AN EMPIRICAL STUDY OF SOFT REAL-TIME PERFORMANCE OF WINDOWS MULTIMEDIA TIMER FOR MECHATRONICS APPLICATION

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Abstract: This paper presented an empirical study of the performance of soft real time multimedia timer in mechatronics application. Most mechatronics systems need periodic functionality and high precision timing capability. Normal operating system timer has low priority and can experience delays, unpredictable timing period and has low timing precision. In this paper, the behavior and characteristic of Windows OS multimedia timer is studied and compared with the normal Windows OS timer. Both timers behavior due to three types of loads were observed and studied. The observation shows that the performance of the Multimedia timer is far superior in terms of predictability and timing precision as compared to normal timer. An application of the multimedia timer in a hardware-in-the-loop mechatronics vehicle simulation system is also discussed at the end of this paper.

Keywords: Mechatronic, Multimedia Timer, Real-Time System

INTRODUCTION

Mechatronic systems contain elements of control and information processing which are composed of many actuators and sensors. Control of mechatronic systems requires reading data from their feedback device such as sensors, calculating signals data based on the sensor data, and then sending these control signals to the corresponding actuators. The sensor data sampling rate and calculations must be very fast and highly accurate in order to maintain the stability of the system. In this context, application of a real-time system and the selection of timer to performing such control and data acquisition tasks from PC are very appealing because of their high-speed processing.

In this paper, a description of the behavior and characteristic of Windows OS multimedia timer and normal Windows OS timer using MS Visual BASIC® are presented. The application of timer in the real-time software for mechatronic systems is also discussed in this paper.

Real-time System

Real-time is an often misunderstood and misapplied. There are many interpretations of the exact nature of a real-time system. The Oxford Dictionary of Computing defines a real-time system as any system in which the time at which output is produced is significant. This usually because the input corresponds to some movement in physical world and the output has related to that same movement. The lag from input time to output time must be sufficiently small for acceptable timeliness [1]. Young defines a real-time system to be a system which has to response to externally-generated input stimuli within a finite and specified period [2].

From the above definitions, a real-time system covers a very wide range of computer activities. The system doesn't just run software to plough through the process; it needs to do it in a timely manner. So, real-time systems care about timeless. The correctness of a real-time system depends not only on the logical results of the computation, but also on the time at which the results are produced [3].

Practitioners in the field of real-time computer system design often distinguish between hard and soft real-time systems. Hard real-time systems are those systems where it is absolutely imperative that responses occur within the specified deadline [1]. A hard real-time constraint in the system in one for which there is no value to a computation if it is late and the effects of the late may cause the system failed. Hard real-time systems are safety critical where life or serious damage is at risk if the deadlines are not met. Examples of hard real-time systems are aircraft fly-by-wire systems, vehicle brake-by-wire systems, and air traffic control systems. In other words, a hard real-time system is one where all activities must be completed on time. Soft real-time systems are those where response times are important but the system will still function correctly if deadlines are occasionally missed. It can tolerate some latency, and the system is not considered failed when the system doesn't meet each and every desired response time. Examples of soft real-time systems are telephone exchanges and some interactive graphical user interfaces [1].

Timers

The most important feature in control and data acquisitions in mechatronic application is the precision of the timer. There are two type of timers supported in MS Windows® [5]:

Timer with a generic API function (normal Windows OS timer): The standard timer supplied with MS Windows® is great for most tasks, but the frequency it updates at isn't acceptable for high-performance multimedia. The normal Windows timer is based on the standard Win32 timer, and this is not intended for time critical tasks. The basic minimum resolution of this timer is no better than about 50ms on a Pentium II system running Win9x, although it is somewhat better on NT/2000/XP, at around 10ms. The Interval property has a few limitations to consider when you're programming a normal Windows timer:

- If another application is making heavy demands on the system, such as long loops, intensive calculations, or drive, network, or port access, the application may not get timer events as often as the interval property specifies.
- The interval can be between 0 and 64,767, inclusive, which means that even the longest interval can't be much longer than one minute (about 64.8 seconds).
- The interval is not guaranteed to elapse exactly on time. To ensure accuracy, the timer should check the system clock when it needs to, rather than try to keep track of accumulated time internally.
- The system generates 18 clock ticks per second, so even though the interval property is measured in milliseconds, the true precision of an interval is no more than one-eighteenth of a second.

