IUE DATA REDUCTION

XXVI. Automatic Registration of the Extraction Slit with the Spectral Format

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I. Introduction

Several changes have been made to the automatic registration program DCSHIFT, which is used in IUESIPS to align precisely the extraction slit with the spectrum. Although the earlier modifications have been described elsewhere (see CSC/TM-81/6117 : "Techniques of Reduction of IUE Data : Time History of IUESIPS Configurations" by Turnrose and Harvel), there have recently been several additional improvements made to increase the accuracy of the registration and to allow more images to be processed without requiring manual registration. The following description should help observers in deciding how to specify the processing requirements for their particular images.

II. Method

The basic procedure has not been changed. The program begins by reading in sections of the raw image determined by the input file of temperature-and-time-corrected dispersion constants and hardcoded wavelengths and order numbers. As shown in Table 1, one set of 12 wavelengths is used for low dispersion images and up to 4 sets of 12 wavelengths for high dispersion images.

a. Processing of each search area

i) Point-source spectra

For point-source spectra the 17-by-17 pixel search areas are rotated 45^{o} so that the dispersion is approximately parallel to the rows of the rotated matrix. The resulting matrix contains 17 rows of 8 pixels which roughly approximate a diamond-shaped area in the raw image space. Rowsums are then calculated and used to generate normalized templates, as shown in Figure 1, which are intended to correspond to the expected intensity distribution perpendicular to the dispersion. The template is passed across the array of rowsums to find the best fit, which, if it passes the program constraints, is used to determine a shift. A shift from one of the 12 regions can be excluded from the average shift for any one of four reasons:

1) the second largest rowsum divided by the second smallest rowsum is less than or equal to 1.5 (i.e. low signal to noise (S/N))

2) the second largest rowsum is greater than 2000 DN (i.e. 8 x 250 which represents nearly saturated data)

3) the search area includes lines flagged as containing microphonic noise

4) the best fit was found with a rowsum at the edge of the search area where it is not possible to interpolate between rows (i.e. shifts greater than 3.5 pixels perpendicular to the dispersion).

The above process is repeated for each wavelength and corresponding search area.

ii. Trailed spectra (low dispersion only)

For trailed spectra a 3-line-by-40-sample search area is used which is not transformed to a rotated reference frame. Instead, 39 sums are calculated, each of which contains the 3 pixels from the diagonal in the search area, which is aligned approximately with the direction of dispersion. A normalized template (as described in Figure 1) is then applied as in the untrailed case. Shifts are excluded from the evaluation for the following reasons:

1. the average DN value for a pixel in the center 5 rows minus the average DN value for a pixel in the first 5 rows is less than or equal to 30 DN (i.e. low S/N)

2. The search area includes line(s) flagged as having microphonic noise

3. The best fit was found with a rowsum at the edge of the search area (i.e. a shift greater than 4.2 pixels perpendicular to the dispersion).

The above process is repeated for each of the 12 wavelength regions.

b. Calculation of average shift

Once all 12 search areas have been evaluated, an average shift is calculated from the shifts that pass the above tests and corrections are applied to compute the line and sample components for a shift perpendicular to the dispersion. The dispersion constants used for the spectral extraction are updated to reflect the perpendicular shift unless:

1. less than half of the 12 shifts were found acceptable as described above

or

2. the RMS deviation of the acceptable shifts was greater than 1.0 pixel

If either of the above conditions is true for a low dispersion image, the program will abort and the image must be processed using manual registration. If either of these conditions is true for a high dispersion image, the entire process described above will be repeated using the next set of 12 wavelengths (i.e., another order as specified in Table 1); the program will finally abort after 4 unsuccessful attempts to find a suitable shift.

III. Comments

1) It should be apparent that the above procedure cannot be applied equally well to all IUE images. In particular, images with unusual profiles such as non-uniform extended source images or images with multiple exposures in the large aperture

may cause the program to abort, or even worse, calculate erroneous shifts. Unless these images have symmetric and uniform profiles it is probably better to request either no shift or manual shift. If the manual shift is specified it may be useful for the GO to comment on how the shift should be calculated.

2) There are currently no production processing schemes for trailed high dispersion images which use automatic registration.

3) Spectral images containing saturated continua will probably run without aborting. This is especially true for trailed images for which no saturation constraints are imposed and high dispersion images for which several orders are tested before the program will abort. The program DCSHIFT will abort only for extreme saturation, and no harm is done in this case, because the image processing will then default to manual registration.

4) In high dispersion, the extracted background depends critically on the registration for the closely spaced orders. For this reason, high dispersion images are registered using order 108. Progressively lower orders down to order 77, are used if order 108 is unsatisfactory. This method allows images of low-temperatures objects with little signal as short as order 108 to run without aborting.

