A Chinese-Character and Graphics Workstation

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Abstract

This paper introduces the design approaches of a Chinese–character and graphics workstation DGS–8000 which has been developed at the Computer Graphics Research Laboratory, Department of Computer Science and Engineering, Zhejiang University. The specifications, architecture, Chinese–character processing environment and working modes of the workstation are described. Especially the I/O interface with the host computer, the processor unit, the graphics generation and display unit, Chinese–character operating system and some main input modes of Chinese–character codes are introduced in detail.

1. Introduction

Due to very rapid development of IC and computer industries, a new type configuration of computer system, namely graphics workstation, has been appeared since early 1980s. The graphics workstation can be characterized as a computer system with sufficient computing power, graphics capabilities and networking ability. Now the graphics workstations are getting popular and popular in engineering application fields, so sometimes they are called as "engineering workstations". The graphics workstations can be used alone to solve engineering problem with certain scale, but also they can be used as a node in computer networks or as a graphics terminal of a host computer very flexible.

This article introduces the design approaches of a high resolution graphics workstation DGS–8000 with Chinese–character processing capabilities, which has been developed at the Computer Graphics Research Laboratory, Department of Computer Science and Engineering, Zhejiang University. The works are based on the previous experiences of the Lab [1] , [2] , [3] , [4] . It is a low–cost high performance graphics workstaton, which will be used primarily as a high performance graphics terminal and a intelligent terminal with Chinese–character processing capabilities of the VAX–11/785 in our Lab. But as a homemade Chinese–character and graphics workstation, we think that in the next step the workstation should be commercialized to satisfy the domestic needs.

2. Specifications of the DGS-8000

The DGS-8000 workstation is compatible with the most popular personal computer IBM-PC/XT and runs under Microsoft DOS operating system and own monitor for use of interactive graphics. The workstation can be configured with various peripheral devices such as digital tablet, plotter, mouse and printer. The DGS-8000 may be interfaced with the host computer via two ways, i. e. standard RS-232C serial port and DMA channel with VAX-11 or PDP-11 series machines. The typical specifications of DGS-8000 are:

Graphics Resolution:	1024×1024 (1024×768 visible) .
Color Resolution:	8 bits, 256 colors displayed simultaneously.
Color Palette:	16. 7 million colors.
Overlay Bitplane:	1024×1024×1 bit.
Scan Mode:	Interlaced or Noninterlaced.
Monitor Format:	19-inch Color.
CPU:	8088, 8 MHZ.
Memory:	768 KB.
Floppy Disks:	2×360 KB.
Hard Disk:	20 MB.
I/O Interface:	RS-232C and DMA.
Operating System:	DGS-DOS Compatible with Microsoft DOS.

Chinese-Character Operating Systems:

DGS-CCDOS and DGS-LXCCDOS.

Chinese-Character Font Library:

Hard font library includes the National Standard Chinese-character Font Libraries of the I and II classes, which contain 8192 Chinese-characters and 616 graphics symbols.

Input Modes of Chinese-Characters:

4 modes under DGS-CCDOS and 12 modes under DGS-LXCCDOS.

