A Remote Sensing System for a Nationwide Data-Bank

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A REMOTE SENSING SYSTEM FOR A
NATIONWIDE DATA-BANK

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H. Dell Foster Co.

I. INTRODUCTION

Our present-day society is rapidly changing and these changes are directly impacting the map-
making industry. Present-day maps become obsolete
as soon as they are completed because of popula-
tion increases, agricultural trends, energy pro-
duction, and general land use changes which alter
the appearance of the land.

It is clear that maps of today will, in a not
too distant future, have only historical and picto-
torial value just like the medieval maps of the
16th and 17th centuries.

In the present-day design of resource devel-
opment schemes, the essential problem for each
country is the skillful management and utiliza-
tion of all available assets--human and material--
to provide the basis for a continuous economic
expansion.

This implies the urgent need for an ongoing
search in a well coordinated effort by government
and private enterprise, for the creation of sound
and reliable projects.

The solving of these complex problems can only
be optimized when sufficient reliable, and up-
to-date information on resources is available and
accessible to decision makers.

In many countries, data is available only at
random or hidden in heterogenous form. The fast-
est way to create access to resource data is to
make use of the fact that most of it fits in a
geographic framework with an absolute coordinate
system for information retrieval of geology and
mining, land-use patterns, urban development, com-
munication systems, civil engineering, etc. This
paper describes the overall Remote Sensing System
which provides the general framework to accomplish
this task.

The Keuffel and Esser Company has recognized
this continuing and growing need. The acquisition
of the H. Dell Foster Company in 1975 provided a
means to sponsor the development of a complete
concept in modern data-base mapping and map compi-
lation. This subsidiary has developed a complete
systems strategy and nearly all elements of the
system are commercially available.

The KAE/H. DELL FOSTER COMPANY's Remote Sens-
ing System is an integrated set of instruments
which utilize mini-computers and opto-mechanical
techniques to process remotely sensed data. The
system is composed of eight instruments.

1. The instruments use aerial photography as
their primary input and produce a digital
data file on magnetic tape (or other ma-
chine readable source) which compiles the
information in an assembly line type se-
quential work flow.

2. The data files consist of a series of X-
Y-Z real world coordinates with coding
separating them into descriptive primary
levels and line type identification. The
primary coordinates serve as the primary
identifiers to attach thematic or descrip-
tive data for information retrieval from
the data base through an information man-
agement system resident at the users mas-
ter computer center.

The cartographer or map makers task has now
expanded to furnishing the absolute structure and
identifiers for a random access geographic data
base.

II. GENERAL INFORMATION AND
WORK FLOW OF THE SYSTEM

1. SYSTEMS INPUT

Figure 1 represents the functional relation-
ships of the various components of the RSS system.
Input information can be categorized as:

A. Aerial Photography
B. Field Control Identification
C. Existing Graphic Information
D. Thematic Information
E. Source Input Data
   1) Airborne Sensors
   2) Ground Sensors
   3) Survey and Geodetic Data
   4) Field Notes and Samples
   5) Source Files and Records
   6) Computer Files

These inputs are used in the following man-
ner:

A and B. Aerial Photography and Field Control
Identification. The RSS system facili-
tates the production of the basic graphic
manuscript by using the RSS-500 and

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The Analytic Data Processor is used for the aero-triangulation program to produce a base control manuscript or a listing for use by the RSS-300 Numerical Stereo Compiler.

C. Existing Graphical Information. Existing graphical information is converted into computer processable form by the RSS-400 digitizing table. This information can be coordinate keyed and has the capability to be alpha-numeric in nature.

D. Thematic Information. Alpha-numeric information associated with coordinates may be plotted or entered at the keyboard and then used by the RSS-900 Numerical Orthophotoscope to produce a photograph which has aircraft tip and tilt as well as relief distortions removed. These orthophotos are used as input by the RSS-400 Graphic Input stations.

The RSS-700 Automatic Digital Drafting machine is a vector plotter which can produce line drawings of the traditional type. The input for the RSS-700 is obtained from the Analytic Data Processor. The Analytic Data Processor has a Cathode Ray Tube capable of graphics as well as alpha-numeric. All graphical data input to the system (from the RSS-400, RSS-300, RSS-600 and thematic data entered at the keyboard) are edited and confirmed by the Analytic Data Processor and its related software. After confirmation, data may be plotted or committed to magnetic tape for data banking.

