Tech advances permit PACS, speech tools on one computer

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Since the beginning of PACS, one of the main rate-limiting components of the image viewing workstation has been the central processing unit. Other parts of the computer are easy to scale up. Computer memory is cheap and plentiful. It's a simple matter to load a computer up with 4 gigabytes—typical PACS software rarely uses more than a quarter of that. Graphics rendering speeds and the speed of the computer bus (the highway system that connects the parts of the computer) are much faster than most PACS software clients need. But it is the CPU that dictates how fast a radiologist can scroll through a stack of images or manipulate a 3D rendering of the heart.

For at least a decade, it has been possible to put two or more processors into a single computer. Early on, however, many who bought these high-priced systems were disappointed to experience no significant increase in the speed of their applications. The reason? Unless an application was specifically designed to use multiple processors, it did not take advantage of them. To some extent this is still true. What's more, operating systems did not excel at balancing the load of multiple applications on multiple processors. Instead, they tended to overload the first one and underutilize the second one.

Several recent advances in processor technology have pushed processing power to a new level, which can seriously affect the radiologist's daily workload. First, raw processing speed has climbed over the 3-gigahertz (GHz) mark, a threefold increase since five years ago. Second, processors are now built with two and even four cores, allowing them to execute multiple instructions simultaneously and function as multiple virtual processors. Third, operating systems are now sophisticated enough to carefully distribute the load of multiple applications and their processes over the available physical and virtual processors so that no one processor gets overloaded. Fourth, and perhaps most important, the price of such processing power has fallen to the $2500 range, which is easily justifiable for a PACS workstation computer.

APPS MUST BE MULTITHREADED

To take advantage of the multiple processor environment, an application should be multithreaded. This is a programming technique that allows the computer to begin a new task before the old one is completed. Newer PACS software is written in languages that make effective use of this environment. Older PACS software cannot do the same. However, even with older PACS viewing software, today's processors and operating systems still manage to distribute their load somewhat.

The other CPU-hungry radiologist application is speech recognition software. In order to deliver real-time speech recognition, which means that a radiologist can see her words within a few seconds of speaking them, the speech engine needs to move fast. It needs to quickly sift through the thousands of words in its lexicon to find the ones with the highest probability of matching what was said. Even by today's standards, this is computationally intense. This high demand on the processor has been the biggest barrier to combining speech recognition and PACS viewing software on one computer. That barrier has finally fallen.

Even if neither the PACS software nor the speech recognition software is written in a multithreaded fashion, today's multiprocessor computers can distribute their load appropriately. What does this mean to the radiologist? It means that a single computer, with a single mouse or other pointing device and a single keyboard, can run both PACS and speech recognition software, plus whatever else a radiologist might need such as e-mail, Web browsing, or a work list tool. It means no more confusion over which keyboard goes with which computer or which mouse controls which screen. It also cuts in half the number of computers that the radiology department needs to maintain. Remote installations for teleradiology are no longer forced to use a router to share an Internet connection.
of the radiologist's applications can reside on one machine, which can serve as a single cockpit to get the work done.

At Staten Island University Hospital (SIUH), we combined our PACS and speech recognition software on one of these new fast computers. The new computer was a Dell Precision 690 with two physical 3-GHz processors, each with dual core and with hyperthreading activated (Figure 1). The Windows XP operating system saw this configuration as eight virtual processors in all.

First, we opened a 100-slice abdominal-pelvic CT scan using the GE Centricity PACS 2.0 RA 1000 viewing software, which was configured to occupy only the two right monitors. The images were magnified to full screen and then scrolled through one at a time as a stack at full speed by whipping the mouse up and down rapidly. Such an operation is one of the most taxing on the CPU. The response time of the system was well within reason and noticeably better than on our other computers, which are older and have a single CPU with one core. This result was not surprising. Nor was it surprising that the system performed perfectly well at achieving real-time speech recognition using MedQuist's SpeechQ for Radiology. Words appeared on the screen within one to two seconds after being spoken.