Windows OS Multimedia Timer (Hires Timer): Multimedia timers are implemented using the Win32 multimedia library (winmm.dll) that works in Kernel Mode. Multimedia timer services allow applications to schedule timer events with the greatest resolution (or accuracy) possible for the hardware platform. These multimedia timer services allow you to schedule timer events at a higher resolution than other timer services. These timer services are useful for applications that demand high-resolution timing and runs in its own thread. For example, a MIDI sequencer requires a high-resolution timer because it must maintain the pace of MIDI events within a resolution of 1 millisecond.

Software Architecture for Mechatronic Application

Mechatronic is the technology of creating advanced functions such as motion control, through the integration of control, computer software and hardware, electronics and machines. Due to the fact that there are physical processes under control, software for mechatronic application is differs from general-purpose software in functionality, performance and high precision timing capability. The foremost responsibility of mechatronic software is to support the execution of control algorithms as well as other related functions. The software with the hardware must support both logical and temporal determinisms. These systems are essentially a real-time system where a missed deadline may impact the system performance, stability and may lead to total system failure [4].

For any computer operating system, especially in general purpose computer operating system such as Windows NT, there is always a slight time delay between the moment an interrupt or timer-based task execution is requested and its actual run. The latencies will cause the sampling period of the process to vary from the intended one. For example, referring to figure 1, when the task (e.g. data acquisition of sensor) is requested to be executed at a sampling period of T_s, the latency time T_l will cause the execution of the task at an apparent period of T_e [1]. If the maximum value of T_l is too large, it might jeopardize the task.

Therefore, a soft real-time Windows OS multimedia timer plays an important role to reproduce real-time software that required to the ensure systems functionality, performance and high precision timing.

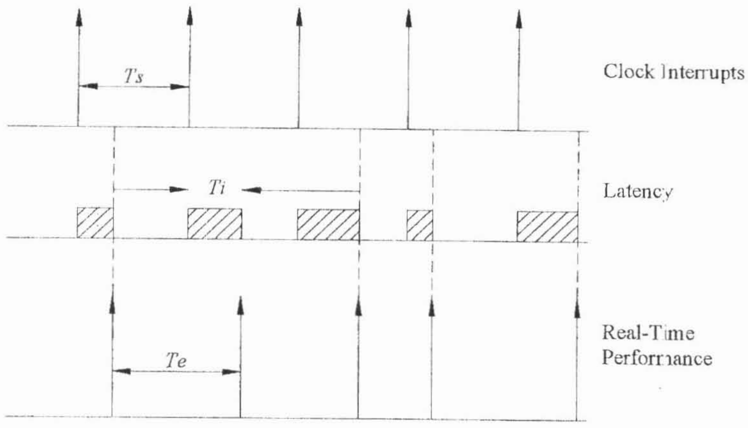

Figure 1: Parameters defining the real-time performance (Latencies)

TESTING METHODS AND RESULTS

In this study, we have developed software that based on three different cases of load.

- No loaded included
- Internal load with low priority included
- External load with high priority included

Figure 2, 3 and 4 shows that the results of the performance of the timers obtained from the study.

