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MAN-MACHINE INTERFACE OF TRISTAN

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Introduction

This report describes a console system which is the essence of man-machine interface used to operate TRISTAN. Ergonomic design and its implementation has been done in construction of the TRISTAN Central Control Room (TCCR) and Operator's Console (OPC).[1] The environment of the console is designed to minimize fatigue, eyestrain and discomfort by optimizing light fixtures, minimizing noises made by fans or footsteps and harmonizing colors and brightness throughout the control room.

The OPC is composed of a special supervisory console at the center and five identical standard consoles. The difference between the two types is that hard-wired switches which manipulate beam gates and related equipments to assure the safety of personnel are mounted only on the former console. The safety system is based on the hardware techniques similar to those have been accepted for the control of critical industrial installations.

Each of the consoles contains ten color TV monitors, two high resolution graphic display monitors and two touch-panels with color character display monitors. Each console is managed by a minicomputer of the TRISTAN control computer network. The graphic displays are connected directly to the computer. The touch-panels and the corresponding character video RAM modules are through CAMAC serial highway.

Design Features

The main objectives of the OPC are summarized in the following points:[1],[2],[3]

(a) flexible and easy operation of the machine in a fully automated way;
(b) centralized control and monitoring of all actions to be performed on the normal operations;
(c) centralized assurance for the safety of the machine and personnel;
(d) real-time presentation of a limited number of pre-selected data;
(e) increased operator productivity by minimizing error, fatigue and discomfort for long working hours.

The OPC was designed with the following features to meet these demands:

(a) use of computers for control, monitoring, data acquisition and analysis;[3]
(b) distributed computer system with an N-to-N network and KEK NODAL which offers high software productivity;[3],[4]
(c) use of a CAMAC system as a standard interface to the process and to the OPC;[5]
(d) integrated operation through four communication paths: computer communication system, central interlock and safety system, central timing system[6] and broad-band CATV;
(e) identical units for the OPC with same configurations are used throughout the system;[1]
(f) keeping the supervisory system separated from its supporting subsystem to reduce the acoustic noise.[1]

Configurations

The TRISTAN machine's control (TMC) is the computer based system. However, the centralized safety system is separate one to assure the safety of personnel and the interlock functions.

The computerized control achieves a high flexibility of operation both for normal operation and for the commissioning and troubleshooting operations. For the normal activity, all modes of operation are implemented by software. Modification of set values or functions can easily be achieved through the interactive, general-purpose Touch-Panels (TPs) available at the console. Conventional panels with meters, switches, etc. to be scanned and handled by operators are not used in the OPC of TRISTAN. Any such devices provided at the local unit, if necessary, are used only for commissioning and maintenance purposes and they are inhibited during normal operation. All parts of the system are integrated by CAMAC and computer communication systems.[2],[3],[4],[5]

As Interlock and Safety System (ISS) has to continue functioning in case of a failure of the machine's control, TMC and ISS are almost independent from each other. ISS interfaces between the operator and devices related for the access to the tunnel, operation of high voltage equipment etc.. It functions to the operator through a synoptic operator's panel which is incorporated by lamps for state indication, push buttons for alarm acknowledgement and beam handling. The panel includes a mode-key-switch for each operation status of TRISTAN. Personnel safety is based on a system of mechanical interlock keys and emergency push-buttons around TRISTAN.

Like the TMC, ISS is subdivided along TRISTAN substations. 9 Programmable Logic Controllers (PLCs) are connected to one PLC at TCCR. The former PLCs provide the interlock functions between their local devices, whilst the latter provides the interlock functions between the subsystems through optical fiber links using time sharing and multi-mode transmission methods.

The PLC has been proposed because they permit a high system flexibility, self testing facilities and have proved their reliability in many industrial installations. Although the response time depends on program length, it is less than 30 milliseconds in our case. In order to reduce an overhead time of the system, each of the local PLCs is responsible for its own internal safety and interlock functions, then the local PLCs interact with central PLC through a limited number of summary signals of each PLC. In addition to this function, it is possible for an operator at the TCCR to monitor and simulate all input/output signals of each PLC by a separate MODEM link along TRISTAN. The link between TMC and ISS is made at TCCR through the CAMAC system.

