An image data acquisition system for large format CCDs

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ABSTRACT

This paper describes the operation and performance of an IBM-PC/AT based image data acquisition system for large format CCDs. The system currently under development can handle image data from CCDs with pixel organisation upto 2048 X 2048. Based on commercially available DT-3852 frame grabber board (M/s Data Translation Inc.) and locally developed I/O interfaces, the system provides an economical and user friendly acquisition, display and quick look analysis facility.

1. INTRODUCTION

The ready availability of large format Charge Coupled Devices (CCD) sensors in recent times, makes it possible to develop camera systems suitable for wide field imaging in astronomical applications.In this paper we have described hardware and software details for the CCD controllers and the data acquisition system for large format sensors.The size of the sensors also imposes demand on the data acquisition system in the form of larger RAM and disk capacity. It would also make demand on the speeds so as to keep the time for data acquisition to reasonable limits.The data acquisition system presently implemented isbased on IBM PC 386/486 and is an extension to a system developed by us earlier[1] with the following major modifications:

a) the software environment is changed from MS-DOS to MS-WINDOWS, thereby overcoming the 640k memory barrier of DOS and allowing large format CCD data to be acquired and processed.

b) Provides a single monitor operations for image display and PC interaction

c) Larger display resolution of 1024 X 768 instead of 512 X 512

d) Better graphics interface and more userfriendly operation.

The personal computer platform has been chosen for its maintainability and cost effectiveness.

2. HARDWARE DETAILS

2.1 Sensors:

The various CCD sensors for which the data acquisition systems are planned are as follows:

a) P8603

b) P88331

c) CCD442

The details of these sensors are given in the appendix.

controllers:

The data acquisition system has been developed keeping in view two types of ccd controllers presently available with us.

a) A commercially obtained camera controller from ASTROMED U.K.

b) a locally developed controller

In the former case the controller and the data acquisition system are connected through a serial link.This controller was originally designed for a P8603 EEV chip, but it can also be adapted for the larger format(1242X1152) P88331S chip with a bit of retuning of the controller electronics voltages for the chip to

operate satisfactorily. This system has however speed limitations due to of serial communication link and internal delays associated with controller electronics.Hence a new controller was developed locally.

The locally developed controller has a parallel link between the controller and data acquisition system.The design is functionally divided into the following modules.

a) PROM and address generator module

b) Clock level shifter, thermal and shutter control module

c) Bias and power supply module

d) Double correlated sampling and ADC module

e) Line driver and receiver module

Various timing signals required for the row and column shifts of the CCD are generated in the PROM and address generator module. The TTL clock levels are level shifted to MOS requirements by the clock and level shifter module before they are transmitted to the CCD.Once a charge packet has been shifted it is processed by the double correlated sampling and digitiser module. The reset noise eleminated signal is digitized and then transmitted to the personal computer through a line driver and receiver pair. The controller details have been published elsewhere[2]. With this controller it has been found that the speeds of acquisition have improved by a factor of ten. Another advantage of the controller is that it can handle any other CCD with a different organisation, by merely changing to appropriate PROM.

2.2 Host environment and interface:

Fig.1. shows the block diagram of the data acquisition system using both the Astromed and locally developed controllers. The PC/AT acts as host computer initiating commands through digital I/O card sitting on the PC-AT expansion slot and a serial/parallel link to the controller mounted on the telescope. The digitized data from the controller is stored in the system RAM and is displayed on the monitor by the frame buffer board DT-3852 (from M/s Data translation Inc.U.S.A,) DT-3852 has as a display RAM of 1MB,acquire RAM of 512 KB and a on board system RAM of 8 MB. It has a built in TMS 34020 graphic processor which is useful for meeting the graphical needs of the application. The system is connected through an ethernet link to a workstation,where astronomical data analysis packages reside. This link facilitates file transfer between the acquisition system and the data analysis facility.

3.SOFTWARE DETAILS

The software is developed under MS-WINDOWS and C.The various features of the system are:

a) System check

b) Image acquisition

c) Instrument control

d) Image analysis

e) Image processing.

f) window operations

The system check tests various functions on the ccd controller. The instrument control functions include operation of various auxiliary facilities like the filter wheel assembly movement,guide camera movements etc., associated with camera system . The image acquisition functions include acquiring dark,bias,flat,preflush and object. The image processing functions mainly include filtering functions and frame buffer operations meant for visual purposes. The window operations are for focussing only. The image analysis functions include intensity of pixels,row-cut,column-cut, histogram and image statistics, thereby providing some simple online quick-look functions for testing the data integrity. But this is not intended to be a substitute for a full fledged

astronomical package for data reduction.Since the instrument control functions are integrated with the data acquisition system,the flow chart shown in fig2. also indicates the various set-up procedures involved in the data acquisition process.

