IUE DATA REDUCTION

XXXIII. Bright Spot Detection on IUE Images*

Introduction

Long IUE exposures characteristically contain "bright spots", i.e., pixels with unusually high DN values which comprise impulse noise often reaching the saturation level. Such bright spots are thought to be caused either by extraordinarily sensitive ("hot") pixels which result in recurrent bright spots at fixed locations or by radiation-induced events within the UV converter which result in randomly placed nonrecurrent bright spots (Ponz, 1980a,b). Tables 1 and 2, reproduced from Ponz (1980a), list recurrent bright spots in the SWP and LWR cameras. The table entries include the line and sample positions both in raw and geometrically corrected frames of reference and the approximate corresponding wavelengths for the various dispersion modes and apertures. The notation "B" means the backgound, rather than gross, spectrum is generally affected. Ponz estimates the expected error in wavelength for low dispersion to be ±5 Å and for high dispersion to be ±0.3 Å. Double high dispersion entries in certain instances indicate that adjacent orders may be affected.

Ponz (1980 a,b) has described an algorithm, discussed further below, for automating the detection of bright spots of either kind in raw images on the basis of the bright spots' limited spatial extent and unusual brightness values. This detection algorithm, incorporated into the IUESIPS program BSPOT by VILSPA, is based on a median-filtering technique and was implemented in the standard production processing on 19 October 1982 at VILSPA and on 19 November 1982 at GSFC. In the sections which follow, the details of the algorithm and a discussion of its limitations are given.

Detection Algorithm

Let DN (i,j) be the DN value of the pixel at line i, sample j. Further, let AVE and MED represent operators which return the weighted average and median values of their argument, respectively. Then the pixel at (i,j) is detected as a bright spot if

$$DN\ (i,j) > AVE\left[DN\ (k,l)\right] + \Delta \qquad (1)$$

and

$$DN\ (i,j) > MED\left[DN\ (k,l)\right] + \Delta \qquad (2)$$

* Based on a similarly titled article by J.R. Munoz Peiro in IUE ESA Newsletter No. 16, April 1983.

where Δ is a DN threshold value and (k,l) are positional elements of a 7-pixel spatial window (see below) centered on the pixel at (i,j) and oriented on the diagonal (i.e., nearly along the dispersion direction). In practice, the area of the image searched for bright spots corresponds to that portion in which the photometric correction is done. Furthermore, although a 7-pixel filter window is allowed by the software, the standard parameters used in production processing reduce the window effectively to 3 pixels by using the set of weights (0,0,1,0,1,0,0). A fixed threshold value of Δ = 90 DN is used in production processing.

Flagging of Detected Bright Spots

Pixel locations detected as bright spots are written to a disk data set which is subsequently read by the spectral extraction routines so that extracted fluxes derived from bright-spot pixels may be flagged, via the epsilon data-quality entries. An epsilon value of -300 in the MELO and MEHI tape files indicates a detected bright spot in the gross spectrum (Turnrose, Thompson, and Bohlin, 1982). A bright spot which occurs in the region of the background spectrum will be flagged only in the CalComp plot of the unsmoothed background. This is because like reseaux, saturated pixels, and microphonic noise, bright-spot pixels are in fact ignored in calculating background fluxes and hence do not propogate through to net-flux determinations. The epsilon value of -250 reserved in Turnrose, Thompson, and Bohlin (1982) for filtered bright spots does not appear in standard output products since the potential filtering option identified in that reference is not implemented in standard production processing.

Discussion and Limitations

The overall suitability of the standard detection algorithm parameters (i.e., filter weights and threshold value) has been tested in a number of cases, but these parameters have not been demonstrated to be universally optimal. For example, the use of a constant threshold value of 90 DN, while suitable for many images, poses a limitation for images with very high background levels (background DN 150 DN): since the maximum possible DN level is 255, some genuine bright spots would be undetected with a threshold of 90 DN. Limited testing at GSFC (Turnrose, 1982) on such images has indicated that the threshold of 90 DN is not appropriate in the sense that an insufficient fraction of the visually identifiable bright pixels are flagged. Although long-exposure images with this high a background level apparently represent a small fraction of all IUE images, it is probably just such images for which bright-pixel flagging is most important. It may be that a variable threshold, determined dynamically for each image on the basis of its background level, is necessary to flag bright pixels effectively over the entire range of image background levels.

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References

Ponz, J.D. 1980a, IUE ESA Newsletter No. 8, p. 12.

Ponz, J.D. 1980b, "Bright Spot Detection on IUE Images", in IUE Data Reduction, ed. W.W. Weiss et al. Vienna: Austrian Solar and Space Agency, p. 75.

Turnrose, B.E., Thompson, R.W., and Bohlin, R.C. 1982, NASA IUE Newsletter No. 18, p. 21.

Turnrose, B.E., 1982, "Bright Spot Flagging", Report to IUE Three-Agency Meeting, September 1982.

Table 1

HOT PIXELS IN THE SWP CAMERA

RAW		GEOMD		LOW DISPERSION		HIGH DISPERSION	
				LARGE AP.	SMALL AP.	LARGE AP.	SMALL AP.
LINE	SAMPLE	LINE	SAMPLE	WAVELENGTH (Å)			
292	413	295	412	—	—	1379.6 B 1393.6	1378.7 B 1392.6
352	501	357	500	—	—	1330.2 B 1343.0	— 1342.2
392	127	386	123	1795 B	—	1859.1 —	1857.8 —
398	521	404	520	—	—	1357.9 B 1371.4	1357.0 B 1370.4
410	535	416	534	—	—	1358.5 1372.0 B	1357.6 1371.0 B
482	342	481	336	—	—	1686.7 —	1685.6 —
568	127	563	112	—	—	— 2060.2	— 2058.9
611	387	613	380	—	—	1779.0 B 1756.5 B	1778.0 B 1755.3 B

Table 2

HOT PIXELS IN THE LWR CAMERA

RAW		GEOMD		LOW DISPERSION		HIGH DISPERSION	
				LARGE AP.	SMALL AP.	LARGE AP.	SMALL AP.
LINE	SAMPLE	LINE	SAMPLE	WAVELENGTH (Å)			
126	291	120	315	--		1919.3	1904.6 B 1920.5
172	200	156	222	1780	1775 B		
175	363	174	394			2172.5	2153.6 B 2173.9
178	610	186	648	--	-	2732.0	2733.8
208	391	207	415			2258.5 B 2280.0	2282.4 B
215	326	210	348	--	2130	2135.3	2117.0 B 2136.7
257	323	251	345	~2190	-	2198.2	2199.7 B 2178.8
333	317	326	335	—	-	2288.9	2290.3 2268.0 B
412	385	407	401	--	-	2570.2	2543.8 B 2572.0 B
434	479	434	498	-		2818.7	2786.3 B 2820.5 B
518	545	521	563	-		3084.0	3086.0 --
532	307	521	316	-		2550.8 2579.2 B	2552.3 -
680	332	673	335	--	-	2838.0	2839.8