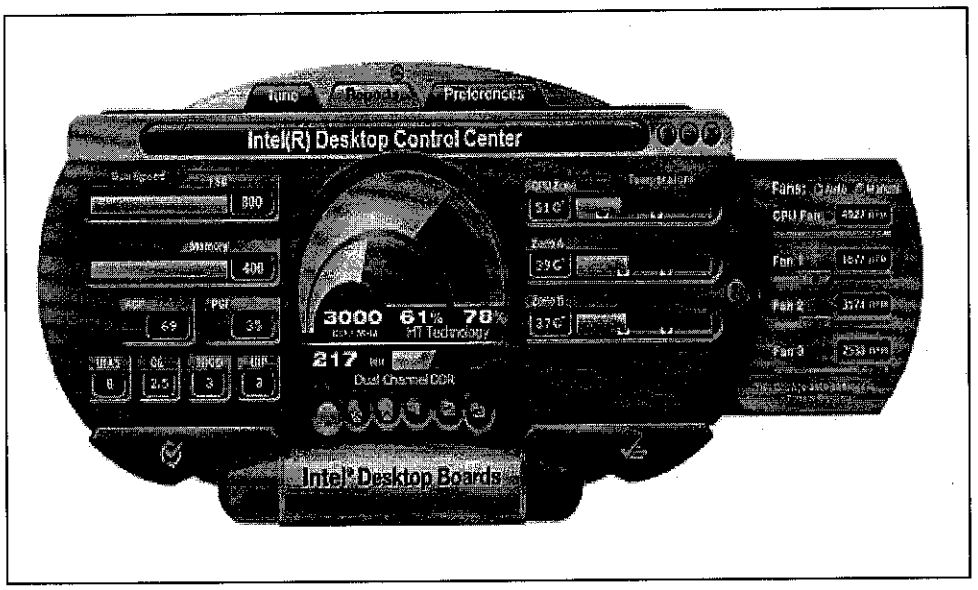

Figure 6.6: Overclocking software designed for high-end Intel motherboard owner

APPENDIX 4

REQUIREMENT DOCUMENTATION

4. Hardware and Software Requirement Documentation

List of hardware and price

Processor

Type	Price
Intel Pentium4 2.4c with Hyper trading support	RM 550
Intel Pentium4 2.8c with Hyper trading support	RM 685
Intel Pentium4 3.2e (Extreme edition)	RM 3600
AMD Athlon XP 1800++	RM 200
AMD Athlon XP 2800++	RM 565

Motherboard

Type	Price
Abit IC7-G (875 P chipset)	RM 635
Asus P4P800 -Deluxe (865 PE chipset)	RM 470
Asus P4C800E- Deluxe (875 P chipset)	RM 780
Abit NF7-S v2.0 (Nforce 2 chipset) for AMD	RM 395
Epox 8RDA v2.1 for AMD	RM 370

Heat sink

Type	Price
Thermalright SLK 900u	RM 200
Zalman cnps7000A-Cu	RM 180
Vantec Aeroflow	RM 150

RAM

Type	Price
256*2 Kingston HyperX PC3200 (High Performance RAM)	RM 490
256*2 Kingston Hynix (Value RAM)	RM 300
256*2 Corsair TwinX PC3200 (High Performance RAM)	RM 490
256*2 Geil Blue PC3200 CL 2.5 (Value RAM)	RM 320

Graphic Card

Type	Price
MSI 64 mbNvidia Geforce 4 MX 440	RM 170
MSI 128 mb Nvidia Geforce 4 Ti 4200 with 8x	RM 450
Asus 128 mb ATI Radeon 9200 SE	RM 225
Asus 128 mb ATI Radeon 9600 XT	RM 800

Power supply unit

Type	Price
ATX I-cute 450 watt	RM 80
Enlight 420 p4/ 420 watt	RM 250
ATX Antec Truepower 450 watt	RM 290