3. Architecture of the DGS-8000

The DGS-8000 workstation is consist of three units, i. e. (1) I/O interface with the host computer; (2) Processor unit; (3) Graphics generation and display unit. The logic block diagram of the DGS-8000 is shown in Fig 1.
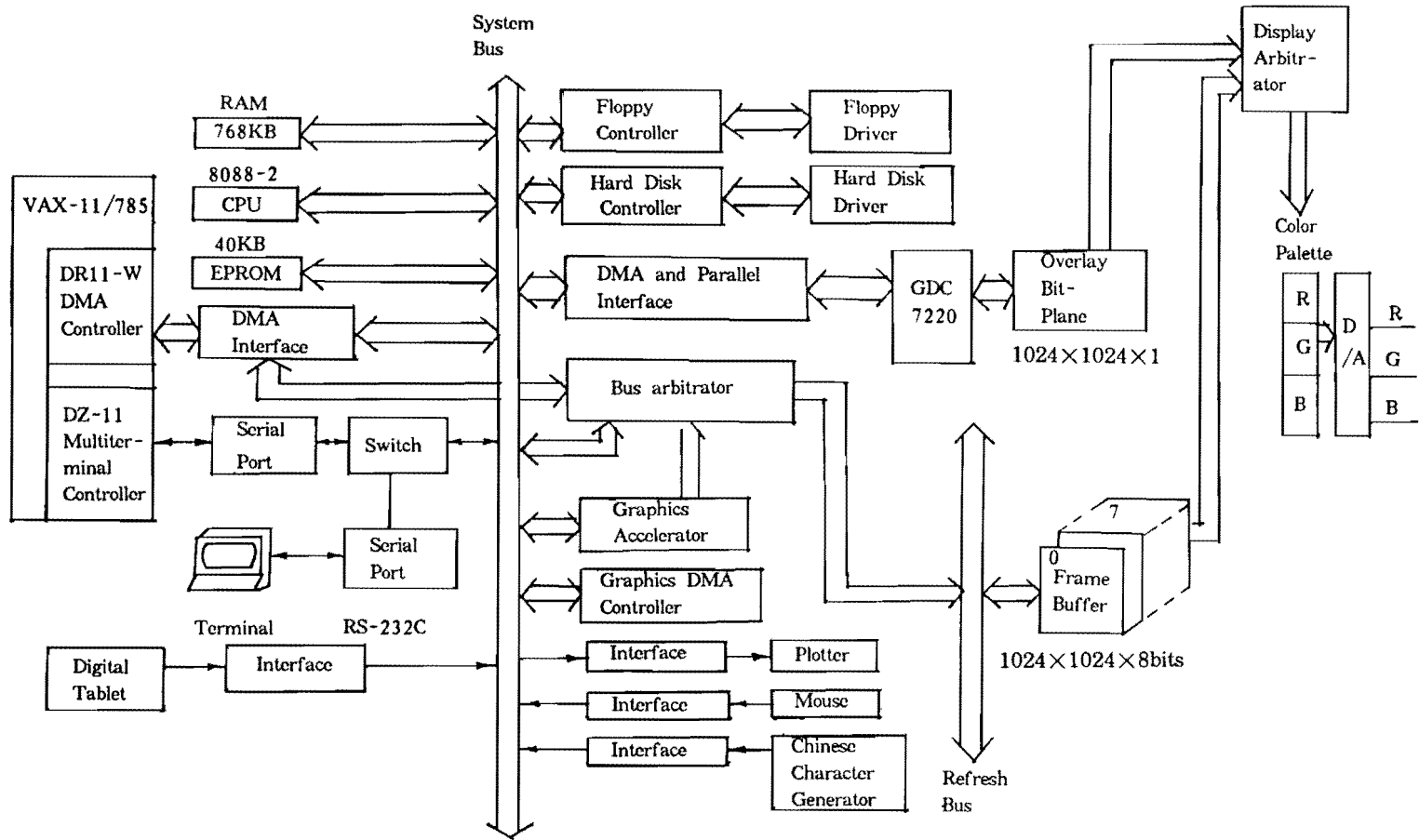
System Bus

RAM 768KB

8088-2 CPU

40KB EPROM

VAX-11/785

DR11-W DMA Controller

DMA Interface

DZ-11 Multiter-minal Controller

Serial Port

Switch

Serial Port

Terminal RS-232C

Digital Tablet

Interface

Floppy Controller

Floppy Driver

Hard Disk Controller

Hard Disk Driver

DMA and Parallel Interface

Bus arbitrator

Graphics Accelerator

Graphics DMA Controller

Interface — Plotter

Interface — Mouse

Interface — Chinese Character Generator

GDC 7220

Overlay Bit-Plane

1024×1024×1

Refresh Bus

Frame Buffer

0   7

1024×1024×8bits

Display Arbitr-ator

Color Palette

R
G
B

D/A

R
G
B

Fig. 1   DGS–8000 block diagram

3.1 I/O Interface

The DGS-8000 provides two I/O interface modes, the serial port and DMA channel, as mentioned in the section 2. The serial port RS-232C is a standard interface which allows DGS-8000 to communicate with any kind of computers, but the data transfer is too slow via serial port. In order to increase the speed of data transfer between the host and the workstation, there is a DMA channel which can be used to deliver graphics commands, as well as to transfer the graphics data which have been generated by the host and stored in the main memory of the host to the frame buffer of the workstation or vise verse.

