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3.8 REPORT OF THE SUBPANEL ON METHODS OF VERIFICATION*

The methods of verification subpanel met for two 4-hour sessions on November 18 and 19, 1981, to define research needs in this area for Earth resource observational systems. The panel consisted of:

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3.8.1 State of Knowledge

We refer to verification as a production oriented question because we are not really doing verification for the uses of research activities. We're trying to verify output data products from a production system for production oriented users. Included in that class of production oriented users is the production system itself, i.e., quality control of output. Verification is not a well defined problem. We're just beginning to focus on understanding what we're talking about. Therefore we recommend a program to improve the state of understanding and of the meaning of verification and the application of verification procedures to a variety of sensor systems.

3.8.2 Recommended Research

The topics of interest that were identified are very strongly interrelated. To show this we have developed a task flow in Figures 1, 2, and 3. Other than having done that, it was found that there is no real priority scheme that could be assigned, as this is an integrated activity designed to provide more understanding into what needs to be done in image rectification. Task one (Figure 1) is to develop verification procedures. Task two (Figure 2) involves an experimental hands-on data demonstration and evaluation of those procedures in a controlled test-bed experiment. For task one, the flow is as follows: you first need to identify what performance measures you're really concerned about. We've suggested a handful of starters such as the number of control points, residual correlation mapped across an image, and the distribution of errors within the image plane for individual and coincident sets of images. Using that information, it is possible to go directly to existing data and compile real and synthetic data sets that can address that problem. In parallel, one can review the current verification procedures that are used.

*Edited oral presentation.

This is not a trivial undertaking in spite of the fact that the current verification procedures are very casual and unsystematic. There are some activties going on in other fields, in mapping especially, that have orderly procedures that are not exactly remote sensing oriented procedures but can be training grounds for a subsequent task. From the existing procedures, identify and recommend the ones on hand that are usable in an operational system, develop additional techniques necessary with some synthetic data sets, and perform specific tests on individual package procedures to analyse the results. The end result then is a set of verfication procedures and software, or at least algorithms, that can be useable. The output of that then goes to task two, which is the verification experiment.

Task two is the end-to-end test experiment. The very first step in task two is to identify the test bed. There are several possible options and it's a matter of timing and some other subtle details that relate to exactly what procedures and requirements you want to develop. The output of the first part of task one delineates what verification you really want to do that will help to choose a test-bed. The obvious choices on-hand are Landsat MSS data or, in the near future, the Landsat-D data processing capabilities. The next step is to design the experiment to test verification procedures. This procedure in development and selection activity is from task one, as it is essentially task one that feeds into that knowledge of the sensor system itself, including error budgets, as a part of establishing the design. Then it's a matter of implementing the experiment. The output of doing software oriented measurements on standardized data sets allows one to perform some accuracy measurements. You want to pay very close attention to the feedback loop so that when you get part way there you start looking at the users on the other side of the information system that need to see the results to help better understand what they really wanted to have asked you for in verification. That finally leads you to moving one step beyond to the internal problem and you start deriving the error sources observed and finally report and assess the results of this experiment.

Tables I and II outline in summary form the required elements for each task described.

TABLE I

TASK 1

DEVELOP VERIFICATION PROCEDURES

1. IDENTIFY PERFORMANCE MEASURES

   - O DETERMINE CHARACTERISTICS OF GEOMETRIC DISTORTIONS
   - O ANALYZE DISTORTIONS RELATIVE TO USER PERFORMANCE NEEDS
   - O IDENTIFY REQUIRED VERIFICATION PARAMETERS AND THEIR EXPECTED VALUE RANGES
   - C OTHER

2. REVIEW CURRENT VERIFICATION APPROACHES

   - O REVIEW EVALUATION PROCEDURES CURRENTLY USED IN REMOTE SENSING COMMUNITY AND RELATED FIELDS (E.G., PROGRAMMETRY)

3. COMPILE SYNTHETIC AND REAL DATA SETS

   - O SYNTHETIC DATA SETS SIMULATING DIFFERENT KINDS AND RANGES OF DISTORTIONS
   - O REAL DATA SETS WITH KNOWN DISTORTION CHARACTERISTICS

4. IDENTIFY RECOMMENDED VERIFICATION TECHNIQUES

   - O ANALYZE DERIVED VERIFICATION REQUIREMENTS VS CURRENT APPROACHES
   - O IDENTIFY VERIFICATION APPROACHES

TABLE I (CONTINUED)

5. DEVELOP ADDITIONAL TECHNIQUES

   O MSS, TM, MLA, MICROWAVE, STEREO, ETC.