Soundcard

Type	Price
Creative SoundBlaster Live 5.1 SE	RM 125
Turtle Beach Santa Cruz	RM 290

Harddisk

Type	Price
80 gb Maxtor/ 7200rpm/ 8mb buffer	RM 290
80 gb Western Digital/ 7200rpm/ 8mb buffer	RM 265
80 gb Seagate Baracuda SATA 150/ 8mb buffer	RM 310

Casing

Type	Price
ATX i-CUTE 450 watt with 4 fan	RM 210

List of software

Table 6.1 List of software used in this project

Specification	Type	Licensing	Developer
Overall torture test	Prime 95	Freeware	Prime
Overall system performance test	SiSoft Sandra	Shareware	SiSoft Utilities
Graphic Card test	3dmark 2001 se 3dMark 2003	Shareware	MadOnion
Graphic card overclocking software	PowerStrip	Shareware	Entechtaiwan
Processor and Memory recognition	CPU-Z	Freeware	CPUID

Possible combination of hardware

SYSTEM 1

P4 2.4c Ghz HT@ 3.2Ghz (1.600V)

(Zalman cnps7000A-Cu & Artic Silver 5)

Asus P4P800 Deluxe 865PE

2x256Mb Kingston HyperX Dual DDR 400Mhz (2-3-3-7) (2.85V)

128Mb Hercules Prophet 9800pro (413/764) (Samsung Syncmaster 765MB)

Creative SB Audigy DE

120Gb @ 8Mb 7200rpm Western Digital

80Gb @ 8Mb 7200rpm Maxtor DiamondMax Plus 9

52*32*52 Lite-On CD-RW, 16X Lite-On DVD-Rom

CoolerMaster IDE Cable, FDD Cable & Aerogate 2

ICute ATX 450W (2* 12cm ICute Fan)

SYSTEM 2

P4 2.6C 800FSB c/w Hyper-Threading Technology @ 3003.1MHz on 1.5375V

Asus P4P800 I865PE / ICH5R MainBoard

Thermaltake Volcano 7+ (RPM: Lo-3000 Med-4750 Hi:6000) Idle: 43C Load: 49C

2 x 256MB Kingston ValueRAM DDR400 (DualChannel) @ 184.8MHz @ 2-2-2-5

ICute 0301SL-BS 450W Casing c/w 4 Fans & Dual fans iCute 450W PSU

Asus GeForce FX5200 128MB c/w TV Output @ 17" Acer Monitor

Creative Vibra @ Home Theater System 5.1 c/w 150W Amplifier

Maxtor 30GB & 80GB Storage @ Asus 52x CDROM & Imation 52x24x52 Burner

SYSTEM 3

Intel Pentium 4 2.8C @ 3.4 GHZ

ABIT IC7-MAX3

2*Kingston HyperX PC3200 BH-5 @ 2-2-2-5

Thermalright SLK 900u

ASUS ATI Radeon 9800XT

Western Digital 120GB SATA Drive

Seagate 40GB SATA Drive

Creative SoundBlaster Extigy 5.1

Sony DVD-ROM, Imation CD-RW

Cooler Master Wavemaster Black Case

Antec Truepower 430watt PSU

Cooler Master Aurora Green CCFL

SYSTEM 4

Athlon XP 1800++ @ 2.3Ghz (220*10.5) 1.725v

Thermalright SLK 900u

Abit NF7-S v2.0

64mb DDR Magic-Pro GeForce4 MX 440-SE

2* 256mb Kingston BT-D43 DDR400 2-3-3-11 - 2.9v

1* 80gb Western Digital 7200rpm - 2mb cache

1* 20gb Seagate 5400rpm - 512kb cache

Enlight 420w PSU

SYSTEM 5

AMD Barton 2500+@3200+mhz@1.55v

Abit NF7-S v2.0 (Nforce 2 chipset)