The output of the system is two files:

A. Graphic Manuscript File is composed of:
   1) Graphic maps of any level.
   2) Registered color separations.
   3) Computer compiled contoured maps.
   4) Planimetric rectified pictomaps or mosaics.
   5) Cross-section and plan profile sheets.
   6) Oblique and perspective visualization.

B. Digital Data Bank File is composed of:
   1) Easting relief profiles.
   2) Geodetic and Survey Control.

2. SYSTEMS OUTPUT

The field and computed control output from the Analytic Data Processor is used by the RSS-300 Numerical Stereo Processor to produce earth profiles (X, Y, Z coordinates in UTM or State Plane). These profiles serve as a digital terrain model which is structured, extendable and maintainable. The profiles are recorded on magnetic tape and then used by the RSS-900 Numerical Orthophotoscope to produce a photograph which has aircraft tip and tilt as well as relief distortions removed. These orthophotos are used as input by the RSS-400 Graphic Input stations.

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Figure 2 is a representation of some of the possible levels of data banks.

III. RSS SYSTEM APPLICATION

1. GENERAL CONSIDERATION

The H. Dell Foster Co. RSS system can accomplish the data acquisition, reduction, edit and storage for a national geographic data bank. A basic mapping unit of 75,000 square kilometers is assumed to develop the data-bank for a country of 750,000 square kilometers. A photography scale of 1:75000, acquired by a standard wide angle camera, is used for both aerial triangulation and geographic data base compilation. Equations (1) through (5) indicate the analysis criterion.

\[ P_w = P_p \cdot P_s \cdot (1-P_l) \text{ km.} \]  
\[ P_l = P_p \cdot P_s \cdot (1-P_l) \text{ km.} \]  
\[ A = P_w \cdot P_l \text{ sq. km.} \]

where

\[ P_w = \text{Net photogrammetric model lateral dimension in KM}. \]
\[ P_l = \text{Net photogrammetric model longitudinal dimension in KM}. \]
\[ P_p = \text{Photograph dimension in meters}. \]
\[ P_s = \text{Photographic scale divided by } 10^3. \]
\[ A = \text{Area of photogrammetric model in KM}^2. \]

\[ N_u = \frac{G}{A} \]  
\[ N_u = \text{Total the number of photographs required uncorrected.} \]
\[ G = \text{Ground area to be mapped.} \]
\[ A = \text{Area of photogrammetric model in } \text{KM}^2. \]
\[ N_c = \frac{N_u}{.85} \]  
\[ N_c = \text{Number of photographs required corrected for navigational errors, weather problems and etc.} \]
Using the previously mentioned photographic scale of 1:75000 and 70,000 square kilometers as a basic mapping unit, Equations (1) through (5) produce the following results:

\[ N_c = 925 \text{ photographs} \]

2. PRODUCTION USING THE RSS SYSTEM

A. Analytic Compiler Operation.

1) Aerial Triangulation.
   It is estimated that the RSS-300 II can produce 25 photogrammetric models per day, hence 925 models will require 37 days.

2) Digital Terrain Models.
   It is estimated that the production rate for the RSS-300 II for producing digital terrain models is 5 per day. Hence, 925 models will require 185 days.

B. Orthophoto Production. The RSS-900 Numerical Orthophotoscope will produce 14 models per day, therefore, 925 models will require 66 days.

C. Digitizing Orthophotos.

1) Urban Areas. It is projected that an average of 10% of a country will be used in the conventional stereoplotter manner for this function. The 7000 square kilometers will require 70 days.

2) The RSS-400. Graphic input terminal can be used to digitize at the 1:25000 scale of the orthophoto enlargements. The remaining 63,000 sq. km. requiring 735 working days.

3. THE PROJECTION OF THE TIME REQUIREMENTS FOR 3)B 1 to 3 INTO EQUIPMENT RESULTS IN THE FOLLOWING FOR A 5 YEAR PROJECT IN A 750,000 SQUARE KILOMETER COUNTRY.

