

QUICK RESPONSE DATA BASES FOR SIMULATORS

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ABSTRACT

The objective of the Rapidly Reconfigurable Data Base (RRDB) project is to develop a system which will produce data bases of terrain, geographic features, and object models which can be directly applied for immediate use with a variety of simulators and mission planning tools. The project emphasis is to produce these data bases rapidly enough that they can be used in a quick reaction mode, i.e., they can be turned around in from one to seven days. As envisioned, the RRDB "system" will consist of a dedicated government owned facility with the necessary hardware/software capability to meet the military's requirement for production of simulator/mission planning tool data bases to support quick reaction mission planning/training. The RRDB facility will produce these data bases according to the format specified by Air Force Project 2851, the Standard Simulator Data Base (SSDB). This paper explores the RRDB system concept and demonstrates its function through the use of a hypothetical hostage crisis situation.

INTRODUCTION

The Rapidly Reconfigurable Data Base (RRDB) project, Naval Training Systems Center (NTSC) Task No. 7714, is sponsored by the U.S. Army Project Manager for Training Devices (PM TRADE). The approach is to make use of multiple data sources combined to form an intermediate (geographic) data base. This data base will then be transformed into the simulator specific data base. Figure 1 depicts the RRDB concept overview.

SYSTEM DESCRIPTION

The RRDB system will consist of off-the-shelf hardware as well as off-the-shelf production software for most needs. Only the integration processing will require new software development. The system will be designed to minimize the data base throughput production time. Therefore the emphasis will be in assembling a hardware/software approach that makes use of the most modern geographic data base production technology

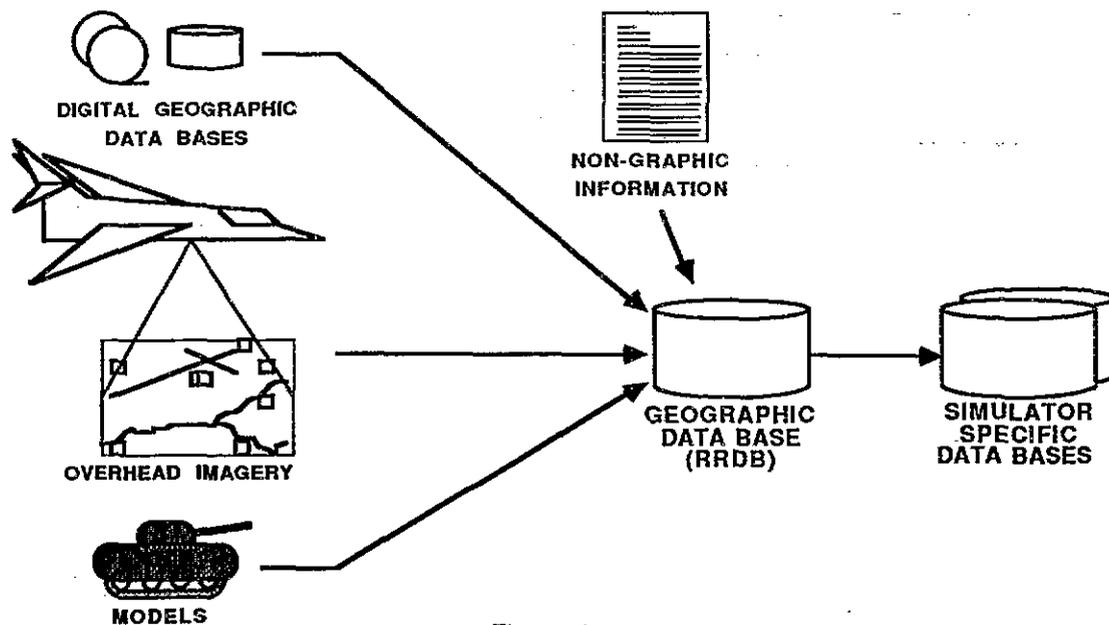


Figure 1.
RAPIDLY RECONFIGURABLE DATA BASE OVERVIEW

available. Throughput speed for the total process and, therefore, the throughput speed of each production component is crucial.

RRDB will be an integrated system of data processing devices, digital input/output devices, and sophisticated analog and digital geographic data analysis/processing tools. As a minimum, the RRDB system will contain the following components (See Figure 2):

- Stereoplotters (with superimposition)
- Digital Image Workstations
- Master Scanners
- Modeling Workstations
- Vector Digitizer
- Electrostatic Plotter
- High Resolution Vector Plotter
- General Purpose Minicomputer(s)
- Peripherals

The following section contains a summary description of each of these devices.