The workstation provides various working modes under control of the console commands. The operator needs only to input on-line or off-line commands on the keyboards, the workstation can be switched flexibly from one working mode to another.

3.2 Processor Unit

The processor unit of the DGS-8000 may be divided by two parts, the core part and the expanded part. The core part of the processor unit is actually a IBM-PC/XT compatible processor. The INTEL 8088 microprocessor, the IBM-PC 62-pins bus standard and PC-DOS are adopted. All these features ensure fully compatibility of our workstation with IBM-PC's existing software and hardware. All PC's peripheral cards can be plugged in our workstation, and all software packages run in IBM-PCs will be run in DGS-8000 perfectly.

The Fig. 1 shows that DGS-8000 provides various peripheral devices and special data transfer channels. Therefore one piece of interrupt controller chip (8259) and one piece of DMA controller (8237) , original PC design scheme adopted, are dissatisfied in our design. DGS-8000 uses two pieces of interrupt controller 8259 in cascade modes. Except original one piece of DMA controller 8237, other two expanded pieces of DMA controller 8237 are used in our design. One expanded 8237 is used as the slave of the original DMA controller. The channels of the slave DMA controller is distributed to satisfy fast data transfer between 8088 and other parts. The four channels of the slave 8237 are as follows:

Channel 0: System RAM Refresh.
Channel 1: Command and Data Transfer from Host Computer to 8088.
Channel 2: Data Transfer from 8088 to Host.
Channel 3: Data Exchange Between 7220 and 8088.

The other expanded DMA controller chip is dedicated for communication between the

host and the frame buffer in DGS–8000. The four channels of this 8237 are distributed as follows:

Channel 0 and Channel 1: They are used for data block transfer with in frame buffer. It results that the contents of one area on the monitor's screen can be transferred very quickly to another area on the screen.

Channel 2: The host reads the data from frame buffer.

Channel 3: The host writes the data to frame buffer.

In the expanded part of the processor unit we added a piece of special hardware for Chinese–character processing which includes two VLSI chips of Chinese–character base and its controller and associate logic. The Chinese–character are displayed on the overlay bit–plane which has highest display priority, so the mixed effect of Chinese–character and image on the screen can be obtained (see Fig. 2) . It is very unique character of DGS–8000 workstation.

We have to mention that we have rewritten the BIOS of the PC–DOS to meet the requirements of expanded hardwares and Chinese–character text editor, but the new version of BIOS is still compatible with the original.
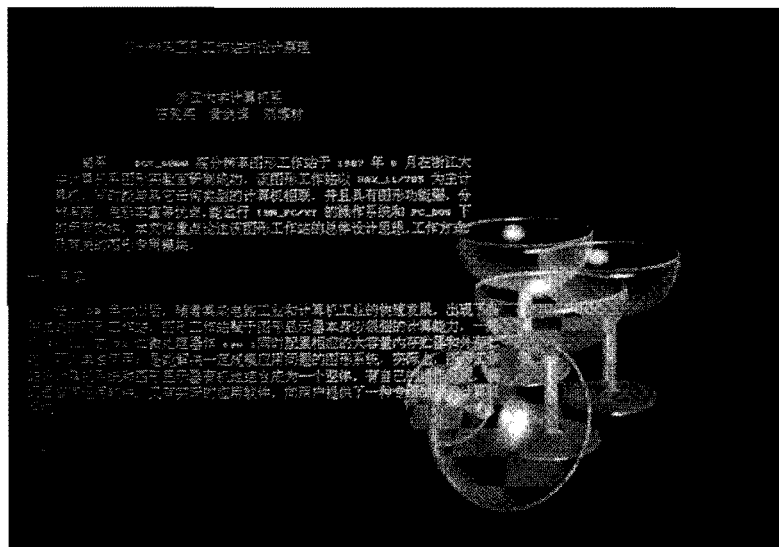

Fig. 2 Mixed Chinese–character and image on the screen

3.3 Graphics Generation and Display Unit

This unit consists of image memory, bus arbitrator, graphics accelerator, display arbitrator, color palette and D/A converter (see Fig. 1) . The image memory is the heart of this unit. It consists of frame buffer and overlay bit-plane. The frame buffer is organized as a 1024×1024×8 bits memory which is used to store image and can be read/written by 8088 cpu, the host computer and the graphics accelerator chosen by the bus arbitrator. The overlay is a 1024×1024×1 bit-plane which is controlled by a dedicated graphics display controller chip-upd 7220. The overlay is used to store wireframe graphics, cursors, alphanumerical characters and Chinese-characters. The overlay has the display priority higher than that of the frame buffer. There are three display modes, i. e. overlay only, frame buffer only and mixed mode of the both. In the mixed mode the overlay image is always in the front of the image of the frame buffer. The display arbitrator controls these three display modes.