A. Three (3) RSS-300 II Numerical Stereo Compiler.

B. One (1) RSS-900 Numerical Orthophotoscope.

C. Three (3) Graphic Edit Stations consisting of:
   3 RSS-400 Digitizers
   1 Analytic Data Processor
   1 RSS-700 Automatic Digital Plotter

IV. CONCLUSION

The K&E/H. Dell Foster RSS National Data Banking system provides all the system components to acquire, edit, update, and produce a source data bank for a country. These instruments have compa-
The RSS System components required to develop a nation-wide data-bank will be described in this section.

**RSS-300 NUMERICAL STEREO COMPILER**

1. **OPTICAL**
   
   High Resolution Optics, 150 L.P.M. at 45X; Image Viewing Area at 10X magnification is 0.7 in (18mm) Dia;
   
   High/Low Stereo Bridging capability through independent zoom optics;
   
   Base-in, Base-out, and full capability to view either stage through each eyepiece.

2. **OPERATOR FEATURES**
   
   Observation area of 10" x 10" (25.4 cm x 25.4 cm) photo size;
   
   Computer generated setup for interior; relative and absolute orientation.

3. **ELECTRONICS**
   
   Automatic scanning and positioning with variable speed at any azimuth for digital terrain data acquisition;
   
   Digital recording in any coordinate system;
   
   Correction for camera distortion, earth curvature, comparator calibration;
   
   One micrometer resolution.

**RSS-400 MULTIPLE GRAPHIC INPUT TERMINALS**

1. **INPUT**
   
   Five volts quadrature square wave;
   
   X and Y displays of six digits;
   
   60 inch per second slew rate;
   
   Real-time scaling for X and Y from 0.0000 to 9.9999.

2. **OUTPUT**
   
   RSS-232, ASCII, 11-9600 BAUD or current loop;
   
   Optional card punch, paper tape and magnetic tape interfaces.

**RSS-700 AUTOMATIC DIGITAL DRAFTING**

1. **INPUT**
   
   RS-232-C, ASCII, 110-9600 BAUD;
   
   Speed 35 inches/second max.; Resolution, .001";
   
   Precision, .006" RMS;
   
   Repeatability, ±.063".

2. **OUTPUT**
   
   Three position, universal drafting head will accept ballpoint and wet ink. Head may be placed on either side of drafting arm. Vacuum hold-down available.

**RSS-900 NUMERICAL ORTHOPHOTOSCOPE**

1. **DATA INPUT**
   
   Original aerial negative, 9" x 9", format; any focal length;
   
   Seven or nine channel magnetic tape—Aerial film or plates.

2. **DATA OUTPUT**
   
   3.0X Negative size to 6.0X size;
   
   46 x 46 inch easel exposure scan range with vacuum hold-down;
   
   Variable exposure scan direction at any azimuth;
   
   Mini-computer real-time control.

**ANALYTIC DATA PROCESSOR**

32K, 16 bit, Data General 3/12 computer;

10 megabyte disk;

Tektronix 4014 CRT;

Nine track, 800/1600 BPI magnetic tape;

Four line asynchronous multiplexer.
MULTI-LAYER MAPPING SYSTEM

LAND USE/ZONING
UTILITY DISTRIBUTION
DRAINAGE/HYDROLOGY
HOUSING
STREETS, ROADS, HIGHWAYS, PLANIMETRIC
PROPERTY BOUNDARIES
GEOLGIC HAZARDS & SOIL TYPES
AIR QUALITY
NOISE CONTOURS
VEGETATION/WILDLIFE
UNIQUE FEATURES (HISTORICAL, ARCHEOL.)
CENSUS TRACTS AND POLITICAL BOUNDARIES
TRAFFIC CIRCULATION
SOCIO-ECONOMIC FEATURES (LAND VALUES, INCOME, RACIAL, EMPLOYMENT, HOUSING, ETC.)
LEGAL DATA (ASSESSOR FILES, CODE CONSTRAINTS, ETC.)
RELIEF PROFILES TOPOGRAPHY

Figure 2