Device Descriptions

Analytical Stereoplotter With Superimposition. An analytical stereoplotter is a device which allows for semi-automatic, three-dimensional, feature extraction from stereo pairs of photographs for inclusion in a digital data base. Superimposition is the capability to superimpose a calligraphic representation of all or part of the data base corresponding to the 3-D area under observation. The analytical stereoplotter(s) will be used primarily to extract planimetric features from high-resolution imagery and to identify those features to the RRDB.

Digital Image Workstation. The digital image workstation is a computer workstation used in the generation or editing of digital data bases. The digital image workstation(s) will be used to construct geographic data bases by combining elevation and feature data (including models) with digital imagery. They will also provide a data base editing function for quality control.

Raster Scanner. The raster scanner is a device which converts an analog image (i.e., photograph, map, plot) into a digital raster image. The raster scanner(s) will be used to scan photographs, maps, charts, and other documents to provide digital imagery for the digital image workstations.

Modeling Workstation. The modeling workstation is a Computer Aided Design (CAD) system which will allow an operator to interactively construct a (CAD) system which will allow an operator to interactively construct a three-dimensional model, or to interactively modify an existing model. Another function of the modeling workstation is feature extraction from hard copy documents.

Vector Digitizer. The vector digitizer is a device which will allow an operator to convert selective information from a graphic document into digital information. It will serve as an interface device for the modeling workstation.

Vector Plotter. The vector plotter is a graphic output device which will generate hard copy of digital graphic data by moving a stylus on a hard copy surface.

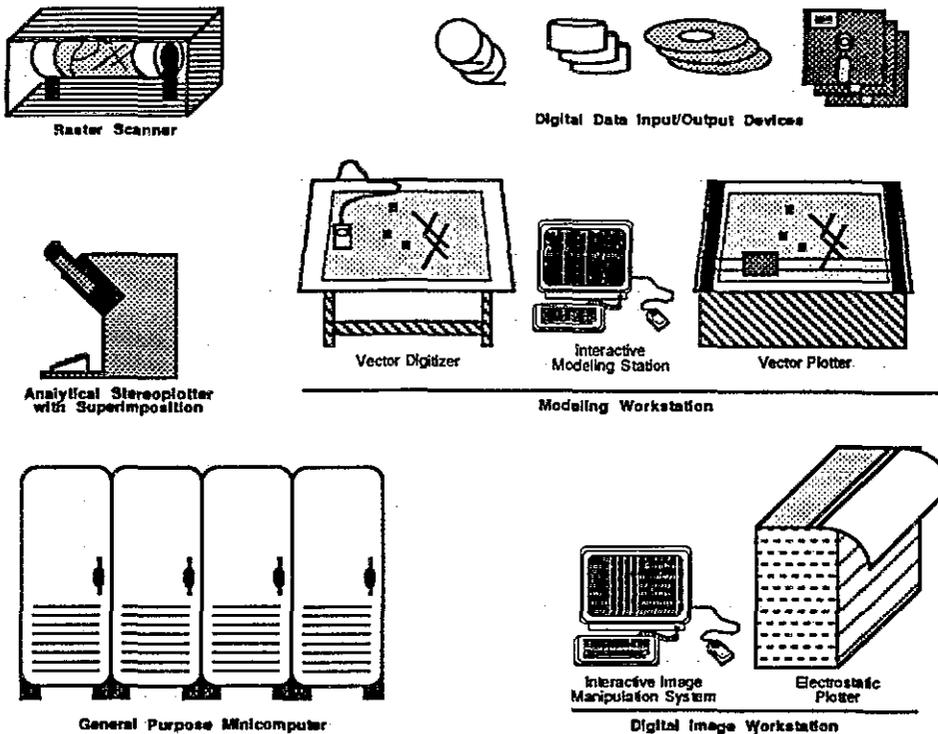


Figure 2.
SYSTEM COMPONENTS

Electrostatic Plotter. The electrostatic plotter is a graphic output device which will generate hard copy of digital graphic data by generating a matrix of dots representing a raster image.

General Purpose Minicomputer. The task of the general purpose minicomputer is two-fold. First, the minicomputer will be used to process the geographic data generated by the stereoplotter and/or digital image workstation. The output to be generated will be a data base which conforms to the format established for the SSDB. The second task is to convert the SSDB into the format used in a specific application (simulator or mission planning tool) data base.

Peripherals. The peripherals support the RRDB system by giving it multi-medium I/O capability.

Software Description

The RRDB system will include both "off-the-shelf" and custom software. Off-the-shelf software will consist of the operating system software of the general purpose minicomputer and the standard system software supplied with each of the various data base production devices. There will also be a need to develop custom software to meet RRDB system needs which cannot be satisfied by standard off-the-shelf products.

