Interleaved FITS DS9 segmentation with shell script metaprogramming for planetary nebulae detection

T.N. Stenborg[1]
1. Dept. Physics & Astronomy, Macquarie University

Introduction

A technique for efficient inspection of high volume imaging data for planetary nebulae (PNe) is presented. Image segmentation to subscreen size is automated. Consecutive small image review avoids inadvertently missing sections of large images with manual image traversal. RGB stacked (emission line on-band R, off-band G) images are auto-interleaved with corresponding difference images. Bidirectional single-click navigation of a segmented, interleaved data set (e.g. Figure 1) allows complementary image blinking and efficient PNe candidate identification.

Technique Overview

A target FITS dataset featuring images of consistent dimensions, stored in an ordered fashion, lends itself to automated processing. Algorithm 1 shows the logic developed for a metaprogram leveraging Bash shell scripting for file and loop handling capabilities, whilst using AWK and DS9 (Joye & Mandel, 2003) command-line scripting as object languages for floating-point arithmetic and FITS segmentation respectively.

Algorithm 1 assumes a source file input list of arbitrary length and arbitrary, but consistent, pixel dimensions for source FITS files and output segmented images. DS9 segmentation calls work by opening the DS9 interface to a geometry compatible with the active monitor resolution, e.g. 1280×633 in Listing 1. The display dimensions input to Algorithm 1 should be those of the DS9 display frame only however, not the entire DS9 interface, i.e. $< (1280 \times 633)$ for the example of Listing 1.

Executing the program once over RGB stacked images and again over their difference images, with alternate output file suffixes, allows the file index i to reset between runs, naming files in an interleaved, sequential manner (e.g. 1RGB.jpg, 1diff.jpg, 2RGB.jpg, 2diff.jpg, etc.). The files can then be blinked for comparison with an image viewer supporting bidirectional single-click navigation, e.g. Preview in Max OS X.

Nebulae Detection

This technique was used for methodical review of the RGB ([O III] on-band, off-band) and difference FITS files from the Galactic bulge PNe survey of Kovacevic (2011). Mosaicked image files (8192×8192 pixel) for 125 survey fields were processed, revealing a significant new PNe candidate population (Stenborg & Parker, 2014).

FITS Segmentation

1 FITS.SEGMENT($sourceList, sourceWidth, sourceHeight, displayWidth, displayHeight$)
2 $i := 1$
3 $x_{max} := \lceil sourceWidth/displayWidth \rceil - 1$
4 $y_{max} := \lceil sourceHeight/displayHeight \rceil - 1$
5 **for** *source* **in** *sourceList* **do**
6 **for** $x = 0$ **to** x_{max} **do**
7 **for** $y = 0$ **to** y_{max} **do**
8 $horzPan := \lfloor sourceWidth \times (x/(x_{max}+1) - x_{max}/(2 \times (x_{max}+1))) \rceil$
9 $vertPan := \lfloor sourceHeight \times (y/(y_{max}+1) - y_{max}/(2 \times (y_{max}+1))) \rceil$
10 DS9.SAVEIMAGE($source, horzPan, vertPan, i$)
11 $i := i + 1$

Algorithm 1: Even FITS file segmentation for arbitrary image and display frame dimensions.

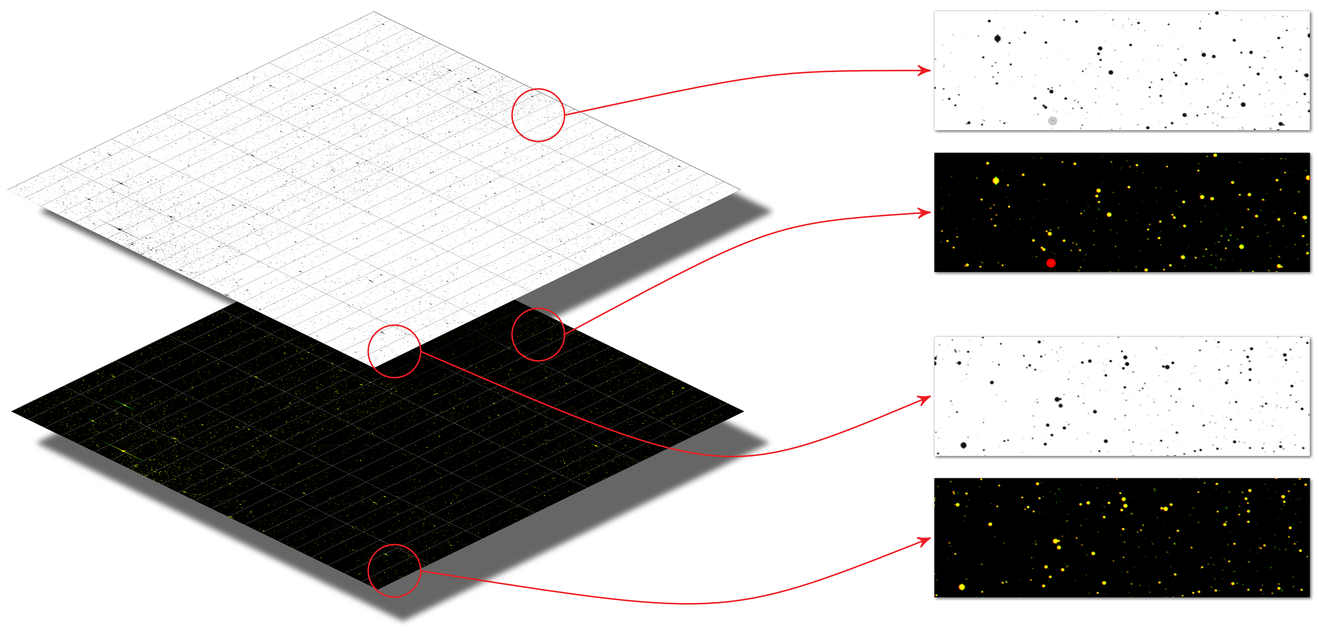

Figure 1: Mosaicked FITS segmentation with interleaving of RGB and difference image frames. Bidirectional single-click frame navigation allows image blinking for planetary nebulae detection.

```
for x in {0..xMax}
do
  for y in {0..yMax}
  do
    let horzPan=$(echo $sourceWidth*($x/($xMax+1)-$xMax/(2*($xMax+1)))
     | awk -F\. '{if(($2/10^length($2)) >= .5) printf("%d.0",$1+1);
     else printf("%d.0",$1)}')
    let vertPan=$(echo $sourceHeight*($y/($yMax+1)-$yMax/(2*($yMax+1)))
     | awk -F\. '{if(($2/10^length($2)) >= .5) printf("%d.0",$1+1);
     else printf("%d.0",$1)}')
    DS9_SAVEIMAGE="ds9 -mosaicimage iraf $source -scale mode 95 -pan $horzPan
     $vertPan -geometry 1280x633 -saveimage ${i}diff.jpg 100 -exit"
    $DS9_SAVEIMAGE
    let i=i+1
  done
done
```

Listing 1: Sample code snippet metaprogrammed with Bash shell / AWK / DS9 command-line script.

References

Joye, W. A., & Mandel, E. 2003, in ASP Conf. Ser., Vol. 295, ADASS XII, ed. H. E. Payne, R. I. Jedrzejewski, & R. N. Hook, 489
Kovacevic, A. 2011, PhD thesis, Macquarie University
Stenborg, T. N., & Parker, Q. A. 2014, in APN VI (these proceedings)

MACQUARIE UNIVERSITY | ASTRONOMY, ASTROPHYSICS AND ASTROPHOTONICS RESEARCH CENTRE