Table 1 - Search Area Wavelengths

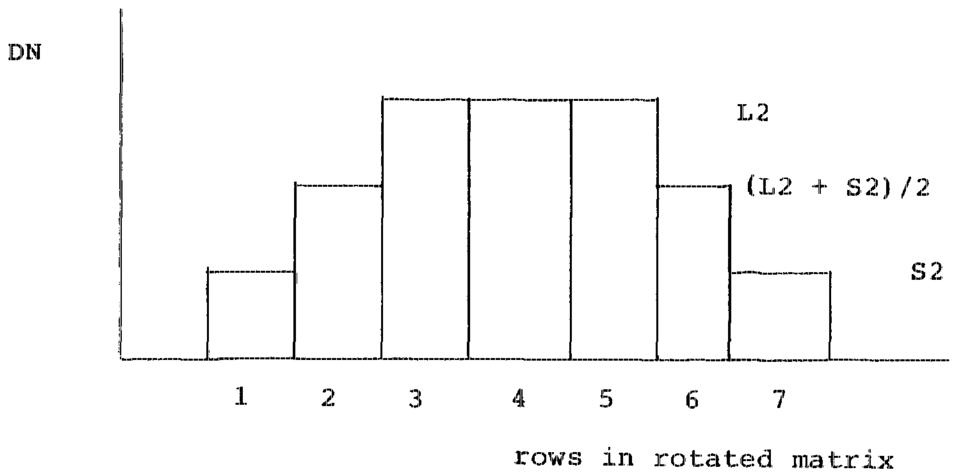
Low dispersion wavelengths (Å)

Long wavelength	Short wavelength
2100	1300
2200	1350
2300	1400
2400	1450
2500	1500
2600	1550
2700	1600
2800	1650
2900	1700
3000	1750
3100	1800
3200	1850

High dispersion wavelengths (Å)

Long wavelength				Short wavelength			
m = 108	100	86	77	108	100	82	77
2132	2303	2677	2995	1270	1372	1671.5	1782
2133.5	2304.5	2679	2997	1271	1373	1673	1783.5
2135	2306	2681	2999	1272	1374	1674.5	1785
2136.5	2307.5	2683	3001	1273	1375	1676	1786.5
2138	2309	2685	3003	1274	1376	1677.5	1788
2139.5	2310.5	2687	3005	1275	1377	1679	1789.5
2141	2312	2689	3007	1276	1378	1680.5	1791
2142.5	2313.5	2691	3009	1277	1379	1682	1792.5
2144	2315	2693	3011	1278	1380	1683.5	1794
2145.5	2316.5	2695	3013	1279	1381	1685	1795.5
2147	2318	2697	3015	1280	1382	1686.5	1797
2148.5	2319.5	2699	3017	1281	1383	1688	1798.5

Point Source Template

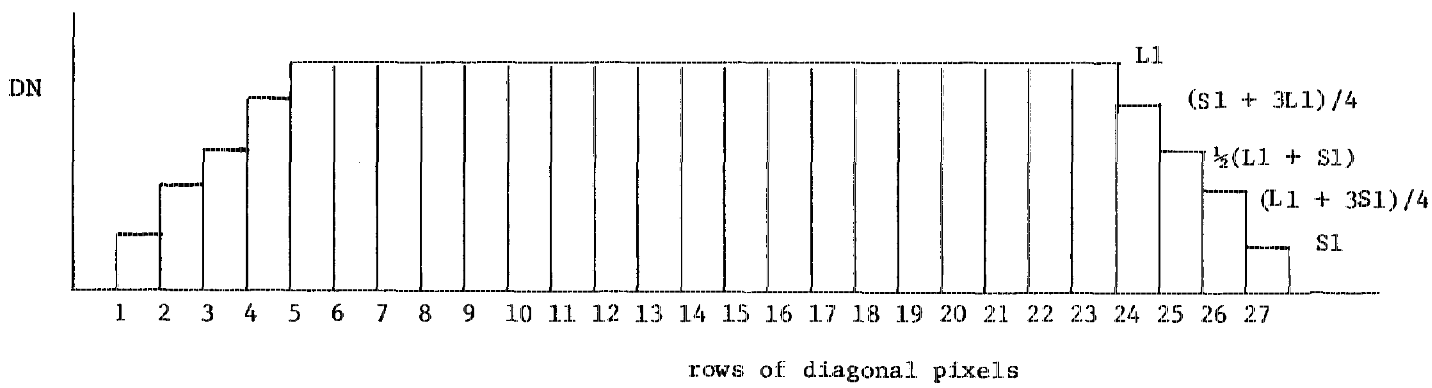


L2 = second largest rowsum in search area

S2 = second smallest rowsum in search area

Note: The separation between rows in rotated matrix = 0.707 pixel in raw image.

Extended Source Template



L1 = largest sum of diagonal pixels in search area

S1 = smallest " " " " " " "

Note: 1 row = 1 pixel

Figure 1 - Normalized Templates