The application also uses TIGA communication software for DT-3852 operation. It is also planned to use a package called 'Globallab software' in our future versions, which has more advanced features, compared to TIGA library.

The 16 bit digitized data from the CCD is presently formated with a header for identification. However it is planned to provide Flexible Image Transport System (FITS)format output for compatiblity with astronomical data reduction packages.

4. DATA ACQUISITION FROM CCD ARRAYS

We are also considering a 2X2 array of CCDs of 2048*2048 pixels each, for imaging in our schmitt camera.The various clock drivers and different bias voltages are carried to the CCD chips through suitable buffers. Each CCD is under the control of 32 a bit microprocessor with a local memory for data and program space. Each CCD has a DCS processing module with an associated digitizer. The clock waveforms are properly synchronised to data acquisition and stored in the respective local memory.The local memory is configured for dual ported addressing derived from the local DRAM address and host-port initiated address.A pipelined clock generation scheme is adapted to enable fast data acquisition from all CCDs within one conversion time (60 microseconds) of the digitizer. Data acquisiton and recovery of data for interleaved gaps: In order to recover the missing data in interleaved gaps occuring while mosaicing, three frames are acquired Viz.,I) One normal frame II)One shifted in row direction by a distance more than the interleaved gap in the row direction but less than the CCD row size III) One frame shifted in the column direction by a distance more than the interleaved gap in the column direction but less than the CCD column size. From the above three frames of data we can generate,using software technique a single frame of data with no interleaved gaps The Sensor under consideration is THX7897M FROM THOMSON-CSF.

4.1 Display of data in array approach:

The DT3852 can accomodate upto 2048 X 2048 pixels of data.Host resident software perforams a 4*4 binning to compress 4096 X 4096 pixels within the display memory.In higher spectral resolution mode any one CCD's data can be displayed with a resolution 1024*1024.

5. CONCLUSIONS

The system has presently undergone testing on the EEV P8603 chip.It is found that it takes approximately 8 seconds for acquiring and storing a frame of information,with the locally developed controller. The data acquisition from other sensors are under trial and could take some time before they become fully operational. As far as the array ccds are concerned the processors controlling the CCD operations are 80386 cpus. However we are considering the use of transputers/digital signal processors for this application.

6. ACKNOWLEDGEMENT

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7. APPENDIX

P8603

manufacturer:	EEV U.K.
pixel organisation:	385*578
pixelsize:	23*23 microns
quantum effiency:	45% around 630 nm

P88331s:

manufacturer:	EEV U.K
Pixel organisation:	1242*1152
pixelsize:	22.5*22.5 microns
quantum efficiency:	40% around 630nm.

CCD442:

manufacturer:	LORAL FAIRCHILD U.S.
pixel organisation:	2048*2048
pixelsize:	15*15 microns
quantum efficiency:	50%around 700nm

THX7897M:

manufacturer:	THOMSON-CSF
pixel organisation:	2048*2048
pixel size:	15*15
quantum efficiency:	40% around 650nm

8. REFERENCES

1. Ananth, A.V.,Srinivasan, R.,Srinivasulu, G. and Chandra mouli, S.S., "A PC-AT Based Image Data Acquisition and Processing System for CCD Cameras", Indian Journal of Pure and applied Physics,vol 29, p 529, 1991.

2. Srivasan,R.,MuraliShankar,S.,RajMohan,R., "Fast Photometry Using CCD "Kodaikanal observatory bulletin (1991),vol 11, p 93, 1991.

