Journal of the Arkansas Academy of Science

Volume 44 Article 33

1990

Impact of Microprocessor Protected Mode Programming on Undergraduate Education n Engineering Technology

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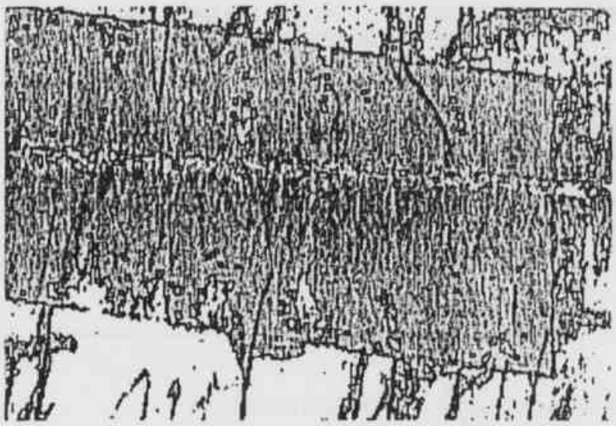

Figure 5. Figure 4 after applying equalization and sharpness

Figure 6. Figure 5 after applying contrast and brightness

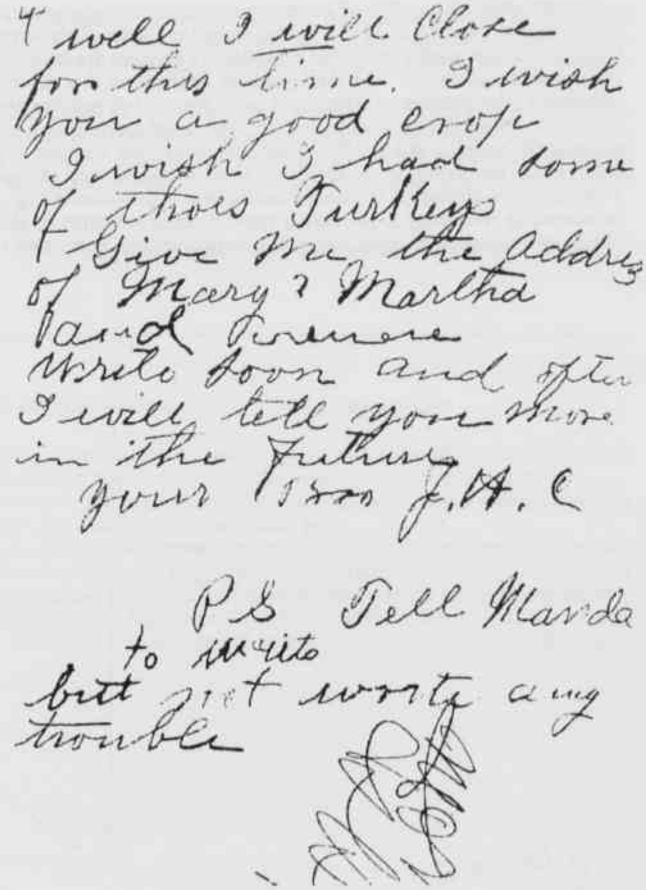

Figure 7. Desired end result after applying proximity algorithm

THE IMPACT OF MICROPROCESSOR PROTECTED MODE PROGRAMMING ON UNDERGRADUATE EDUCATION IN ENGINEERING TECHNOLOGY

The purpose of this paper is to examine some of the rapid changes that have recently occurred (and are continuing to occur) in microcomputers and the impact of these changes on both faculty and students in engineering, technology, and related fields — such as physics, biology, mathematics, and chemistry.

