

NPIC/D-98/70

9 APR 1970

MEMORANDUM FOR: Assistant Deputy Director for Intelligence

SUBJECT : [] Proposal for Testing of Digital Signal-to-Noise
Optimization Techniques at a Cost of []

1. This memorandum requests approval for the commitment of funds for a contract. The specific request is stated in Paragraph 9.

2. The size and distribution of the silver particles that comprise a photographic image limit the fine detail that can be recorded on any photographic emulsion. Images examined under high magnification have a granular structure which gives rise to the term "graininess." When the examination is performed by an instrument which scans in a raster mode, like a TV, the grains cause random fluctuations in the output trace or image which are not related to the object originally recorded; i.e., they produce an error signal. The more grain, the greater the random signal fluctuations and the greater the loss in fine detail. The situation is analogous to the white noise or specks seen on a TV receiver with a poor antenna. Such a scanning operation is employed in microdensitometry and in digital image manipulation in order to transfer the image on the film into a useable input to the computer. In both cases the transfer must occur with minimum error; in one situation, the structure of the image is being investigated, while in the other, the input image is already degraded and an improved representation is being sought.

2. Currently, we attempt to minimize errors due to grain noise by a mathematical averaging of the data in the computer after scanning. Although some improvement is achieved, it is not adequate for NPIC operational applications. Better techniques are necessary and information theory says they are possible. Historically, new methods for noise reduction have required more data points (over-sampling) to achieve limited success, thereby increasing processing time and computer storage requirements. What is needed is a technique that will simultaneously reduce the effects of noise, decrease the number of data points required, and improve the system accuracy. Addressing this problem, the [] [] developed the [] Criterion, a mathematical computer algorithm named after the originator, []. The first photographic applications were to [] microdensitometer traces being transmitted from a West Coast to an East Coast computer for analysis. Typically, 135 data points were required per trace. Applying the [] Criterion to the trace

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data, only 25 data points were necessary, and the accuracy of the trace improved. Similar application of the [] Criterion to NPIC microdensitometer traces would improve the quantification of the parameters used in photo-optical image evaluation--the only advance of this magnitude developed in the last five years.

4. The project proposed is concerned with improving the accuracy of information extracted from photographic images during the scanning and digitizing operations employed in microdensitometry and digital image manipulation (DIM). Extending the [] Criterion concept to the [] DIM software would visibly improve the quality of the image manipulated and, at the same time, reduce by 50 to 60 percent the computer core storage required, with a corresponding reduction in computer processing time. An improvement in computer processing efficiency is especially important. One square inch of operational NPIC imagery digitized to only two gray levels contains enough data points to fill the core storage of over sixteen Univac 494 (32K core) computers.

5. This project is designed to be executed in four phases over four months. Preliminary experiments would apply the [] Criterion to one-dimensional data, such as edge traces of "CORN" resolution targets. Success in this application would lead to extension of the algorithm to the two-dimensional case suitable for use with the [] DIM software. Because the first DIM experiments on operational material will be conducted in NPIC during this period, operational tests of the [] Criterion would be integrated with that effort. Computer time required to compile and test the algorithm would be provided by [] Software will be written in Fortran IV suitable for use on the Scripps 360-44 computer. [] will train NPIC personnel in the detailed use of the algorithm. The [] Criterion would also be tested with DIM programs previously written by [] and preliminary, unclassified tests would be conducted to evaluate their potential to NPIC applications. [] will deliver a comprehensive technical final report detailing both practical aspects and the theoretical basis of the [] Criterion. In addition, a one-day tutorial session by [] will be given early in the project to impart essential expertise to NPIC personnel.

6. The theoretical foundation of the [] Criterion is sound, and the initial results are positive. The value of extending the technique to NPIC imagery cannot be estimated quantitatively, though the potential is very high. In addition, it can be applied to other community digital enhancement efforts as well as to color imagery, to electronic signals from MTF analyzers currently under development, and to the generation and fabrication of more accurate filters for optical image manipulation systems. The potential improvement is considered to be worth the low risk involved.

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25X1 The unsolicited proposal from [] offers a unique opportunity to improve the product of a variety of key projects.

25X1 7. The [] Criterion is an [] proprietary technique. Accordingly, no other proposals were considered. The funds required were programmed as part of the FY-70 R&D budget. The project has been closely coordinated to insure that it will not conflict with the [] DIM project or the routine use of the APSD microdensitometer. Informal contacts with AFSPPF, Westover AFB, ORD/DDS&T, TSD/SSP, NRTSC, and Wright-Patterson AFB have resulted in requests to be kept informed of the work since it applies to projects in their respective areas. The project has been designed to permit application to microdensitometry, color imagery, electronic signals, etc., by anyone knowledgeable in the field. A follow-on may prove desirable, but it would not necessarily be with the same contractor. 25X1

25X1 8. The sterility code [] is appropriate; the Project Officer will assign security classifications to the individual reports.

25X1 9. It is requested that the negotiation with the [] for a contract to conduct the program described at a cost not to exceed [] be approved. 25X1

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ARTHUR C. LUNDAHL
Director
National Photographic Interpretation Center

Attachments:

1. Proposal
2. Form 2420

APPROVED: 5

Assistant Deputy Director for Intelligence

17 Apr 70
Date

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