Our memory organization of the frame buffer is different from the common bit-plane organization. In bit-plane organization each bit of the bit-plane corresponds with a pixel [5] . In DGS-8000 each pixel contains 8 bits, if bit-plane scheme is adopted, the 8 bits of the pixel will be located on 8 different bit-planes. Therefore to modify a pixel value, each bit-plane has to be read, modified and written. Obviously it slows down the operating speed. The block diagram of frame buffer organization of the DGS-8000 is shown in Fig. 3. One byte of the bit-plane corresponds with a pixel on the screen. Consequently to modify one pixel value only one bit-plane needs to be read, modified and written. The operating speed is increased.
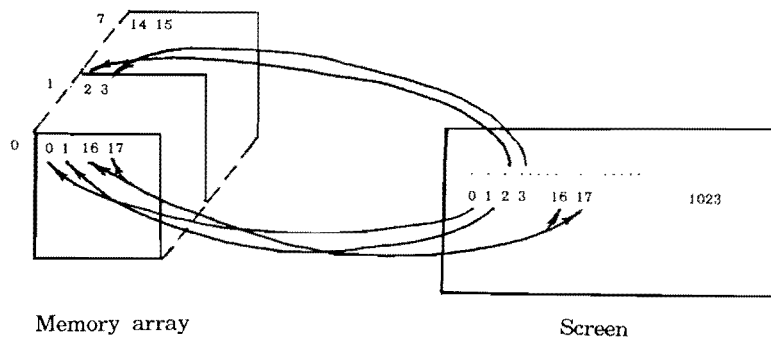

Fig. 3 Memory organization of the frame buffer in DGS-8000

The graphics accelerator is implemented using 16-bit bit-slice microprocessor 29116, timing controller 2910 and 16 bit high speed multiplier TDC-1010. All these high speed

ICs and their associated logic are assembled on a card which can be plugged into 62-pin PC-bus. The accelerator functions include hardware generation of the graphics primitives, such as lines, arcs, circles and curves etc. , and geometry transformations. And a molecular model generation algorithm developed in our lab is implemented in the accelerator using microprogramming technique.

4. Chinese-character Processing Environment

It is true that any computer system without Chinese-character processing capabilities can't be got popularity in China. The DGS-8000 provides users a powerful Chinese-character processing environment. There are two Chinese-character operating system such as DGS-CCDOS and DGS-LXCCDOS. The origin of these two OS is the CCDOS which is the first Chinese-character operating system compatible with the Microsoft DOS. So the DGS-CCDOS and DGS-LXCCDOS are compatible with the DOS too. The hierarchical structure of the CCDOS is shown in Fig. 4.

