APGD IFD
Monthly Report #2

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SRI Contract #1515
DARPA Contract #NMA202-97-C1004

July 15, 1997

The following tasks from our Statement of Work summarize the work being carried out by SRI International and its subcontractors GDE Systems and Vexcel Corp. on the DARPA Automatic Population of Geospatial Databases Integrated Feasibility Demonstration contract.[1]

A description of our activities in the latest reporting period in support of each task follows the task description. Because of the late start of the program all scheduled reports and deliverables will be delayed three months from the schedule in our proposal.

This report is also available through the URL `http://www.ai.sri.com/~apgd/reports/`.

[1]The information from the monthly reports from GDE and Vexcel has been integrated into this report. The full text of the the GDE and Vexcel reports are included as appendices for reference purposes.

1 Technology Development

1.1 Refine the BOS architecture

Review the current BOS architecture, enhance it, and distribute a description of it to the APGD community.

Our current view is that the architecture as described in the proposal requires no high-level change. As we continue to instantiate the lower-level components, we will verify that the communication paths and functional requirements are satisfied with the architecture as it currently exists. Our plan is to develop an end-to-end example (raw data to visualization) for linear delineation and use it as an additional check on the suitability of the architecture.

1.2 Develop CBACS

Extend and enhance existing RADIUS HUB architecture to meet the requirements of the CBACS to serve as the control structure for invoking feature extracting algorithms.

The first step in this task is to develop the updated rule-packet specification language and verify that it is sufficient to express the information needed to control the feature extraction algorithms. The purpose of the rule packets is to allow the algorithm designer to describe his knowledge of the performance of a particular algorithm under different parameter sets as they relate to different contexts relevant to our application domain (e.g., urban vs. rural sites, high vs. low resolution imagery). Current activity involves analyzing the results from on-going experiments with the baseline algorithms for linear delineation, building extraction, and material attribution to establish the explicit representation for the rule packets.

1.3 Develop feature extraction managers

Design and develop feature extraction managers for terrain, linear, area, compact 3-D features, and dynamic objects.

The feature extraction manager encapsulates the semantics of the corresponding feature extraction task: the entities to be extracted (e.g., roads, rivers in the case of

linear features), the model parameters, extraction requirements, and so forth. We are currently developing the skeleton for this component, which will be demonstrated at the upcoming IPR.

1.4 Survey automated model extraction techniques

Identify potential algorithms for improving the performance of planned or installed BOS testbed capabilities and extending the operating domain of existing algorithms.

Surveys are almost complete for linear delineation, building extraction, and material classification. The initial compilation will be made available on the APGD Virtual Lab web page sometime in August.

1.5 Develop feature extraction and consistency enforcement algorithms

Adapt, integrate, and enhance IU algorithms for extracting terrain, linear features, area features, 3-D compact objects, and dynamic objects. Develop new techniques that capitalize on the complementary aspects of radar data and E-O and multi-spectral data. Adapt the Model-Based Optimization (MBO), deformable mesh, and consistency enforcement technology to work with extracted features and their attributes.

The baseline selections for linear delineation and building extraction have been made. The main considerations were performance and availability. Evaluation experiments are underway. The preliminary implementation of the low-resolution linear-feature delineation capability (with appropriate references) has been installed in the Virtual Lab Remote Execution Facility.

The selected building extraction algorithm is based on the work of Ram Nevatia and associates at USC. GDE is currently working with USC to transfer the technology to their lab for benchmarking and evaluation. Vexcel has defined the SAR and IFSAR data extraction and conditioning requirements for the material classification task. Currently they are using a commercially available classifier (PCI's), which we expect to replace with something more effective.

1.6 Develop techniques for multi-sensor registration

Extend the Model-Supported Positioning technology to include radar imagery and multi-spectral imagery. These will co-register images from different modalities in a common coordinate system. Extend the sensor model API in the RCDE to provide a homogeneous interface to the full range of data, including the transformations to map back and forth between image coordinates and 3D coordinates. Implement photogrammetrically rigorous error analysis and propagation facilities in the RCDE.

