MULTIPLE MIRROR TELESCOPE OBSERVATORY

TECHNICAL REPORT NO. 6

CID CAMERA IMAGE ANALYZER

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MAY 1980

TABLE OF CONTENTS

ABSTRACT

This report presents the basic instructions for operating either of two CID cameras on the MMT under microprocessor control. Procedures are listed for initialization and operation, and a glossary of user commands is given which describes in some detail the various methods of taking pictures and of analyzing multiple images. A listing of the MICROFORTH control program is also given.

I. INTRODUCTION

The Multiple Mirror Telescope (MMT) has two CID cameras available for telescope pointing, tracking, focusing, and alignment tests. The camera sensors are red-sensitive GE TN 2200 solid state silicon chips with a 128 x 128 pixel array. The pixels are spaced 45.7 μm apart, so one pixel in the guide/alignment telescope focal plane (plate scale = 15.75 ″/mm) is 0.72 ″ on the sky. The field of view is about 92 ″ square. The second camera is located at the MMT combined focus (plate scale = 3.7 ″/mm), and one pixel equals 0.170 ″ on the sky. The field of view of the MMT focus camera is only 22 ″ square. The 16,384 pixels are read out sequentially and displayed on an intensity-modulated oscilloscope to form a visible image. A Digital Group Z-80 microprocessor also sends the analog voltage output of each pixel through a D/A converter to a digital memory where pictures can be integrated and processed. A Uniblitz electronic shutter is used for exposure control and dark current subtraction. A keyboard and CRT monitor are used to issue commands to the microprocessor in the FORTH language and to display the results of various fitting routines. The software commands are listed in section III of this report, a program listing is given in section VI, and a computer interface map is given in Sec. VII.

A typical application of this system is the collection of telescope pointing data. Here the guide/alignment telescope camera is used to view a single bright star image. A picture is taken and stored in the computer memory. Then a software routine calculates the two-dimensional centroid of the star image, which can be compared with other data to determine relative pointing errors in azimuth and in elevation.

A common use of the MMT combined focus camera is for studying the image alignment capabilities of the active optics system. Here several (up to six) images are viewed simultaneously, and changes in their positions can be used to evaluate the closed-loop performance of the servos which continuously coalign the images from the six primary telescopes.

II. POWER UP PROCEDURE

In order to prepare the system for regular operation, perform the following steps in sequence:

(1) Insert a tape cassette labeled "CID Image Analyzer - Side 1" into tape deck #Ø with the label facing to the front so it can be read.

(2) Push the power switch on and wait for >_ to appear on the CRT monitor screen

(3) Type: RU FRTH22 cr.

(Note: cr means the RETURN key.).

(4) When the screen blanks, hit cr.

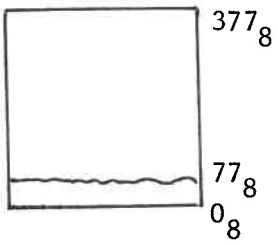
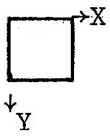
(5) If the UC key (upper case) is not brightly lit, press it once for upper case letters.

(6) Reverse the tape cassette so SIDE 2 appears in the tape drive window.

(7) Type: 6Ø LOAD cr.

(8) When _ appears on the screen, the operating system is loaded and is ready to operate.

III. GLOSSARY OF USER COMMANDS

FUNCTION	DESCRIPTION
1CAM	Switches control to Camera #1 (MMT focus)
2CAM	Switches control to Camera #2 (Guide/Alignment telescope focus)
N_R RATE	Sets camera rate to the # on top of the stack ($2 \leq N_R \leq 7$). A larger N_R implies a slower scan rate.
N_R BIAS	Sets the camera gains for the rate that is on top of the stack ($2 \leq N_R \leq 7$). Nominally the intensity display should be barely above the bottom of the screen:  Push SEND to terminate.
DISP	Present a real-time display of the camera's output. Push SEND key to terminate.
AIM	Same as DISP with a crosshair located at the X coordinate XXX and the Y coordinate YYY. The brightness of the crosshair is controlled by MAGG (43 XXX ! 63 YYY ! 77 MAGG ! cr). 
N_R RPIK	Takes a picture using the scan rate N_R. The picture is stored in 1ARRAY. Exposure time is .1333 sec at 2 rate. 2 rate is the fastest rate at which a picture can be taken ($2 \leq N_R \leq 7$). Exposure time = $133 \times 2^{(N_R-2)}$ msec.

FUNCTION	DESCRIPTION
N_E N_R ZPIK	Picture routine for the rate N_R and the exposure time N_E (in msec). Again 2 rate is the fastest possible rate at which a picture can be taken ($2 \leq N_R \leq 7$) and 133 msec is the longest exposure at 2 rate. ($\sim 2^{(N_R-2)} \leq N_E \leq 133 \times 2^{(N_R-2)}$ msec).
$I_{1_{max}}$ $I_{1_{min}}$ ....$I_{N_{max}}$ $I_{N_{min}}$ N ZN	This routine will form contour rings in the specified intensity intervals. For example: 100 90 25 15 2 ZN CR (in decimal mode) will plot 2 zones within the cursor box where the pixel intensities range from 100% to 90% and 25% to 15% of the maximum pixel intensity within the cursor box. The cursor box is controlled in the same manner as it is in XY, except S will plot the contours within the cursor box.
N_L 1LDISP	Produces a plot of the intensities in 1ARRAY for the line # N_L ($0 \leq N_L \leq 127_8$). To terminate, push SEND. The brightness of the plot is controlled by BRIGHTNESS (200 BRIGHTNESS !).
1SCAN	Displays the intensity profile of each line in 1ARRAY in sequence.
2SCAN	Same as 1SCAN for 2ARRAY.
1OUT	A two-dimensional display of 1ARRAY. Push SEND to terminate. 2 rate is the fastest possible rate.
2OUT	Same as 1OUT for 2ARRAY.