Operator's Console

There are six Operator's Console(OPC) units which are installed in line as shown in Fig. 1. Each OPC unit is connected to the corresponding operation computer and has ten 10" TV Monitor(TVM)s, two 20" color Graphic Display Monitor(GDM)s, and two 14" TPs. They all are equivalent with each other except that the central OPC unit has the beam switch board. The TVMs are used to display various TV signals from TV cameras located in the accelerator tunnels, from screen monitors of the beam and from synchrotron light monitors. They are also used to display information about the accelerators generated by Character Video RAM(CVRAM) modules. The GDMs are used to display high-resolution graphic data such as the closed orbit distortions of the beam as shown in Fig. 2. Two TPs are used to select program, to select equipment to operate, and to input commands or numbers.[2] One TP on the left side is used mainly for menu-selection and the other is for input of para-

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meters. The video signals for TPs are also generated by the CVRAMs. An example of the TP is shown in Fig. 3.

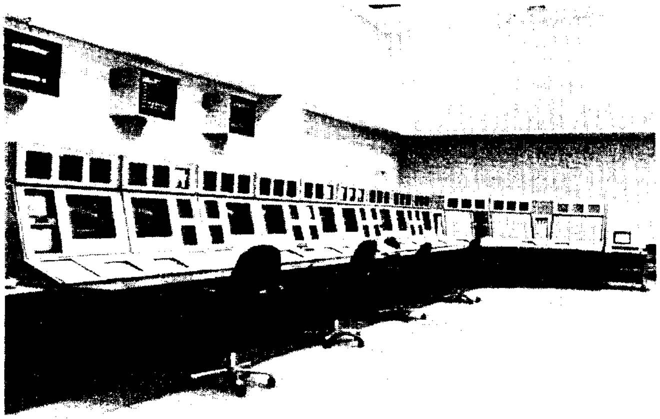

Fig. 1. A view of TRISTAN console.

Character Video-RAM(CVRAM) Module

A CVRAM is a CAMAC module which generates a composite video signal or separate TTL video signals both in 8 colors. In the composite video mode, a CVRAM module can generate up to 16 lines of 36 characters on the screen, and the output signal is based on the TV signal standard. Therefore, the signal can be accepted by the TVMs of consumer grade and can be transmitted through the CATV network. On the other hand, in the separate video mode, it generates 32 lines of 80-characters on the screen. Each character is expressed in 8-bit code and formed in 9 X 12 dots. This mode requires 384 x 720 dots capacity and is prepared for the TP.[1],[2]

Considering the ergonomic aspects, to reduce the eye-fatigue of the operators, the CVRAM module adds the over-scanned background image in a manually predefined color. It reduces eye-fatigue due to abrupt changes of the contrast in the image on the screen. In the separate video mode, raster of the picture is not interlaced and it reduces flickering of the picture which also irritates operators.

CVRAM modules are also used to inform operators or other personnel in KEK of general information about TRISTAN such as the operation mode, the beam energy and beam intensities. Some of the CVRAMs are used to display local hardware status of the beam transport system, RF stations and of the vacuum system to ease traffic jams of the computer network by separate media.

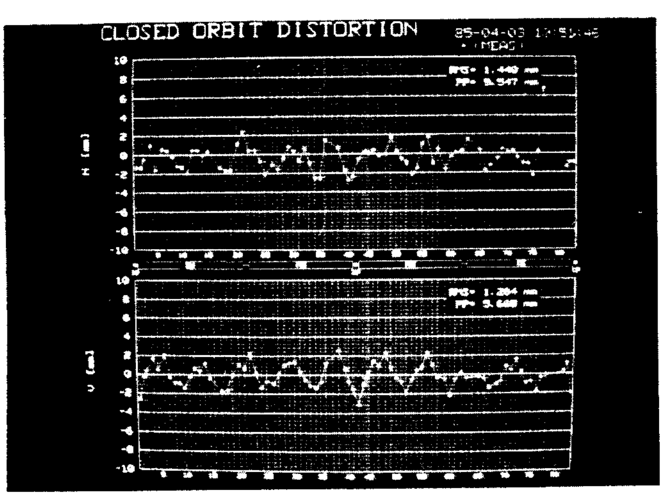

Fig. 2. An example of the GDM.