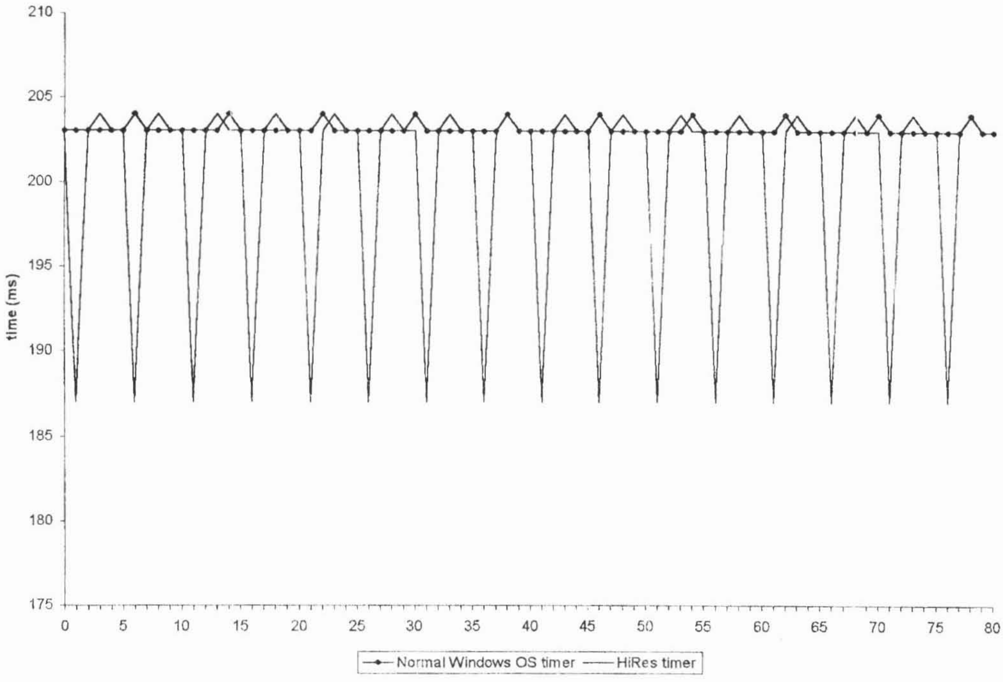

Figure 2: Comparison the performance of the Hires timer and normal Windows OS timer when no load included

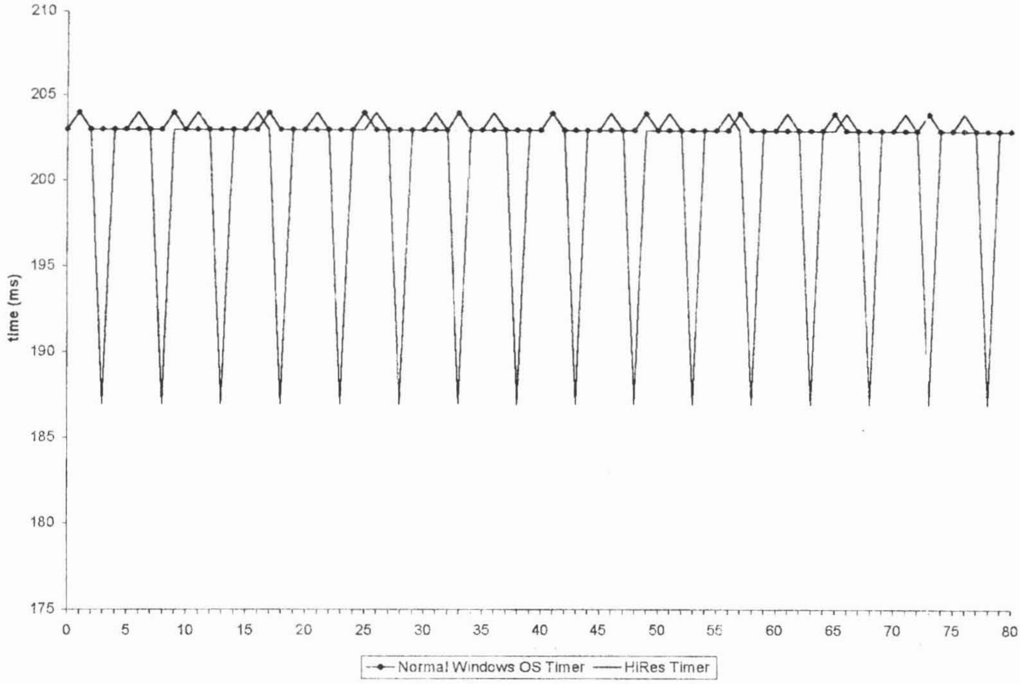

Figure 3: Comparison the performance of the Hires timer and normal Windows OS timer when loaded with the low priority application