An Example Operational Scenario

The following narrative is a fictional representative operational scenario for the RRDB system. This example will be used to demonstrate how the RRDB facility will function in response to a quick reaction tactical situation.

It describes in detail how the RRDB facility components will be used during data production, transformation, and dissemination.

The Scenario. On 1 June, extremists in Abdullah kidnap the U.S. Embassy staff and take them to an undisclosed location. Intelligence sources discover the location on 2 June, and, on 3 June, the U.S. Air Force obtains some limited (cloud cover) photo reconnaissance. Also on 3 June, the U.S. Army is told to mobilize its Quick Reaction Force for transportation to a staging area on 8 June, and to prepare an operations order. The mission is to capture the terrorists and to recover the hostages.

On 4 June, intelligence sources report that the hostages were moved very suddenly to a building known to be about 300 feet south of the original building. About an hour after the move, an explosion reduces the original building to rubble. It is not known who or what caused the explosion.

Data Base Requirements. On 4 June, the Army tasks the RRDB facility to produce data bases for the UH-60 Blackhawk simulator, the AH-64 Apache Combat Mission simulator and for the C-130 SOF, to meet the following requirements,

a. The simulator data base must be delivered to the simulator sites by 6 June (48 hours) so that mission rehearsal/training can begin.

b. The data base must consist of 4 - 3kmx3km navigation points and a 1km square target area, all to a ten meter resolution. Also required is a 25 km square target acquisition area equivalent to Defense Mapping Agency (DMA) Level I data augmented to include vertical obstructions, lines of communications, and significant (visual and sensor) reference points.

c. The remainder of the data base (the background database) will be DMA Level I (30 meter resolution).

Source Data. The following source data is assumed to have been provided by the Army, DMA, and Intelligence sources to the RRDB site.

a. Ten aerial photographs (2 stereo pairs) of the Abdullah area of interest taken at 15000 feet on 2 June.

b. Current land based target intelligence reports which indicate that the building where the hostages were being held was destroyed by an explosion. The hostages had been moved prior to this and were safe in another building across the street. There is a large tent or canvas draped across the south side of this building.

c. DMA Level I Digital Terrain Elevation Data (DTED) and Digital Feature Analysis Data (DFAD).

d. Commercial satellite imagery (10 meter resolution).

e. DMA 1:50000 topographic map.

Production Procedures. Figure 3. depicts the general "flow" of the RRDB production process. From left to right, the analysis of multi-source data, its integration into the data base, and its transformation into a variety of simulator data bases is shown. The remainder of this section provides a step-by-step detailed explanation of the process.

Step 1 - Load the existing digital geographic data. This involves the reading of the DMA DTED and DFAD 9 track tapes, sorting the data to acquire the appropriate areas of coverage, and building a local data file using the format created for the SSDB.

Step 2 - Perform feature extraction from stereo photographs. Mount and register the appropriate aerial photographs onto the analytical stereoplotter. Download the digital geographic data into the stereoplotter for superimposition. Perform feature extraction where appropriate. Reload the data base into the SSDB. Note that, in this example, cloud cover restricted the view of one of the areas of interest to a single photograph, making stereo observation impossible for that area, while some other areas of interest were completely obscured. Download the new data into the minicomputer for inclusion in the Standard Simulator Data Base (SSDB).

Step 3 - Exploit the digital image data. Load the data from the digital image tape (in this case an image tape from the LANDSAT VII satellite) into the digital image workstation, then load the SSDB