Graphic Display Monitors

As stated above, there are two GDMs on each OPC and these are used to display high-resolution graphic images. A GDM has 1024(X)x980(Y) pixels on the screen and 16-bitx16-bit addressable points in its memory. It also has functions of windowing, segmentation of images, movement, rotation or zooming of a segment, and etc. One can draw pictures in 16 colors in the color look-up table out of 4096 colors.

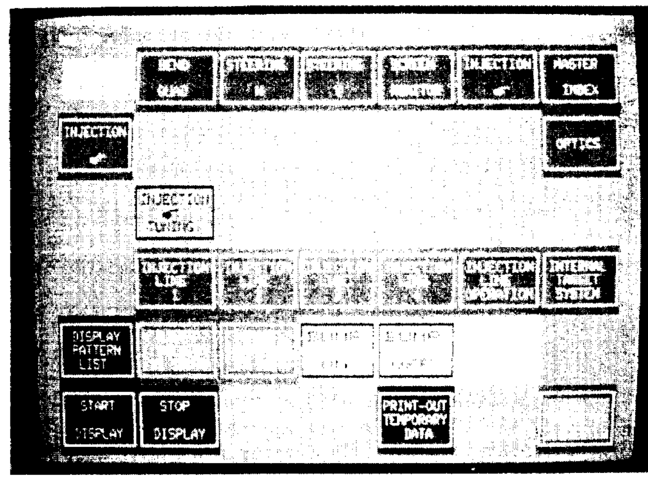

Fig. 3. A menu-selection panel.

Touch-Panels

A TP system is composed of a CVRAM module, a medium-resolution RGB video monitor, a touch-panel and a touch-panel controller module. Fig. 4 shows a block diagram of the TP system. The video monitor is a 14" 8-color TV monitor, but the phosphor for blue color is changed to emit so-called sky-blue color in order to reduce difference of relative brightness among 7 colors. And the blue color is usually used as background color of whole screen.

The touch-panel is an E260-13SM type touch-panel made by Elographics Corp. It gives an overall resolution of less than 4mm on both axes. As the position of a button is not fixed by hardware, the TP can be fully programmable. The touch-panel controller is a CAMAC module and it supplies constant current to the touch-panel. When the TP is touched, a micro-processor in the controller senses it and converts the divided voltages of x and y axes into digital values, which are taken by the computer.

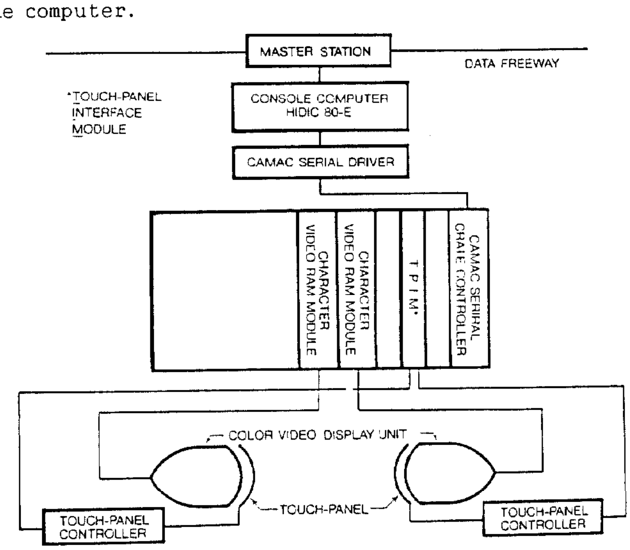

Fig. 4. A block diagram of the TP system.

An operator can select a program or an equipment to be controlled by using a TP at his left-hand side. There can be 42 buttons on this menu-selection panel. On each button, up to 3 lines of message can be displayed, 9 characters in a line at maximum. The messages may contain program names, equipment names, measured values, and/or values to be set.

To set the value of the equipment or to do on/off/reset or up/down actions, he uses a TP at his right-hand side. There are ten-key, on/off/reset, up/down, and left/right buttons when he wants to handle devices such as magnet power supplies or screen monitors. Sometimes, he wants to input a file name or comments by alphabetic characters, then the panel is changed to a TTY keyboard.

As the number of buttons on the menu-selection TP is 42 and is large compared with those formerly used which had 16 buttons, an operator can access an equipment by touching only 3 or 4 times even from the master index panel. It makes the operation easier.