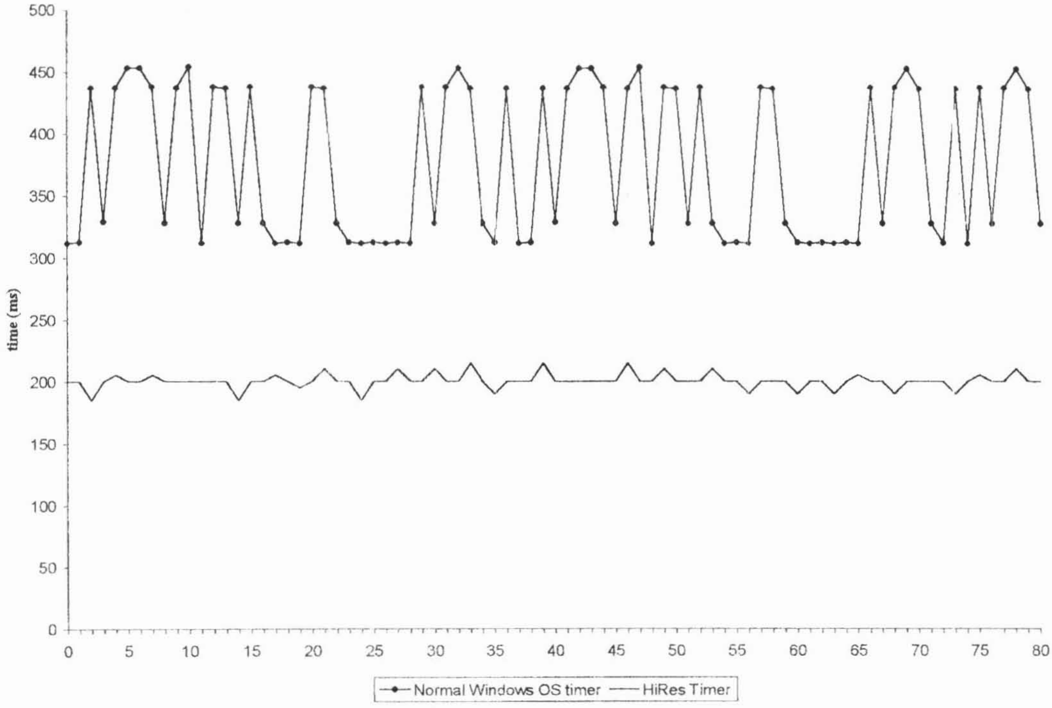

Figure 4: Comparison the performance of the Hires timer and normal Windows OS timer when loaded with the high priority application

Table 1: Standard deviation of the normal Windows OS timer and Hires Timer

	Case 1		Case 2		Case 3	
	Normal Windows OS timer	HiRes Timer	Normal Windows OS timer	HiRes Timer	Normal Windows OS timer	HiRes Timer
Maximum Value	204	204	204	204	454	205
Minimum Value	203	187	203	187	312	190
Min	203.12	200.03	203.12	200.03	375.95	200.24
Standard deviation	0.33	6.52	0.35	6.52	62.15	5.80

If the analysis runned at 200 ms, from the figures above shows that the normal Windows OS timer have a performance better than the Hires timer when the application are unloaded and loaded with a low priority applications. However, from the table above, the HiRes Timer have shows a good performace where the it is (min value) always closed to the fixed interval timer (good latency) and have a short delays in three cases. Therefore, from the result observed in this study, we can say that the Windows OS Multimedia timer is far superior in terms of predictability and timing precision as compared to normal timer.