The current SRI implementation and specification for the Generic Sensor Model API (available from the APGD Virtual Lab) has been reviewed by Walt Mueller and Arliss Whiteside of GDE and Ed Mikhail of Purdue. The SRI approach to sensor model adjustment and error modeling, as described by Lynn Quam at the APGD Kickoff meeting, has been adopted by GDE for their Universal Sensor Model work. *If adopted by NIMA, this represents a major transfer of key technology from SRI, via this research project (and the RADIUS project), into the National imagery dissemination chain.*

1.7 Refine the design of, and implement, the persistent store

Specify the data format (syntax and semantics) and API for the spatio-temporal database component of the BOS, based on the requirements derived from the selected SE and MSE applications. Implement the dynamic database component of the BOS.

We continue the process of reviewing the requirements, and specifying data formats. An initial implementation for linear features has been completed. This has methods for translating the internal representations used by the linear delineation system into RCDE manipulatable objects and for persistent storage. This also has facilities for maintaining information about which images at what resolution were used for the extraction, as well as the location of the 3D features in each of the images used.

2 APGD Community Development and Technology Transfer

2.1 Produce, maintain, and distribute calibrated datasets to FRE and IUBA contractors

Collect, calibrate, and document classified and unclassified sets to be distributed to the community for experimental and evaluation purposes.

The rectified SAR magnitude and IFSAR-derived DEM coverage of Ft. Hood has been added to the dataset. Appropriate transforms have been added to allow this data to be georeferenced and coregistered with existing panchromatic coverage of Ft. Hood. Work is currently being carried out to rectify and mosaic the "raw" SAR coverage of Ft. Hood, to provide a registered correlation image, as well as possibly improved magnitude and DEM data.

Imagery is being assembled for the Ft. Benning data set. GDE has provided E-O imagery and camera parameters and DEMs to SRI. Vexcel has provided 2.5m SAR and IFSAR coverage. In addition 0.4m SAR and IFSAR coverage has been received from NIMA. When Vexcel has compiled the material classification results, they will added to this dataset.

2.2 Construct and distribute ground-truth models

Interactively construct attributed, detailed 3D models of three sites (e.g. Ft. Hood, Ft. Irwin, and Ft. Benning) to be used for benchmarking and evaluation.

RCDE "ground data" models for approximately one-third of the structures and linear features in the motor pool area of Ft. Hood have be constructed. Working is proceeding on deriving an annotated pixel classification image of the fhn717-719 area of Ft. Hood. This labels pixels as roads, proto-roads, etc., as well as indicating the surface material. This will be used to evaluate automatic extraction algorithms and will be made available via the Virtual Lab in August. GDE is constructing "ground data" for evaluating building extraction algorithms by interactively extracting building models in selected areas within the motor pool area.

SRI supplied Vexcel with digital versions of seven aerial photos of Ft. Hood. Vexcel is currently rectifying and mosaicking the images. A human operator will thematically classify the regions in order to support evaluation of IFSAR classification via confusion matrices.

In response to a request by SRI, Vexcel has initiated a hunt for SAR data capable of supporting more discriminating material classification than can be supported by vanilla IFSAR. Two sources for such data are JPL (which flies the AIRSAR sensor) and MIT's Lincoln Laboratory (which flies the Advanced Detection Technology System).

2.3 Develop evaluation metrics and procedures and perform evaluations

Design an evaluation process that can be used to identify significant advances in feature extraction or attribution. Enhance metering facilities currently available in the RCDE. Periodically run evaluations to document the current competence of the evolving system. These results will be posted on the network for comment and comparison.

We have completed the first draft of evaluation metrics and procedures for linear features and buildings. These will be briefed at the upcoming IPR and made available via the Virtual Lab shortly thereafter.