During the PACS scrolling test, one of the eight CPU graphs peaked at about 90% utilization with marginal activity on one of the other CPU graphs. During the speech recognition test, another of the CPU graphs peaked at only about 50% utilization, with yet another peaking at 20% activity. The key test, however, was using PACS and speech recognition at the same time. To our surprise and delight, neither function slowed in performance at all. We could scroll and dictate, dictate and scroll, and the images kept on moving as fast as before and the words appeared in the dictation window as quickly as before.

**TESTING AT FULL THROTTLE**

During this full-throttle testing, the system managed to keep the CPU utilization reasonably well distributed over the eight processor graphs, with no one processor exceeding 90%. This test was repeated many times with the same result. We have decided to use this hardware platform for all new workstations. Likewise, the Massachusetts General Hospital radiology department plans to deploy all of its new Agfa IMPAX PACS workstations on this platform. It also plans to run Commissure's RadWhere on this standardized platform for speech recognition, work lists, and advanced communication functions.

For balance, we tried conducting the same test at SIUH on a Dell Dimension 9100, which has a single 2.7-GHz processor, dual core, and no hyperthreading (Figure 2). The operating system saw this as only two virtual processors. In this case, performance under the full-throttle test was adequate, but applications showed the strain. Scrolling in PACS slowed down by about 30%, and speech recognition also slowed noticeably, although without any change in accuracy. However, under normal dictation conditions of intermittent scrolling and intermittent dictating, which only sometimes overlapped, performance was more than adequate. The speech engine was able to catch up during the normal pauses in dictation, and dictation only occasionally slowed down scrolling.

To round out the picture, we also tried the test on a Hewlett-Packard Evo D7100 with a single 1.8-GHz processor with a single core running Windows 2000. The computer slowed after a few seconds and then completely froze and rebooted itself during the test-an unsuccessful test by any measure.

This trend in processing power can have an untoward effect on PACS software that can not multithread. In an effort to reduce power consumption and heat production, companies such as Intel and AMD are producing processors that have more and more cores but run at lower clock speeds. The goal is to reduce the electrical overhead while preserving processing speed by adding more cores. That's fine if the software applications can make effective use of the multiple cores, and most modern software can. But legacy systems may actually run slower on these newer processors because they can use only one of the cores on one of the physical processors. Imagine paying a premium for the latest processor only to find your PACS software runs slower!

Curious to hear their reaction, I contacted both MedQuist and Commissure representatives to let them know how well their software runs on the same machine as PACS.

"In the past, when speech recognition and PACS have operated on a single workstation, there was always uncertainty and instabilities around shared system resources between the two resource-intensive applications," said Michael Mardini, CEO of Commissure. "With the latest developments in CPU design, we have overcome a significant hurdle to reliably deliver integrated workflow solutions in a single box environment."
Frank Lavell, CEO of MedQuist, also responded.

"With SpeechQ for Radiology, MedQuist has focused on enhancing the radiologist’s workflow. Integrating speech recognition with PACS has been vital to improving that workflow and patient care," he said. "Our engineers are working to make this process as seamless as possible to the end user. We are excited at the results from the Staten Island tests."

Although strong processing power is necessary to run these multiple applications, it is not sufficient. You can't navigate the dictation application, the work list, and the image visualization all on one monitor, no matter how large. Fortunately, attaching multiple monitors to a computer has become much simpler over the past few years. A four-head video card such as the NVidia NVS 440 can run four monitors, each up to 2.3 megapixels (1200 x 1920).

Alternatively, a variety of inexpensive dual-head video cards are available that can run two monitors. Most higher-end computers can handle up to four or five expansion cards of any type, including video cards. Thus, whether using consumer displays for image viewing or displays that are specifically marketed for radiology, it is not too hard to add another display or two for speech recognition and work list functionality. Screen real estate is now cheaper than ever. A 19-inch color flat panel can be had for about $200.

The ability to combine PACS visualization software and speech recognition on one computer represents a breakthrough in terms of simplifying the work environment for radiologists. As these applications begin to share physical resources such as the CPU and memory, they are also beginning to demonstrate higher levels of integration, such as the ability to share patient context-no more having to type in the accession number to synchronize applications. Such trends could reduce medical errors and should result in greater efficiency and satisfaction in the radiologic interpretation process.

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Disclosures:

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