UTILITIES AND HIGH-LEVEL	
COMMAND. COM	LANGUAGE PROCESSING PROGRAMS
DOS. COM	
BIO. COM ROMBIOS	CCBIOS

Fig. 4 The structure of the CCDOS

From Fig 4. the difference between DOS and CCDOS is the additional part of the CCBIOS which is the unique expand part of the ROMBIOS. CCBIOS includes several driver modules such as Chinese-character keyboard input, Chinese-character display and Chinese-character printing etc. . We have transplanted CCDOS to our DGS-8000 workstation hardware and software environment and a series of modifications have been introduced. The font library management, display management, keyboard management, communication management and printing modules are all rewritten completely. The structure diagram of the DGS-CCDOS Chinese-character processing module is shown on Fig 5.
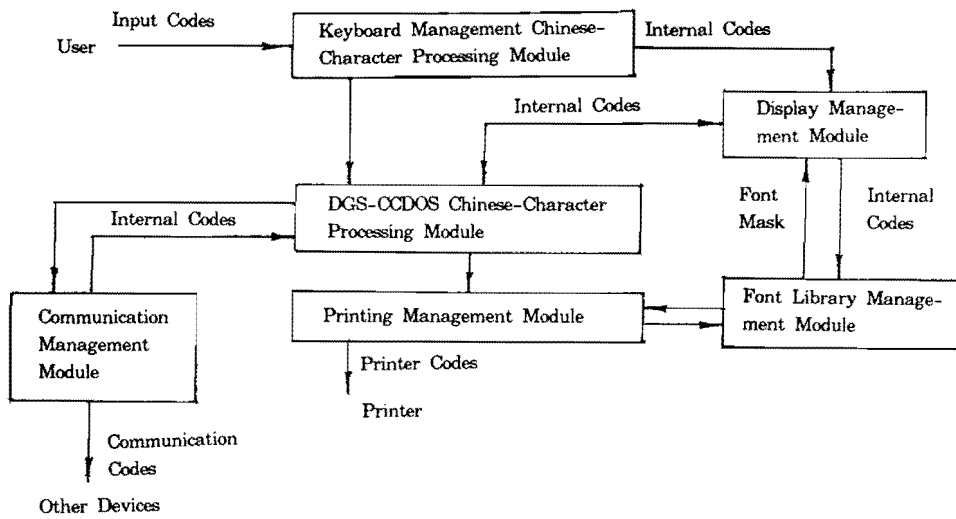
Fig. 5 The structure of the DGS-CCDOS' Chinese-character processing module

The screen display format consists of 25 rows and 40 Chinese characters per row. The hard font library is a set of two custom design chips. One is a 2 MBytes ROM which contains 8192 Chinese characters in 16×16 dot matrix form each. The another is a decode chip. The advantages of using hard font library are the high access speed of the dot matrix data, easy to program and no memory space needed.

DGS-8000 Chinese-character processing environment includes UNIX's vi simulator when DGS-8000 communicates with the host computer via RS-232C. It means that DGS-8000 can simulate not only UNIX's vi full screen text editor in English, but also can simulate UNIX's vi text editor in Chinese-characters. As we know vi text editor under UNIX is a very powerful tool, so that our vi simulator in Chinese-character also is a highlight in Chinese-character processing environment.

5. Some Main Input Modes of Chinese-Character Codes

In Chinese information processing area more than four hundred kinds of Chinese character encoding modes have been developed in China now, but only a few encoding modes got to be used popularly. Many of the encoding modes are too difficulty to learn. The research topic on Chinese-character encoding is still very popular, because people would like to make the input of Chinese characters easier and faster. The most

popular encoding modes of Chinese-character are "zip" code, pinyin code, fast pinyin code, telegram code, five-stroke code, eight-stroke code, head-tail code, English input code etc. The Chinese character encoding modes can be categorized basically into four classes, they are position based, phonetic alphabet based, character structure based and character radical based classes.

Two powerful Chinese-character operating systems can be run in the DGS-8000 workstation, i. e. DGS-CCDOS and DGS-LXCCDOS. They are developed from the original Chinese-character operating system CCDOS. Especially the DGS-LXCCDOS is the most powerful Chinese-character operating system which is able to output associate words when a single Chinese character is given. For example, when a Chinese character "人" (which means a person) was input, a series of Chinese words associated with this "人" will be displayed on the echo line of the screen, such as

  "人民" which means "people"

  "人群" which means "crowd"

  "人口" which means "population"

  "人才" which means "a talented person"

  "人道" which means "humanity"

  "人类" which means "mankind"

  etc.

So the DGS-LXCCDOS is often called as associated Chinese-character operating system. All Chinese character encoding modes mentioned in the previous paragraphs are adopted by either DGS-CCDOS or DGS-LXCCDOS. Now we introduce several typical Chinese coding modes in a bit detail.

The "zip" code mode is a position based encoding mode. According the national standard GB2312-80 Information Interchange for Chinese Character Code, the Chinese characters and graphics symbols are positioned on a two-dimensional array with 87 rows and columns respectively. The characters of the font library class one are located in the range from row 1 to 55, and characters of the font library class two are located in the range from row 56 to 87. the character is coded by the row number and the column number of its position. For example, the character "啊" is located in row 16 and column 1, it is coded as "1601". The code "1601" is used as to input the character "啊". When "zip" code mode is used, four digital keys need to be struck to input one character.

