IUE DATA REDUCTION

XXVII. Improvements to the Visibility of Spectral Features on IUE Photowrites

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I Introduction

The IUE photowrite system currently produces the quick-look (SOC) photowrites which display the raw image at a scale of 200 μm px^{-1}, and the reduced photowrites which consist of three 100 μm px^{-1} images displaying the raw image, the raw image with a wavelength scale overlay, and the photometrically corrected image. Both types of photowrites are produced on Kodak 2474 or 2476 Linagraph Shellburst film using one of two Optronics International P-1500 photowrite systems and developed in D-19 with a Colenta automatic processor. In addition, two contact prints are made from the reduced photowrite original using Kodak 2421 Aerial Duplicating film.

The Optronics photowrite software system has the capability of allowing the user to modify the effective system response relating digital input values to exposure level on the film. This is done by using a table lookup function called a "transfer characteristic" to map the input digital data values to a new set of digital data values before exposing the film. In many applications this capability is used to correct for non-linearities in the exposure and processing of the film so that a linear relationship then exists between the input digital data number (DN) and the output film density. This capability to modify the system response is not limited to the linearizing case, however. For example, last year a transfer characteristic was implemented in the production of the reduced photowrite original films to assure that the contact prints were produced with the same contrast as the quick-look 200 μm photowrites although it was not intended to remove any non-linearities in the system response (Mallama, 1981). Given this use of transfer characteristics, the following situations existed:

1) although the reduced contact prints matched the quick-look films in providing a high level of contrast at low DN values, the system response for each type of product was such that spectral features were often poorly distinguishable from the underlying continuum for continuum levels above DN ~100 (See Figure 1 in Section III);

2) the only means of modifying the image contrast on the quick-look films (and hence on the contact-print films which were forced to match the quick-looks) was to adjust the development process;

3) since photowrites were routinely underdeveloped to produce reasonable contrast and densities (e.g. 5 min. development compared to the recommended 8 min. for 2474 film) the quality of the photowrites was more sensitive to changes in the development temperature.

The purpose of this study, therefore, was to determine a transfer characteristic resulting in a system response which would improve the contrast and consistency of both the reduced photowrite contact prints and the quick-look (SOC) photowrite originals. In order to accomplish these goals a desired system response was selected according to the criterion that a test wedge containing 16 equally spaced input DN intervals spanning the range from 0 to 255 should result in 16 visually distinguishable gray levels on film developed for the recommended time in D-19*. The process of defining the final transfer characteristic and system response was an iterative one as described below.

II Method

An applications program was written to generate suitable gray scale test-wedge images on the Sigma-9 computer in various steps from 0 to 255 DN. These images could then be written to tape and processed as standard quick-look photowrite images using the recommended development time for D-19 and evaluated both visually and photometrically.

A continuous function representing a relation between input DN and final photographic density was defined to represent a trial system response presumably satisfying the desired criterion. Data describing the trial system response and the original default system response (determined from averaging density measurements from several test wedge images produced in the default mode, i.e., without a transfer characteristic) were fed into a computer program which generated the corresponding transfer characteristic needed to realize the trial system response. With this test transfer characteristic programmed into the photowrite system, a 16-step test wedge was generated and evaluated. If all 16 gray levels

* D-19 was used because it is the only recommended developer with a film capacity suited to the processing equipment used.

were not visually distinguishable the trial system response was modified and the above process repeated until a satisfactory system response and corresponding transfer characteristic were determined.

Having defined the transfer characteristic described above, which resulted in the desired system response for quick-look images, a second transfer characteristic was generated so that the final contact print copies of the reduced photowrite films also achieved the same desired system response (see the discussion of Figure 1 in Section III).

III Results

Figure 1 shows diffuse photographic density as a function of input intensity (in DN) for the original (default) system response, the response of the contact print made from the original, and the final desired response which produces the 16 distinguishable gray levels. Since the contrast is proportional to the slope of the curve, one can see how the original system response produced images with good contrast at low DN levels and rather little contrast at DN levels greater than 100. The default contact print response was just the opposite of the original, producing little contrast at DN levels below 160. As discussed in Section I, this contact print response was modified for production work in 1981 (Mallama, 1981) to agree with the original default system response.

The newly implemented transfer characteristics modify both the original and the contact print responses to agree (typically, to within 0.1 density units) with the final desired response designated by the solid line in Figure 1. The intent of this desired response is to produce a photowrite with approximately visually equal contrast at all DN levels. Although the contrast achieved at lower DN levels with the new response is less than it was with the original response, it is felt that the new response is a better overall compromise and produces a more useful "roadmap" of IUE images.

The transfer characteristics described above were implemented at GSFC in the production of the quick-look (SOC) photowrites on August 10, 1981 and in the production of the reduced photowrites on October 19, 1981.

