

BEAM PARAMETERS MEASUREMENT BASED ON TV METHODS

E. Klimenkov, G. Losev, Yu. Milichenko, V. Voevodin, IHEP, Russia

Abstract

The paper describes hardware and software used to control TV-cameras and to process TV-images of luminescent screens placed along the beam transfer lines.

Industrial devices manually control the movements and focusing of the cameras. All devices are linked to PC via PCI interfaces with homemade drivers for Linux OS and provide both selection of camera and digitizing of video signal synchronized with beam. One part of software provides means to set initial parameters using PC consol. Thus an operator can choose contrast, brightness, some number of significant points on TV-image to calculate beam position and its size. Second part supports remote TV controls and data processing from Control Rooms of U-70 complex using set initial parameters.

First experience and results of the method realization are discussed.

INTRODUCTION

The TV based measurement subsystem (TVS) of the U-70 control system (CS) is intend to define beam size and position of the Booster injection and ejection beam transfer lines (BTL). There are 16 TV cameras and luminescent screens for each of beam transfer lines. The TV frame containing luminous shape of beam is digitised and processed. Exist five, essential for TV-image processing, combinations of beam vertical/horizontal axis, depending on TV-camera position to beam direction and looking camera to screen directly or through mirror (see Fig.1). The results of TV-image processing are accessible from any consol of CS.

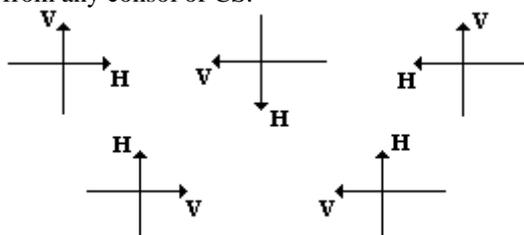


Figure 1: Possible TV image orientations

HARDWARE ARCHITECTURE

Any TV camera may be switched on/off, focused, turned, screen may be moved to/from beam manually by using remote manual consol. The Fig.2 shows the principal scheme of hardware to control up to 32 cameras and screens.

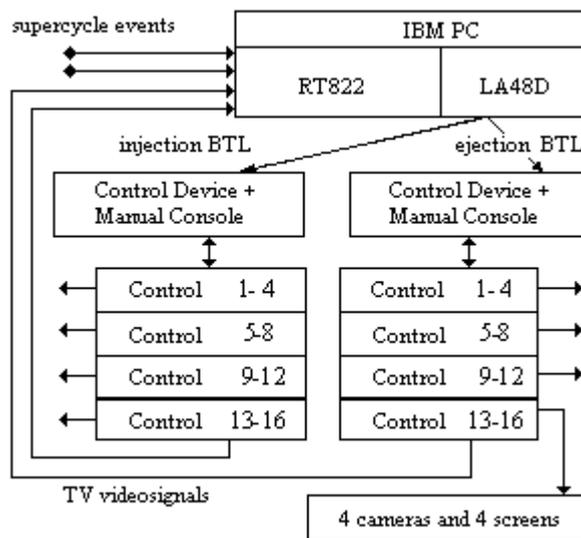


Figure 2: Scheme of hardware architecture

The PCI digital I/O circuit board LA48D supports computer control of switching on/off cameras and movements of screens for both BTLs. The TV I/O module RT822 gives possibility to digitise video signals and to synchronize with accelerator supercycle events. Manual and computer control to select and manipulate cameras/screens are made by usage of special industrial devices. The TVS computer control is based on the only PC with Linux operating system.

SOFTWARE

The software consists of three parts. homemade drivers for Linux to support functionalities of the LA48D and RT822 modules and utilities library, the program to set initial values of cameras parameters, general TV control and data processing software.

Utilities library

The set of drivers and library functions services the activities on cameras and screens, supports the synchronised start/stop TV frame digitising procedure, provides testing facilities, etc. It has suitable interface for all further mentioned applications to test, to control with/without synchronization and to read/write video data.

TV tuning program

The special tuning program is meant to set preliminary parameters for data processing software just from PC consol using mouse and keyboard (see Fig.3). The GUI is built on base of gtk+ graphical library. This program interactively sets for each of 32 TV cameras next preliminary parameters which values it writes to the real time database (DB):



Figure 3: The GUI to set initial parameters

- The level of contrast and brightness for RT822 module to digitise video signal with.
- Coordinates of four points with known distance between them in millimeters.
- Coordinates of the assumed centre of the beam.
- Coordinates of the rectangular working area to search beam trace in.

The pure digitised image or with drawn preliminary parameters may be shown on the PC consol screen (Fig. 3), printed or saved to file.

General control and data processing

This application may be activated from any consol of any control room of the U70 accelerator complex [1]. It corresponds to the rules and architecture requirements of the U-70 CS software [2] and takes initial parameters values from DB. The Figure 4 shows the example of real TV frame with beam and drawn source parameters.



Figure 4: Source image and preliminary parameters shown

The aim of data processing is to define the beam shape and to describe it by ellipse formula, which is helpful to calculate a beam dynamic.

The source image is an imprint of beam trace under some angle to beam direction, depending of the position of camera and screen. The software reconstructs the image to be perpendicular to camera (see Fig.5) using values of preliminary parameters for corresponding type of axes (Fig.1).



Figure 5: The graphical form of data processing results

The search of beam shape is based on levels of brightness and density of shining pixels disposition. The result of search is a rectangular area, which is used to define parameters of ellipse formula.

CONCLUSIONS

On start of the accelerator run an operator directs the cameras to screens manually and focuses them looking to TV monitors. Using tuning program he sets the preliminary parameters. After this the system is ready to work from any control rooms consol.

The TVS was created in relatively short time on base of fully industrial hardware. It is a useful tool to tune injected/ejected beam to/from the Booster.

The long-term archive of pictures for each of TV camera is very important for accelerator maintenance.

REFERENCES

- [1] V. Komarov, Y. Milichenko, V. Voevodin, V.Yurpalov, "Draft Design Study for the Control System of the U-70 Complex", IHEP&CERN, PS/CO/Note 96-26, Switzerland, Geneve, 1996.
- [2] V. Voevodin, "Software architecture of the U-70 Accelerator Complex New Control System", Proceedings of the ICALEPCS'99, Italy, Trieste, 1999, p. 457.