6. UNIT-TEST TECHNIQUES

TABLE II

IMAGE VERIFICATION END-TO-END TEST

SELECT REMOTE SENSING SYSTEM(S) AS TEST-BED

DESIGN EXPERIMENT

- O SELECT IDENTIFIED PROCEDURES (TASK 1)
- O ESTABLISH SUCCESS CRITERIA

IMPLEMENTATION

- O MEASURE ACHIEVED ACCURACIES OF PRODUCTS
    - SYSTEMATIC ERRORS
    - RANDOM ERRORS
    - COMPUTATIONAL SYSTEM IMPRECISIONS
- O DERIVE ERROR SOURCE ESTIMATES
    - SPACE SEGMENT (S/C/, INSTRUMENT)
    - GROUND SEGMENT
- O RECOMMEND PROCESS CHANGES TO IMPROVE PRODUCT QUALITY

EVALUATION

- O USER CHECK OF ACCURACY REPORT
- O SENSOR SYSTEM DEVELOPER OPINION OF RECOMMENDED CHANGES

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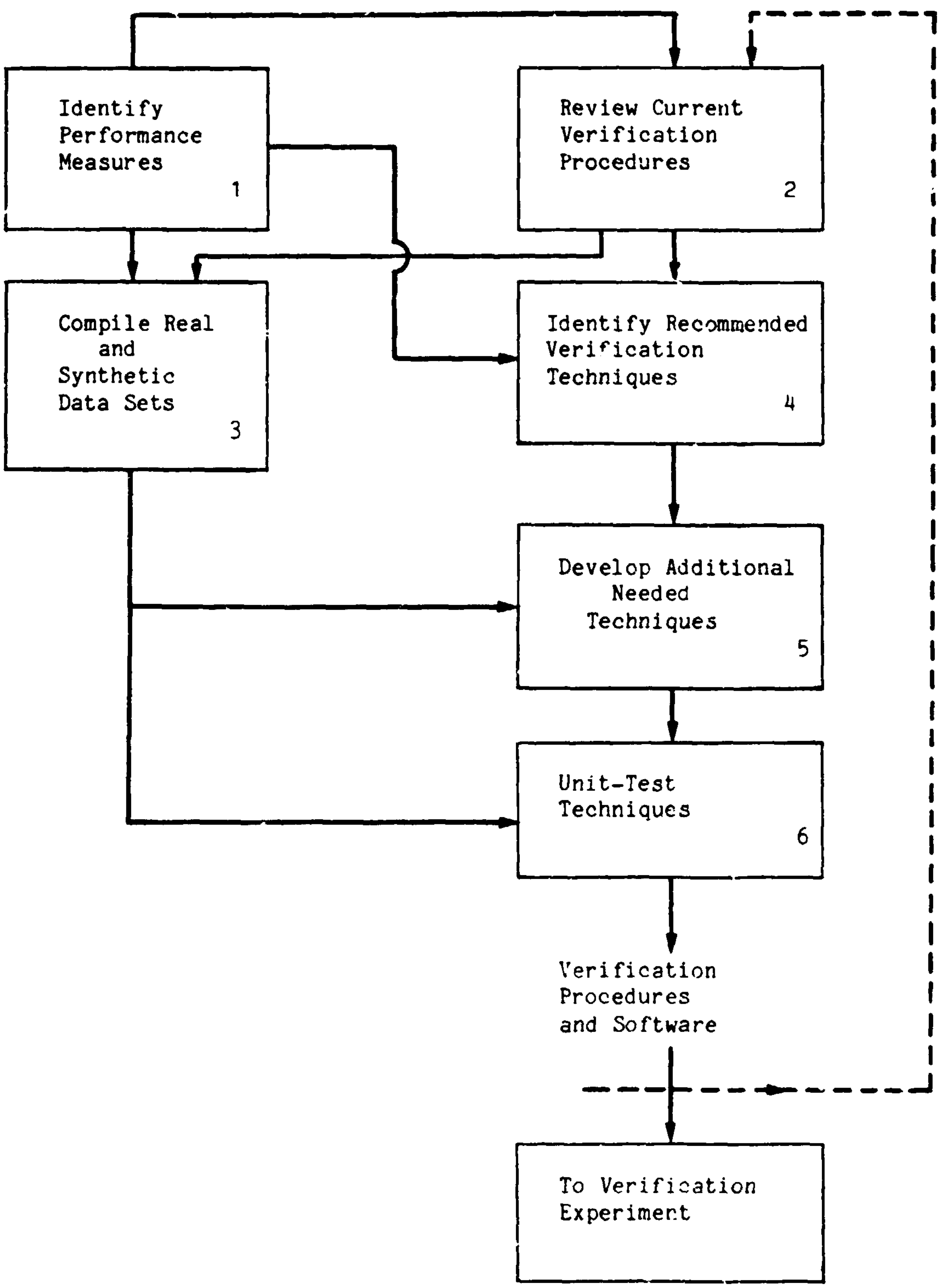