A microcomputer is any computer that uses a microprocessor for its central-processing-unit (CPU). In fact, a "microprocessor" can be described or defined as a CPU on one integrated circuit or "chip." Because of their small size and low cost, microprocessors, which were first developed in 1971, have revolutionized the computer industry. Before the advent of microprocessors, all computers were generally classified as main-frame or mini computers. Since main-frame and mini computers are usually very large and expensive, their resources are almost always shared by several users. By using microprocessors for the central processing unit, manufacturers were able to develop much smaller and less expensive computers. By 1981, improvements in capabilities of microprocessors led to the development and introduction of the now famous IBM Personal Computer (PC). The PC was different from existing mini computers and main-frame computers because it was intended for use by one person (single-user), and the software operating systems developed for the PC's (PC-DOS and MS-DOS) further limited the PC's to one user application program at a time (single-tasking). Performance improvements in existing characteristics such as operating frequency, address and data bus size, and chip integration are considered *evolutionary* changes in microcomputers. For example, the operating frequency of microcomputers has increased from one megahertz (MHz) to 33 MHz in the last 10 years. While this is a significant increase in operating frequency, 33 MHz is not even close to the current state-of-the-art in supercomputers such as the Cray computers which operate in the 300 MHz range. Of course, the Cray does not use a microprocessor as a CPU. The data bus size in microcomputers has increased from 8 to 32 bits, and the address bus size in microcomputers has increased from 16 to 32 bits in this same time span. This increase in address bus size has increased the amount of physical memory from 64 kilobytes to four gigabytes. These evolutionary changes are currently available in microprocessors operating in what we now call the "real" mode, which means single-user and single-tasking application that use only physical, i.e., "real," addresses. Using very large scale integration (VLSI) techniques, the number of transistors per integrated circuit has also increased dramatically from less than 30 kilo transistors per chip in 1978 to over one million transistors per chip in 1989. Intel Corporation predicts that "by the year 2000, the 100 million transistor i786 [microprocessor] will appear, running at 250 MHz while occupying only 1 square inch." (Intel, AT DEADLINE, page 1, August 31, 1989). The rate at which these changes are occurring can be displayed in many ways, such as operating frequency, millions-of-instructions per second (MIPS), dhrystones, and whetstones. A display of frequency versus time is provided in Fig. 1 because the shape of this curve dramatically indicates that the rate-of-change in operating frequency is increasing rapidly. Improvements in electronics technology invariably lead to improvements in computer technology. Major evolutionary changes occur in microcomputers every two or three years.

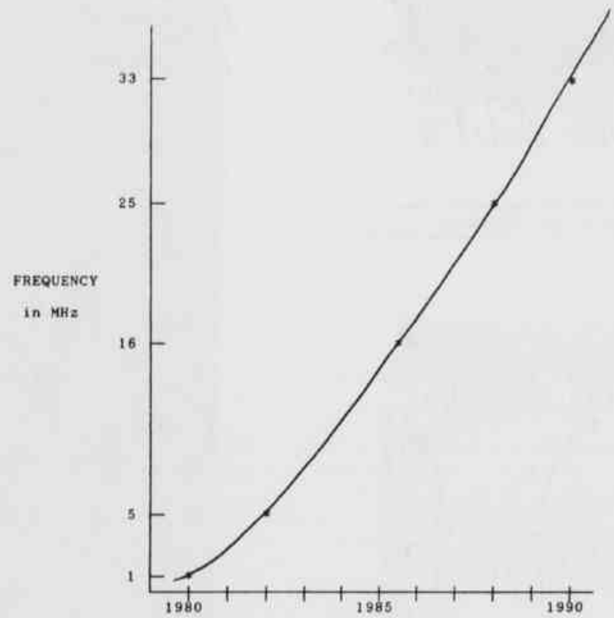

Figure 1. Improvement in operating frequency.