Any future changes to film batch characteristics or the development process can now be compensated for by appropriate adjustment of these transfer characteristics to assure a consistent system response .

References

Mallama, A.D., 1981 NASA IUE Newsletter No. 12, p. 27.

Figure Captions

Figure 1: Various system response functions expressed in terms of diffuse photographic density as a function of intensity for Kodak 2476 film developed in D-19 for 12 min. The three curves shown represent the original default system response, the empirically determined desired response and the response of the Kodak 2421 copy of the original before correction. After implementation of the new transfer functions the original and copy responses should approximate the desired response.

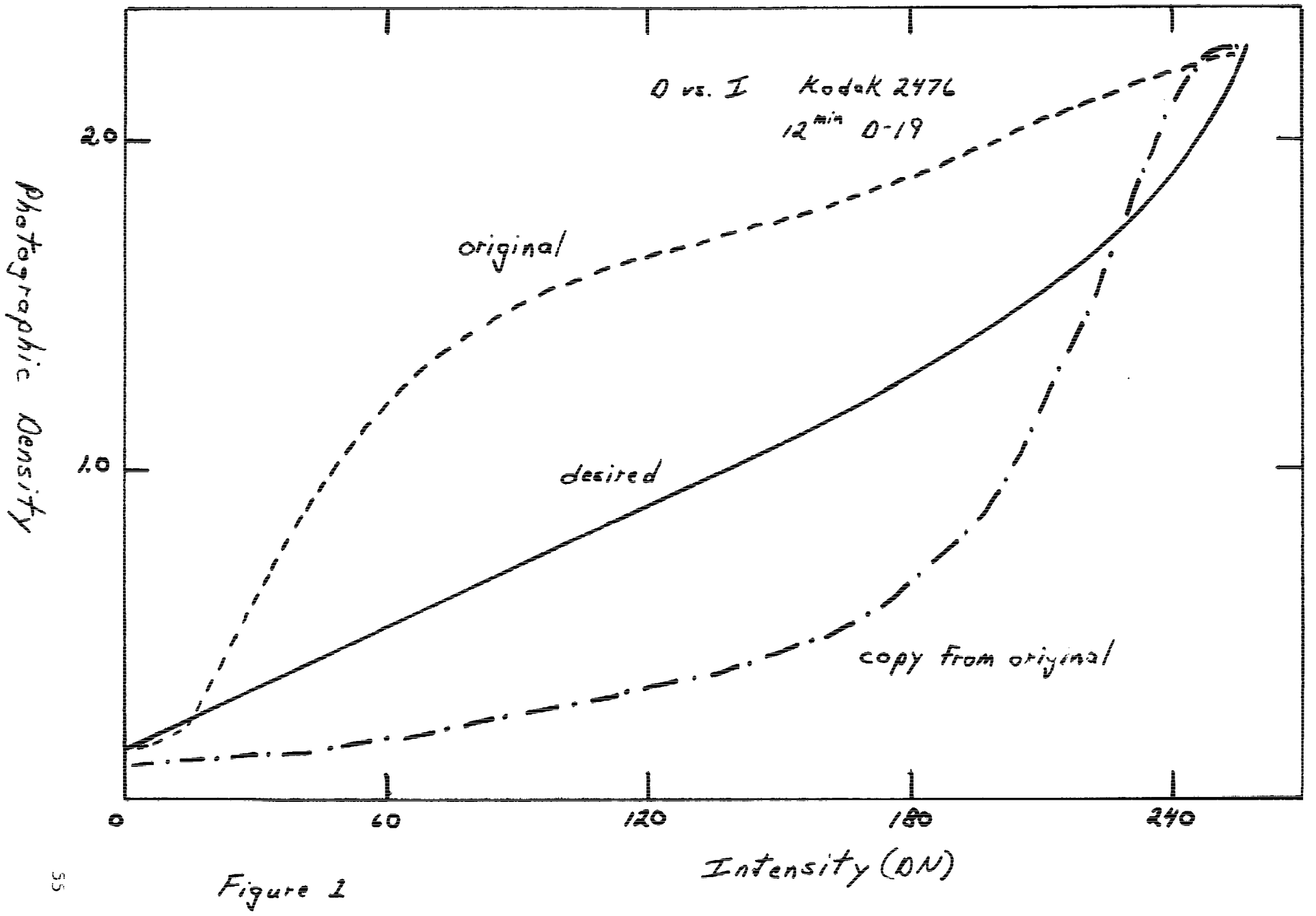
D vs. I Kodak 2476
12 min D-19
original
desired
copy from original
2.0
1.0
0
60
120
180
240
Photographic Density
Intensity (DN)

Figure 1