512x2 hyperx pc3200@200mhz@2.77vdim@2-3-3-11

Stock Heat sink fan

PowerColor 9800pro AIW

M-audio revolution

2x80bg western D

Antec 480w

Cooler Master WaveMaster

APPENDIX 5

LOOP-TIMER PROGRAM

5. Source code for Loop-timer program (Highest level of testing)

```
#include <windows.h>
#include <stdio.h>
//#include <iostream.h>
//#include <mmsystem.h>

int main()
{

static float framesPerSecond    = 0.0f;
static float lastTime           = 0.0f;
static char strFrameRate[50] = {0};

        static char strcurrentTime[50] = {0};
        static char strcurrentTime2[50] = {0};
        static char strloopacc[50] = {0};
        static char strtime[50] = {0};
        int loopacc=0;


        float currentTime = GetTickCount() * 1.0f;
```

```
for(int x=0;x<100000000;x++)
{
        loopacc++;
}

for(int x2=0;x2<100000000;x2++)
{
        loopacc++;
}

for(int x3=0;x3<100000000;x3++)
{
        loopacc++;
}
```

→ Looping structure

```
float currentTime2 = GetTickCount() * 1.0f;

float time = currentTime2 - currentTime;
```

→ Arithmetic function

```
printf("triple 100000000 loop\n");
sprintf(strcurrentTime, "time before loop: %d", int(currentTime));
sprintf(strcurrentTime2, "time after loop: %d", int(currentTime2));
//sprintf(strloopacc, "number of loops: %d", int(loopacc));
sprintf(strtime, "processing time: %d", int(time));


printf(strcurrentTime);
printf("\n");
printf(strcurrentTime2);
printf("\n");
printf(strloopacc);
printf("\n");
printf(strtime);
printf("\n\n\n");



system("pause");
return 0;

}
```

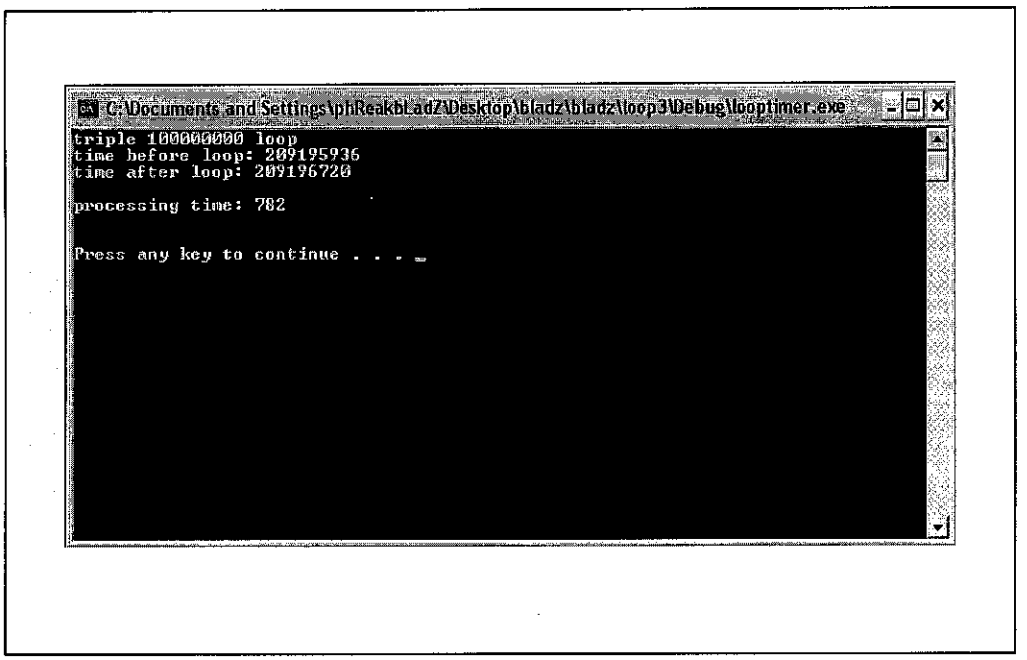

Figure6.7: Loop-timer testing program