Any change that affects the way that a microprocessor fetches and executes instructions is considered to be *revolutionary* instead of evolutionary. Examples of revolutionary changes are pipelining, cache memory, protected mode operation, and virtual addressing mode operation. Revolutionary changes often lead to new "generations" of microprocessor. Pipelining, which requires additional hardware inside a microprocessor, speeds up operation by allowing several functions to be accomplished simultaneously. Pipelining allows one unit in a microprocessor to execute one instruction while another unit is fetching the next instruction and/or data. Cache memory, which consists of a small amount of very high speed static chips, permits the use of low cost, high density dynamic chips for the bulk of the memory with very little loss in performance. The most important recent development in microprocessors is the addition of a memory management unit (mmu) and associated system registers in the microprocessor chips. The addition of these components allows these microprocessors to operate in a real mode or a protected virtual addressing mode (also referred to as the protected mode). Intel 80286, 80386, and 80486 (microprocessors are examples of devices that can be operated in either the real mode or the protected mode. In the real mode, these microprocessors provide improved performance while maintaining compatibility with software written for earlier microprocessors which do not have an internal mmu and system registers. In the protected mode, these microprocessors provide multilevel protection for multi-tasking and task switching. The virtual addressing capability of the 80386 and 84086 provides programmers with a logical addresses into the physical *per task*. The mmu maps these logical addresses into the physical address space. PC-DOS and MS-DOS support operation in the real mode only. OS/2 and UNIX operating systems support operation in either the real mode or the protected mode.

The rapid changes that are occurring in microcomputers are affecting both faculty and students. Most faculty members are forced to learn new hardware and software concepts on their own. The integration of new computer concepts into classes has been very uneven because there are very few specific requirements to use computers in the learning process.

Actually, there are a variety of courses available for faculty development. The American Society for Engineering Educators (ASEE) has a very popular summer program that pays the tuition for faculty to attend intensive two week courses at selected universities in the United States. These courses are taught by regular faculty, and they cover all of the material that is normally covered in a semester. I recently completed one of these ASEE courses in VLSI design at the Massachusetts Institute of Technology (MIT). Many companies allow university faculty to attend their training classes free. Most of the material used in the microprocessor classes that I teach comes from short courses taken at Intel Training Centers.

Curriculum development is also affected by the rapid changes in microcomputers. One of the faculty members in Electronic Engineering Technology at Memphis State University recently developed and started teaching a new course in electronic computer aided design (CAD) that provides students with the computer expertise needed to design complete electronic circuits, test these circuits using simulation, do a parts layout, and design a printed circuit board. Equipment that can use the output from this CAD software to make printed circuit boards using numerical controlled machines is currently being investigated.

The rapid changes in microcomputer hardware and software make maintaining state of the equipment very expensive. The use of new or revised software often requires upgrading or even replacing existing operational microcomputers. Replacing operational microcomputers is often difficult to explain and justify.

What about the future? We must shift our emphasis from courses that use computers as tools to courses that use computers as an integral part of the learning process. Cognitive science and neuroscience are being used to create new models that can be used to analyze the behavior of students in problem solving. We need to find ways to combine the computing power available in the new microcomputers with this model to improve our educational techniques.

The latest revolution in microprocessors has been used to create computers that look like a PC but have the multi-tasking multi-user capability of mini computers and main frame computers. To utilize fully these capabilities, advanced operating systems such as OS/2 or UNIX must be used. Evolutionary and revolutionary changes in computers are occurring so rapidly that many educators and educational institutions have been unable to utilize fully the phenomenal computing power that is available today. As educators, we need to find ways to use these new computers as an integral part of the learning process.

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CHARACTERIZATION OF RADIOACTIVITY IN HOT SPRINGS NATIONAL PARK, ARKANSAS

The objective of this study was to determine the types and measure the levels of radioactive emissions found within the Hot Springs National Park boundaries. The study should help determine if the emissions pose a significant health hazard to the public or to park workers.

The thermal springs of the Hot Springs National Park at Hot Springs, Arkansas, are radioactive. These springs have been a natural resource of international renown for many years. Many tourists are attracted to the spa city and visit the park each year.

The National Park is nestled in the eastern portion of the Ouachita Mountains in west Central Arkansas. The springs emerge in a compact belt about one-fourth mile long and a few hundred feet wide, along the southwestern slope of Hot Springs Mountain. Excavation and covering of springs, to increase and concentrate flows, have reduced the number of spring openings from 72 to less than 40. Each spring opening is completely encased in metal and concrete and capped with a gas-tight metal hatch. A gravity collecting system (Figure 1) channels the flow of the springs to a central reservoir (Hanor, 1980), from which the water is redistributed to individual bathhouses and to public drinking fountains (Bedinger, *et al.*, 1979).