The pinyin code mode is a phonetic alphabet based encoding mode. Pinyin mode used 26 English letters as Chinese phonetic alphabets. For example, the pronunciation of the Chinese character "中" (which means "center") is "zhong". In order to input "中", five keys "z-h-o-n-g" need to be struck. For decreasing the number of struck keys, the fast-pinyin input mode has been developed. In fast-pinyin mode some combined vowels and consonants are defined as a single key. Fig. 6 shows the definitions of the

combined vowels and consonants. Now two strikes "a-s" are needed only to input the "中".

PINYIN	CORRESP. KEYS
zh	a
ch	i
sh	u
ao	k
ai	l
ü	v

PINYIN	CORRESP. KEYS
an	j
ang	h
en	f
eng	g
ong	s
ing	y

Fig. 6 Fast-pinyin keyboard

The head-tail code mode is a character structure based encoding mode. In this mode all Chinese-character can be constructed by the 52 character-roots, and these 52 character-roots are assigned to 26 letter keys. As an example, Fig. 7 shows several key assignments in this mode.

keys	character-root
a	小
	又
b	宀 宀
	山
c	士 土
	尸 尸

keys	character-root
s	八
	女
w	厂
	犭
z	人
	ﾄ

Fig. 7 Some key assignments in head-tail code

In the head-tail code mode a Chinese-character is always encoded by its left-upper part and right-lower part. For example, a Chinese character "从" can be encoded by its left-upper part "人", and right-lower part "人". From Fig. 7 we see that character-root "人" is corresponded with key "z", so striking key "z" twice will input the character "从".

The five-stroke code mode is a character radical based encoding mode. In this mode all Chinese character are divided into 132 radicals, which are assigned to 25 English letter keys from a to y, There is a song to help people to learn by heart the assignment of the 132 radicals to 25 letter keys. So the five-stroke code is a very fast input mode. A skilled typist may input about 270-160 Chinese-characters per minute.

Finally, it is very interesting that one of the Chinese character input modes uses English language as an input mode. It means when user input an English word, the screen echoes a Chinese word. Under this mode, for example a word "people" was input. then corresponding Chinese word"人民" appears on the screen. This input mode is very convenient for the people who knows English and is learning Chinese.

6 Working Modes of the DGS-8000

DGS-8000 provides various flexible working modes which can satisfy users' requirements. It may work alone either in DOS environment, under this mode plenty PC software may be called, or in interactive graphics mode, under this mode screen image can be modified interactively. On the other hand it can be communicated with host computer, under this mode the host resources can be used, the drawing commands and data can be transferred via DMA channel or serial port RS-232C.

There are 6 working modes as follows:
(1). DOS Environment: Under this mode PC' s software can be run. Using soft interrupt INT 60H, 256 graphics routines can be called.
(2). Interactive Graphics Mode: The screen image may be modified interactively using keyboard, menus, mouse or tablet etc.
(3). Selftesting Mode: The selftesting routine is called.
(4). On-line, Nongraphics Mode: The DGS-8000 communicates with the host computer via RS-232C. The workstation's console simulates the host's terminal. The data can be exchanged under control of communication software.
(5). On-line, DMA Drawing Mode: The workstation's console simulates the host's terminal. The drawing commands may be sent from the host to DGS-8000, and the host generated image can be transferred into frame buffer and displayed on the screen; at the same time the contents of the frame buffer or the status the workstation can be read back to the host. When whole

frame image is exchanged, the DGS-8000 provides the run-length encoding and decoding hardware to compress information volume and increase transfer speed.

(6). ON-line, Serial Port Drawing Mode: The workstation's console does not simulate the host's terminal. The host sends the drawing commands directly via RS-232C.

All these working modes can be switched from one to another very flexibly.

7. Conclusion

The design principles of the DGS-8000 are based on common IC chips and the popularity situation of the personal computers in China today. Therefore the DGS-8000 is a low-cost workstation and is easy to use. We think the graphics capabilities of the DGS-8000 may be matched with popularized version of the workstations abroad. The Chinese-character processing capabilities of the DGS-8000 are higher than them. The next step of our works is to commercialize DGS-8000 and to improve processor unit using 32 bit microprocessor.

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