# REPORT ON BRIGHT SPOT DETECTION IN IUE IMAGES

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It has been known since launch that IUE images are subject to contamination from "bright spots" - pixels with anomalously high DN values which do not correspond to "real" data. These occur at specific pixel locations (the so-called "hot" pixels) and also at random positions on the images. Lists have been compiled of the hot pixels for each camera, but the randomly-distributed bright spots, thought to be due to radiation-induced events within the UV converter (Ponz 1980a,b), are more difficult to deal with. Current IUESIPS processing uses an algorithm due to Ponz (1980a,b) to detect bright spots which classifies a given pixel as a bright spot if it exceeds a DN value characterizing the immediate neighborhood of the pixel in question by a preset amount, called the threshold. Currently, the threshold is 90 DN. It is important to note that current processing merely flags bright spots without changing their DN values.

It has been realized for some time that the current BSPOT program has difficulties with at least certain classes of images. Turnrose (1983) discusses the problem that arises with high-background images. For this reason, there has been an ongoing effort to improve the algorithm so that it is more reliable for bright spot detection. One way of improving the algorithm that has been explored is to allow the threshold to depend on the characteristics of the image being processed. The threshold could conceivably be allowed to vary within a given image. However, after a considerable amount of study, it has been concluded that it is best to leave the current IUESIPS bright spot processing as is. The remainder of this Report explains the reasons for this recommendation.

The key issue for the possible improvement of the program BSPOT is whether or not it is possible to unambiguously identify bright spots (or "hits") and to discriminate between hits and real data. No reliable algorithm has been developed to do this. Perhaps this is not surprising, because there are many cases of images in which the discrimination between real data and hits cannot be made with confidence even with visual inspection on the observing console. It seems that any algorithm one might devise will be subject to errors. These errors will be of two types; first, there may be pixels identified as hits which in fact contain real data ("Type I errors"), and second, there may be pixels which contain a hit but are not identified as such ("Type II errors"). Designing a BSPOT algorithm becomes an optimization problem in which one wishes to minimize errors. The question then arises as to whether one wishes to minimize Type I errors, Type II errors, or some combination. By appropriate choice of parameters, one can usually eliminate one or the other class of errors, but not both. For example, by reducing the threshold in the current BSPOT algorithm, one can reduce the number of Type II errors, perhaps even eliminate them. The price paid, however, is to increase the number of Type I errors. Here also the question of filtering versus merely flagging bright spots arises. It is generally agreed that one should go to great lengths to avoid destroying real data. Thus, if one chooses to filter the image, one must very strongly favor minimizing Type I errors. In the context of the current algorithm, this would mean raising the threshold to very high levels, and thus incurring many Type II errors. In such a situation, it is not clear that BSPOT is useful at all, because very few, if any, pixels would be filtered. It would appear that the argument above is general and is not dependent on the particular algorithm used to recognize hits, as long as it subject to both Type I and Type II errors. Thus, we seem to be led inescapably to the following conclusion:

<u>In production processing, bright spots should never be filtered.</u>

If we confine ourselves to merely flagging bright spots, we may be allowed to have a reasonable number of Type I errors. Just how one assigns the priority to minimizing Type I errors versus Type II errors is complex - perhaps in the end a matter of personal judgment. It should also be kept in mind that there is no reliable independent check as to whether a particular pixel is a hit or not. However, by a detailed study of a large number of images, it might be possible to define image parameters which the number of bright spots in an image depends on. For example, exposure time and radiation level might be two such parameters. It might also be possible to separate real data bright spots from hits by studying images of the same source which vary in some parameter or parameters such as exposure time. This would, however, be true only statistically; that is, one could not infer that a particular bright spot was or was not a hit, only that the mean number of hits on such an image was a given value.

What are the potential improvements to BSPOT besides varying the threshold? Consider one particular variant of a Type I error, namely, the erroneous identification of strong emission lines as bright spots. If a strong emission line occurs with a weak or non-existent continuum, then it is an excellent candidate for being identified as a bright spot. Several examples of such misidentification have been supplied by C. Imhoff (1985). See also Grady and Imhoff (1985). In this case, one might argue that an algorithm could be devised that took advantage of the extra knowledge available about the characteristics of an emission line - that it falls in a particular region of the image, for example. In general, one could probably devise complex algorithms that relied on special characteristics of the images, such as the location of the spectral format. As discussed above, however, all such algorithms would necessarily be subject to the basic Type I and Type II errors. For this reason, it is by no means clear that use of more complex algorithms would be an advantage. While such algorithms would hopefully perform better in terms of reducing errors, they would have the disadvantage of being more opaque to the IUE Guest Observer, who might thereby place an unwarranted amount of faith in the reliability of bright-spot flagging. As we have demonstrated, errors are inevitable in any algorithm, regardless of its complexity. The only way of dealing with such errors is to allow the individual scientist, who may be in the best position to judge whether a particular bright spot is real data or not, to make the decision. Seen in this light, the function of BSPOT is merely to identify the potential bright spots, and for this purpose, the current algorithm is adequate and has the advantage of simplicity. Thus, we recommend retaining the current IUESIPS BSPOT algorithm.

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