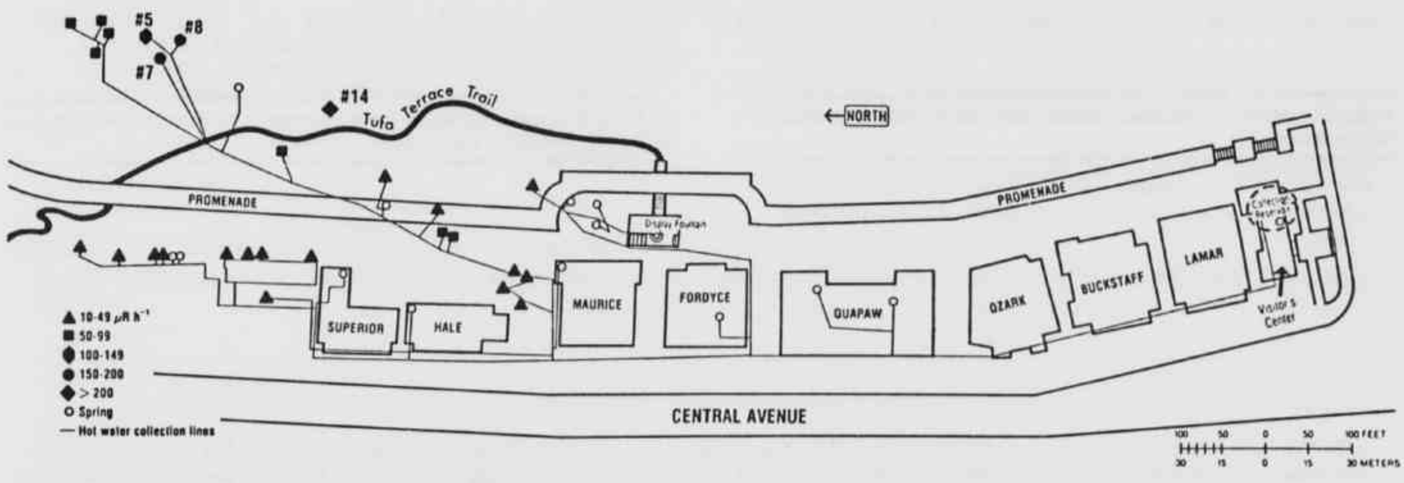

Figure 1. Distribution of the springs and bathhouses. Measured exposure rates of springs are depicted by geometric symbols. Units are μRh^{-1}.

The combined flow of the hot springs is currently about 670,000 gallons per day. The flow of the springs is highest in the winter and spring and is lowest in the summer and fall. While the temperature of individual springs may vary, the temperature of the combined hot springs waters is about 62°C.

The radioactivity of the hot springs waters is due mostly to dissolved radon and radon daughters with a small contribution from radium. USEPA reported a radium concentration in the waters of 2.1 ± 0.22 pCi L^{-1} (Bedinger, *et al.*, 1979). The radon concentration of 25 hot springs ranged from 140 to 30,500 pCi L^{-1} with a model value of 820 pCi L^{-1} (Kuroda, 1953).

Radon concentrations were measured using passive alpha track monitors (ATM) (Ronca-Batista and Magno, 1988) and, in some cases, activated charcoal (AC) canisters (Gray and Windham, 1987). A pressurized ion chamber (PIC) and environmental thermoluminescent dosimeters (TLD) were used to make differential and integral exposure measurements of radon daughters. Gamma ray identities were confirmed using a portable multichannel analyzer (MCA) with a sodium iodide probe. A proportional probe and counter were used for charged particle detection. Several consecutive PIC readings were taken and averaged for each measurement. ATMs and TLDs were left in place for at least 90 days. AC canisters were placed for 48 hour periods. Some measurements have been made year round over the past 2 years.

External gamma fields were measured by placing the PIC in direct contact with spring covers or as close as possible to the region of interest. A map of the area and the exposure levels are shown in Fig. 1. The springs are numbered according to the Park Service's system. The largest exposure rates were observed from springs located at higher elevations. Rates decrease considerably at lower levels. This is probably due to the migration of radon gas back up the gravity collection system to higher elevations.