Optical Fiber Network for Video Signals

All of the video signals related to operation of TRISTAN are transmitted from each substation of the control to TCCR by optical fiber video links. These are screens of oscilloscopes or spectrum analizer and images of the screen monitors and synchrotron light being taken by TV cameras. The latter video signals are taken at the position of such monitors and sent to the nearest local control stations through coaxial cables. Then they are converted to light by electric/optical conversion modules to be transmitted to TCCR via optical fiber cables. For this purpose a complex cable which consists of 8 optical fiber strands of single-mode graded index quarts and 20 pairs of cupper wire is laid between TCCR and each local control station. All the optical signals are converted into electric ones at TCCR by optical/electric conversion modules. Then, they are boosted by distribution amplifiers to be monitored by TVMs on the OPCs and to be transmitted by the CATV system.

CATV Network

For those who take an interest in latest status of the TRISTAN accelerators or experiments, a television network is introduced. This system is a bi-directional broadband CATV network and has a capacity of 30 or more TV channels downward and 4 channels upward. The information is mainly serviced around TRISTAN and Photon Factory areas. At each TV receiver, there is an RF Cnverter/Tuner (RFCT) to receive TV signal. The RFCT is remotely controllable and the TV receiver can be switched on/off or forced to tune to the channel by the command from TCCR.

The CATV system in KEK uses transmission frequencies in a range of 70 to 300MHz for downstream and 10 to 50MHz for upstream. The CATV network is going to be used for the Local Area Network (LAN) because of its interconnectivity between different devices. Signals of all control/status data of RFCT and LAN are transmitted using the frequency range of 10 to 90MHz.

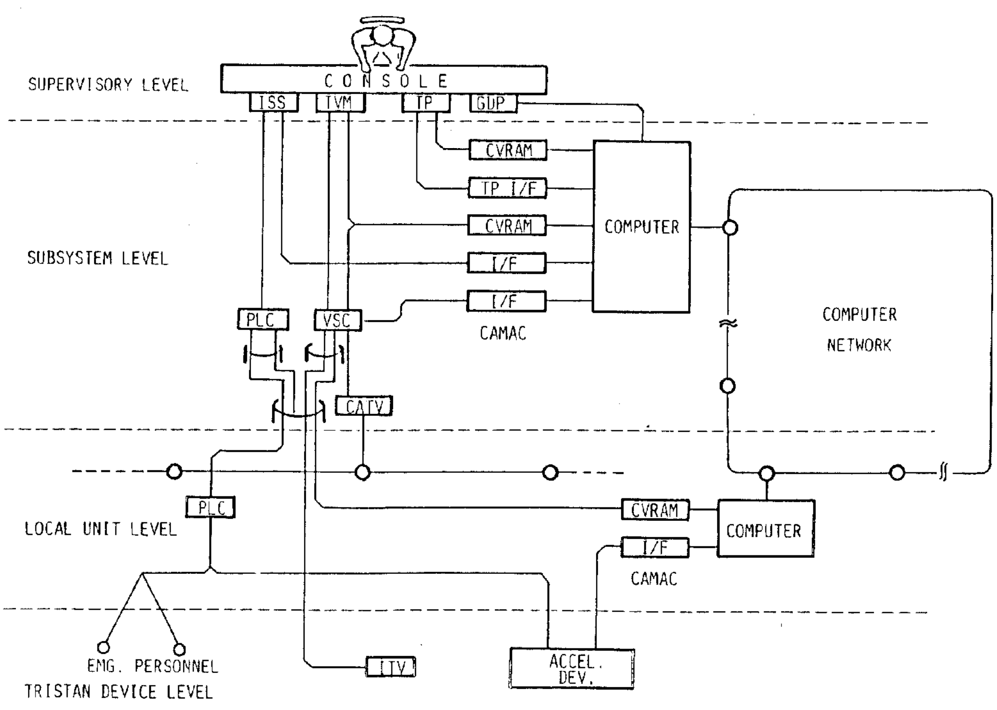

Fig. 5. A schematic description of the man-machine interface.

Conclusion

A schematic description of the system is shown in Fig. 5. The man-machine interface of KEK is composed of the above mentioned functions which are being joined each other by most effective media in order to exchange useful information.

Acknowledgements

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