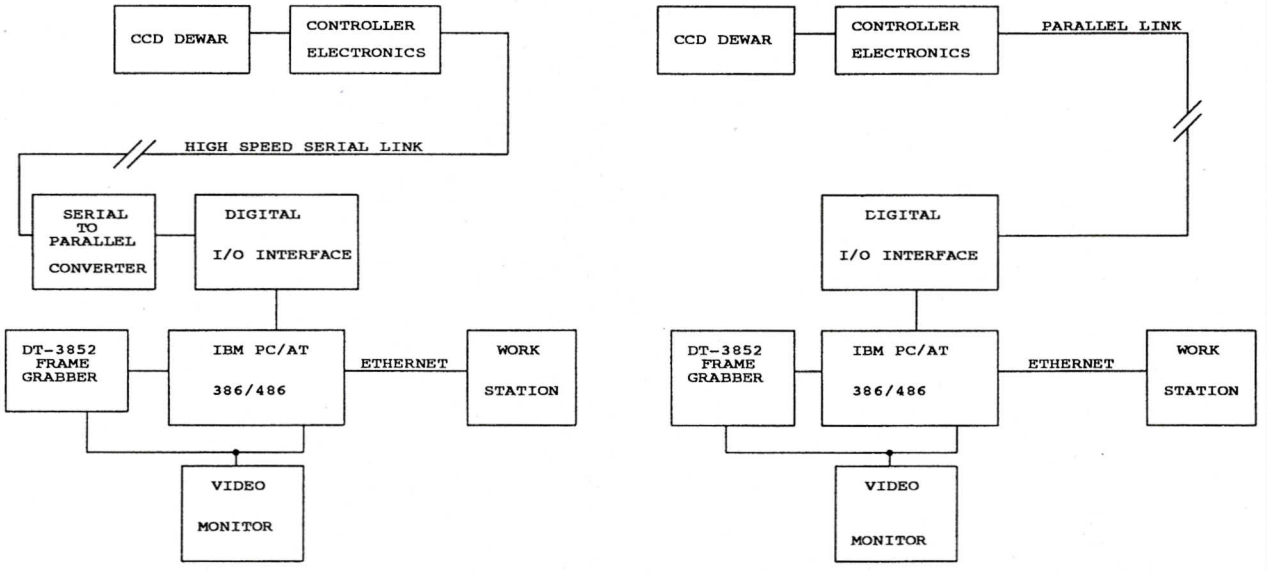

Fig.1 BLOCK DIAGRAM OF DATA ACQUISITION SYTEM

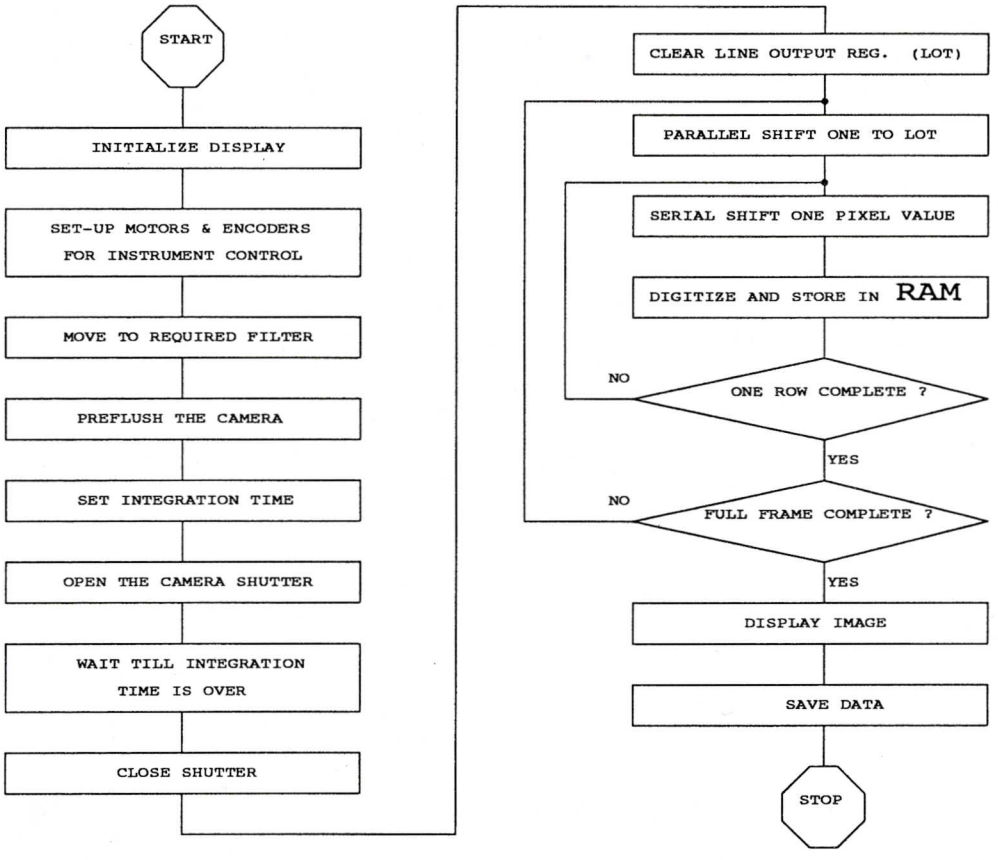

Fig.2.FLOW CHART OF THE DATA ACQUISITION PROGRAM.