2.4 Establish and maintain the APGD virtual lab

Provide continuous access to data, ground-truth models, and results on a WWW site. In this way, any group can compare its results with the current best results.

The initial page for the Virtual Lab has been created. The URL is `http://www.ai.sri.com/~apgd/vl`. It provides a summary of data sets currently available from SRI for use by the APGD contractors and access to relevant documents. As described above, the SRI low-resolution linear delineation system is available via the Remote Execution Facility. We expect to add bibliographies on algorithm extraction techniques during August.

2.5 Interface to FRE contractors

For each FRE, select one of the three partners to be the primary interface for that FRE.

For the first year, GDE has been selected as the primary interface for FREs working on building extraction (UMass, USC). Vexcel has been working with MIT on photogrammetry and image registration issues, and has provided a free license for their Foto-G system to MIT.

With vigorous support from Michele Motsko, Vexcel has made progress in putting together the radar course. Based on e-mail responses from people in the APGD community, we now anticipate more than 15 attendees, with inquires still filtering in. Two guest speakers have been scheduled.

2.6 Develop and perform demonstration scenarios

Identify realistic processing scenarios and demonstrate prototype systems for them. Include scenarios and demonstrations for systems working with classified data.

We have had discussions with William Glatz of NIMA to investigate the feasibility of using the former-NEL facility at Bldg. 213 for classified demonstrations and evaluation of APGD-developed technology. After the IPR, we plan to become significantly more actively involved with George Lukes, Doug Climenson, and Michele Mostsko, to develop an appropriate mission-specific demonstration scenario for APGD.

GDE is investigating the use of RapidScene to provide a perspective scene rendering capability to the BOS system in support of the demonstrations.

2.7 Transfer technology

Develop and carry out pilot insertions of the developed technology into existing systems, such as GDE's SOCET SET and Vexcel's mapping system.

We have formulated a design to provide a data path between SOCET SET and RCDE, to help in carrying out pilot insertions and evaluation of APGD developed

technology. Phil Carenas of GDE visited SRI from 30 June to 3 July and worked with Chris Connolly and Aaron Heller, to become familiar with the RCDE and SRI's feature extraction technology. The first experiment in data exchange between SOCET SET and RCDE has been completed with successful results. *We consider this data path to be a critical development for near term technology transfer from APGD to operational organizations.*

GDE has provided SRI with a copy of SOCET SET which as been installed in our SCIF. We are currently working on the licensing paperwork to provide a copy of RCDE to Vexcel. An SRI-Vexcel TEM is planned for the day following the SAR Course.

As noted earlier, the SRI approach to sensor model adjustment and error modeling, as described by Lynn Quam at the APGD Kickoff meeting, has been adopted by GDE for their Universal Sensor Model work. *If adopted by NIMA, this represents a major transfer of technology from SRI, via this research project (and the RADIUS project), into the National imagery dissemination chain.*

3 Meetings and Reports

Gary Harper, Ken Loudoun, Gene Clendenon and Justin Poole of the NIMA Geospatial IPT, visited SRI on 11 June. Aaron Heller briefed them on our RADIUS, SAIP/SMS, and APGD work. In addition, they saw demonstrations of the RCDE and SRI Model-Based Optimization system, as well as, a demonstration of SRI's linear feature extraction technology being developed for APGD as applied to the problem of rapidly modeling railroads from SAR and IFSAR imagery.

Phil Carenas of GDE visited SRI from 30 June to 3 July for the purpose of technical exchange. Jim Pearson of GDE came to SRI for a day-long project planning and coordination meeting with Marty Fischler and Aaron Heller on 1 July. On going project management, planning, and coordination is accomplished by weekly teleconferences between SRI, GDE, and Vexcel.

The next scheduled meeting is the IPR on 14 August.

A GDE Monthly Report

B Vexcel Monthly Report