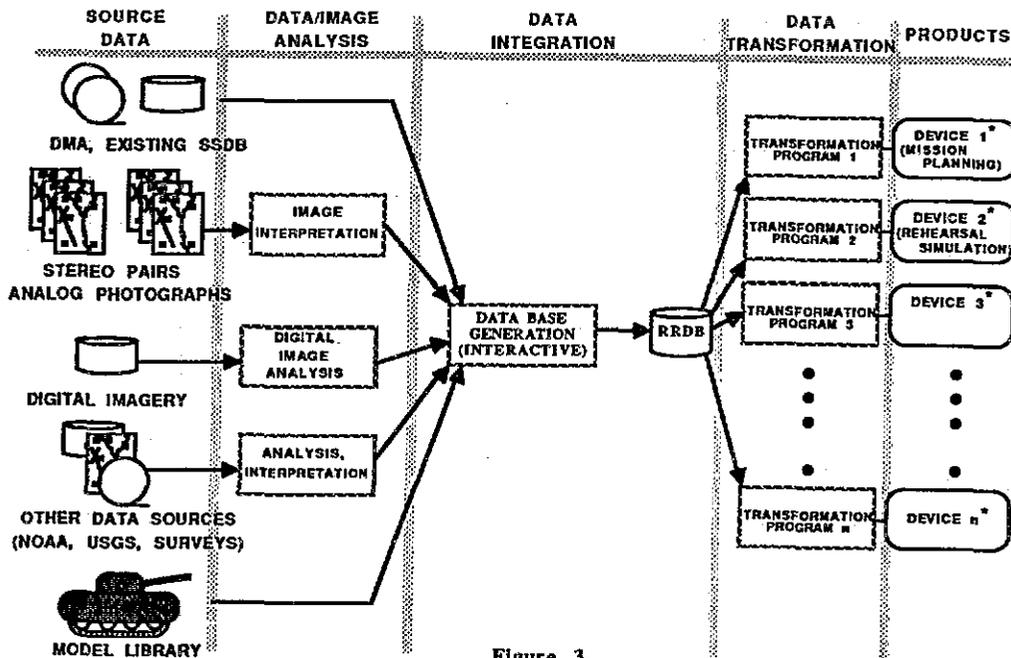


Figure 3.
RRDB PRODUCTION PROCESS

data and overlay it onto the image. Perform whatever feature extraction is still required to fill in the gaps left by the cloud cover in the aerial photos. Use the digital image to generally check the accuracy of the features on the DMA map, especially if the map is not current.

Since the workstation is necessary for Step 4, there is no need to download to the SSDB format at this time.

Step 4 - Perform 3-D feature extraction from a single photograph. Using the raster scanner, digitize the single photograph of the area of interest which has no stereo counterpart photo. Download the image onto the digital image workstation, along with the existing geographic data. Add height descriptions to all significant features which are not already so defined.

Step 5 - Add the non-graphic intelligence data. Although either the digital image workstation or the geographic modeling workstation can be used to edit the data base, the digital image workstation is used because it is already set up and registered from work performed under the previous step. Add and delete targets from the data base as dictated by current intelligence. Delete the building that has been destroyed. Add the tent to the outside of the building where the hostages are being held. Other intelligence to be added includes the annotation of the airport hangar with five MIGs reported under cover. A Soviet air search radar vehicle is deemed a principle target and its location is added to the data base, as is one of the new Surface to Air Missile (SAM) sites. Expected processing time is a function of whether or not the models for these features and targets already exist in the customer's model library. For this example it is assumed that the air search radar vehicle and SAM site descriptors already exist, but that the MIGs do not. Download the data

base into the minicomputer for inclusion in the SSDB.

Step 6 - Build a model of a MIG. Using the geographic modeling workstation, construct a three-dimensional model of a MIG. This will not be fancy, with see-through cockpits, etc., but rather will be a simple description of edges in 3-space depicting the appearance of a MIG. Non-graphic descriptors (movement restrictions, capabilities, heat retention, IR signatures, etc.) can be added if available. Download the data base into the minicomputer for inclusion in the SSDB.

Step 7 - Transform the data to application data bases. Using SSDB output, execute a transformation program to convert the data base to the format required to run in the targeted simulator(s) (Apache, Blackhawk, and C-130 SOP).

Step 8 - Distribute the RRDB/SSDB data. Distribute the simulator data base on 9 track tape, or other appropriate medium, to the training site(s). Distribution will occur using whatever channels were arranged when the using organization first became a customer of the RRDB Program.

CONCLUSIONS

The data base production, as just described, is based on the use of existing, proven, off-the-shelf technology. Current capabilities are sufficient to supply much of the demand for quick response data bases. All that remains is to integrate the existing equipment, and the dream of providing military personnel with the capability to do true quick response mission rehearsal will become a reality.

REFERENCE

(1) Magee, Ronald L. and Thomas W. Verscharen, "The Rapidly Reconfigurable Data Base (RRDB) Progress Report (Technical Requirements), Naval Training Systems Center, Orlando, FL., May, 1987.

ABOUT THE AUTHORS

Mr. Verscharen is a Computer Scientist for the Naval Training Systems Center where he serves as Principle Investigator on the RRDB project. He holds an MS degree in Industrial Engineering and Operations Research from Penn State and is currently working towards his PHD in Industrial Engineering at the University of Central Florida. Tom has eight years experience serving in engineering/technical positions in both government and industry, including the last five in training systems development R&D.

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Mr. Green is an Electronics Engineer for the U.S. Army Project Manager for Training Devices where he serves as RRDB Program Manager. Ray has served in various technical and management positions in both industry and government over the past twenty years. His most recent work is in the area of data base R&D for training systems.