FIGURE 1. TASK ONE: ACTIVITY FLOW

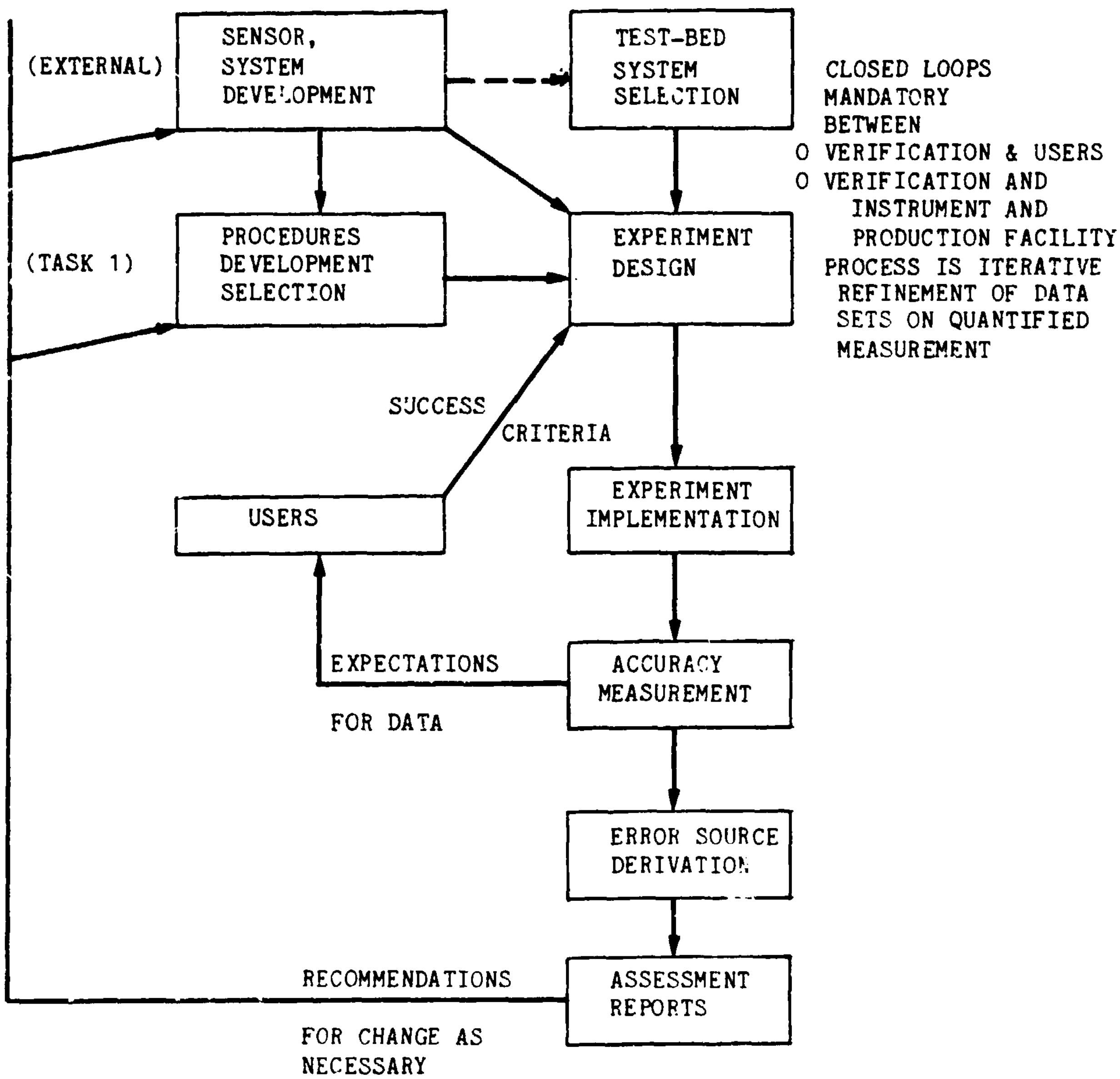

FIGURE 2. IMAGE VERIFICATION END-TO-END TESTING

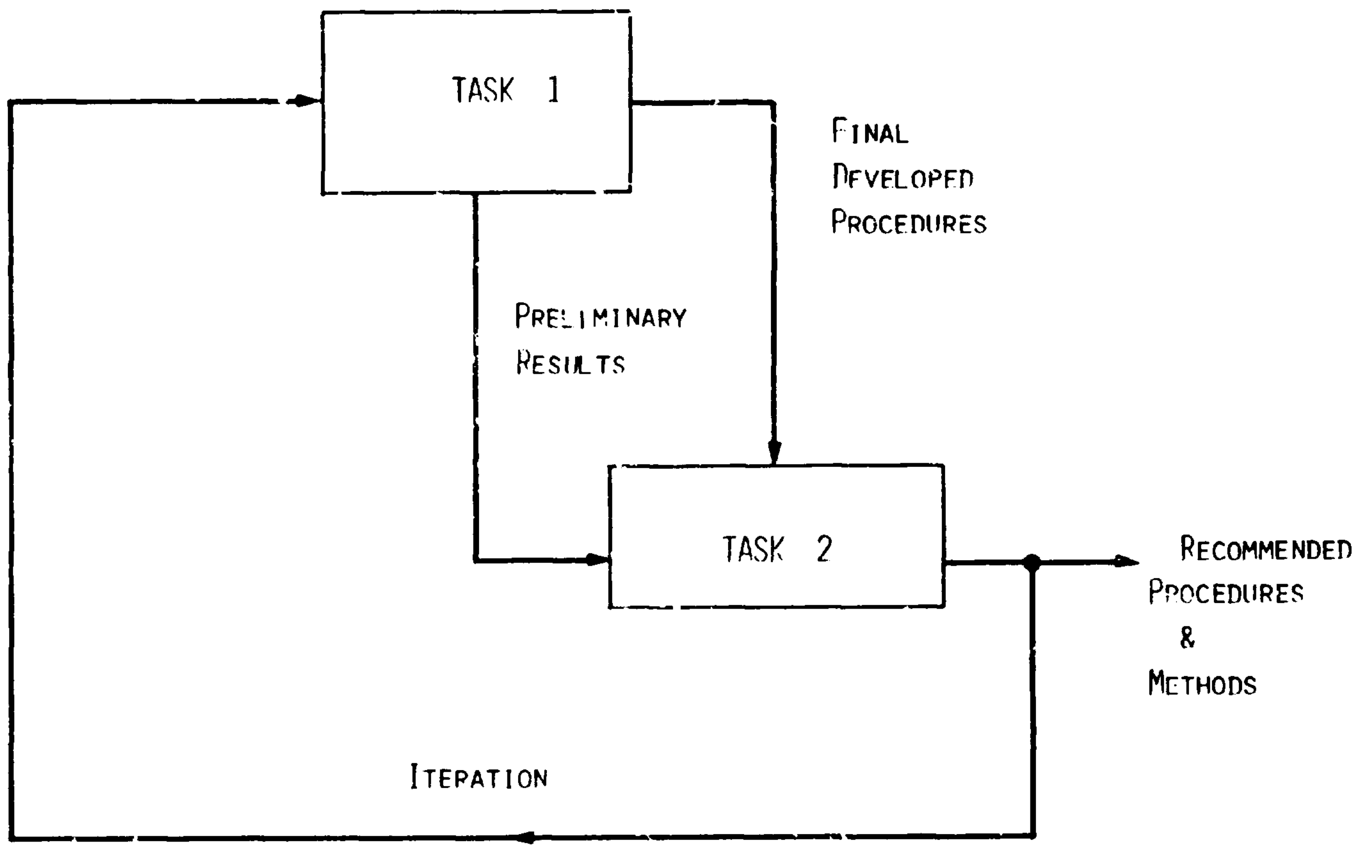

FIGURE 3. PROGRAM TASK FLOW

4.0 PRESENTATIONS ON USER NEEDS

4.1 INTRODUCTION

It was the purpose of the User Needs presentations to discuss the implications of satellite image positional accuracy capabilities upon their discipline's use of the data. Discipline experts discussed the manner in which data are incorporated into their inventory, decision, or analysis models and operations. For each discipline area, monitoring and data base integration strategies were discussed; in particular, implications for registration and rectification requirements. In addition, the discussants pointed out the potential benefit that might accrue from improved registration/rectification accuracy. Where applicable, the discipline experts discussed their desire to implement multitemporal, multistage, and multisensor data sources for addressing a problem, as these imply constraints on registration and rectification accuracies. Users also described the experimental design (e.g., sample segments or full-image area coverage) used to analyze a problem.