Windows Multimedia Timer for Mechatronics Application

Due to Window OS Multimedia Timer (Hires Timer) have a good performace in high precision timing, it is suitable for mechatronic application. In this study, we have applied it on a mechatronic vehicle simulator system. The simulation software for the driving simulator was programmed using MS-Visual Basic 6.0. It has motion control module that's communicated with the simulator hardware (actuating system). The simulation software sends the command the actuating system and captures the position from the encoder. Figure 5 shows the main simulation software user interface.

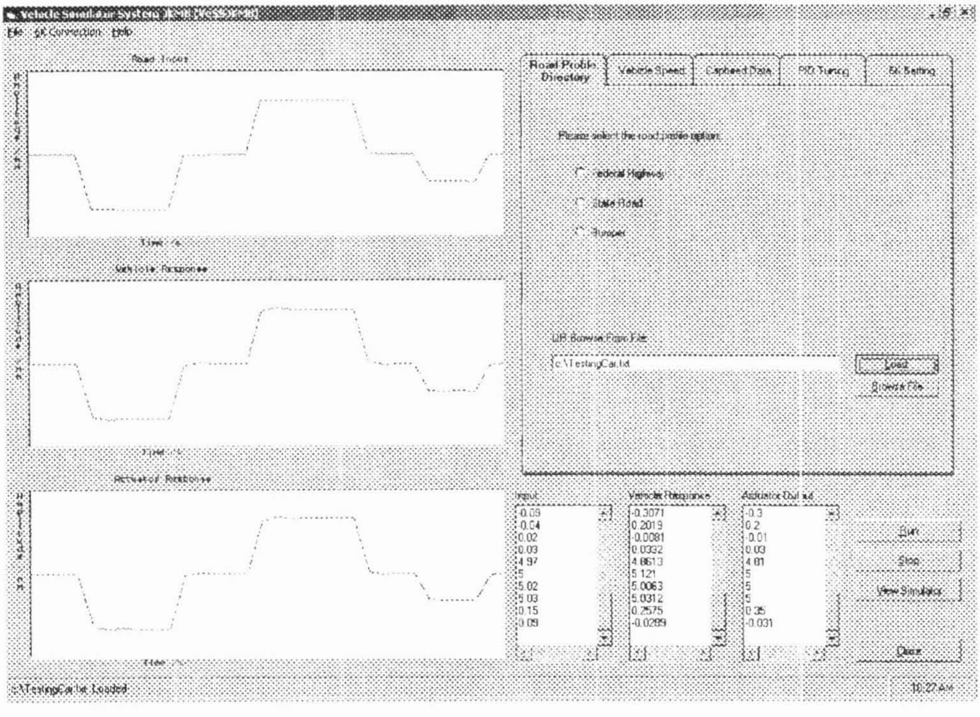

Figure 5: Vehicle simulation software

CONCLUSION

Windows OS multimedia timer (Hires timer) has priority and can experience short delays, predictable timing period and has high timing precision. The needed of the Hires timer have made mechatronics systems become more powerful and accurate.

ACKNOWLEDGEMENT

This work was supported in part by the Ministry of Science, Technology and Environment, Malaysia under Grant IRPA 03-02-02-0016-SR0003/07-02 in the 8th Malaysia Plan.

REFERENCES

1. Alan, B. and Andy, W. 1990. "Real-time System and Their Programming Languages". Wokingham, England. Addison Wesley.

2. Young, S. J. 1982. "Real Time Languages: Design and Development". Chichester. Ellis Horwood.

3. Furr, S. 2003. "What is Real Time and Why Do I need it?" www.qnx.com

4. Alvarez, B. , Iborra, A. , Pastor, J. A. and Fernandez, C. 2001. "Software Architecture for Development of Mechatronic Systems: Service Robot". www.dedicated-systems.com

5. http://msdn.microsoft.com