NATIONAL IMAGERY AND MAPPING AGENCY
SUBMISSION OF PROPOSALS

GENERAL INFORMATION

The mission of the National Imagery and Mapping Agency (NIMA) is to provide timely, relevant, and accurate Geospatial Intelligence in support of national security. Information on NIMA's SBIR Program can be found on the NIMA SBIR website at http://www.nima.mil/poc/contracts/sbir/sbir.html. Additional information pertaining to the National Imagery and Mapping Agency's mission can be obtained by viewing the website at www.nima.mil.

Inquiries of a general nature or questions concerning the administration of the SBIR program should be addressed to:

National Imagery and Mapping Agency
Attn: Mr. Derrick Riddle, IDR, MS: D-82
4600 Sangamore Road
Bethesda, MD 20816
Email: RiddleD@nima.mil

For technical questions about the topic, contact the Topic Authors listed under each topic on the DoD website before 2 December 2002. For general inquiries or problems with the electronic submission, contact the DoD Help Desk at 1-866-724-7457 (8AM to 5PM EST).

PHASE I PROPOSAL INFORMATION

Read the DoD front section of this solicitation for detailed instructions on proposal format and program requirements.

NIMA has developed topics to which small businesses may respond in the fiscal year 2003 SBIR Phase I Iteration. These topics are described on the following pages. NIMA will accept only unclassified proposals on its topics.

The maximum amount of SBIR funding for a Phase I award is $100,000 and the maximum period of performance for a Phase I award is 9 months. NIMA does not participate in the Fast Track program.

Selection of Phase I proposals will be in accordance with the evaluation procedures and criteria discussed in the DoD solicitation (refer to Section 4.2). The first criterion, (a) soundness, technical merit, and incremental progress toward topic or subtopic solution, is given slightly more weight than the other two evaluation criteria, (b) the qualifications of the proposed principal/key investigators, supporting staff, and consultants; and (c) the potential for commercial application and the benefits expected to accrue from this commercialization, which are equal. All evaluation factors other than cost or price, when combined, are significantly more important than cost or price.

NIMA reserves the right to limit awards under either topic, and only those proposals of superior scientific and technical quality will be funded. If proposals under one topic are superior than proposals received under other topics, NIMA reserves the right to make awards under one or all topics depending on proposal superiority. NIMA also reserves the right to make awards based on program need and/or balance. At this time NIMA intends to make two Phase I awards; however, NIMA reserves the right to increase or decrease the number of awards based on funding availability.

Federally Funded Research and Development Contractors (FFRDC) may be used in the evaluation of your proposal.

NIMA typically provides a firm fixed price level of effort contract for Phase I awards. The type of contract is at the discretion of the contracting officer. Phase I awards will have a requirement for monthly status reports.

NEW REQUIREMENT: ALL PROPOSAL SUBMISSIONS TO THE NIMA SBIR PROGRAM MUST BE SUBMITTED ELECTRONICALLY

It is mandatory that the entire technical proposal, DoD Proposal Cover Sheet, Technical Proposal, Cost Proposal, and the Company Commercialization Report are submitted electronically through the DoD SBIR website at http://www.dodsbir.net/submission. If you have any questions or problems with the electronic submission contact the DoD SBIR Helpdesk at 1-866-724-7457 (8AM to 5PM EST).

Please note that in addition to the electronic submission it is required that one copy of the entire signed hard copy proposal be mailed to the following address:

National Imagery and Mapping Agency
Attn: SBIR / ACW / MS: D-6
4600 Sangamore Road
Bethesda, MD 20816

Hard copy proposals mailed to NIMA at the above address will not be evaluated unless they are also submitted electronically via the SBIR DoD instructions.

If a vendor occupies space in a NIMA activity or has a support contract to provide services outside of an SBIR Phase I, II or III contract award with NIMA, they must indicate this in proposal. NIMA is concerned with potential conflicts of interest. If a vendor replies yes to either of these questions, and it is determined that their participation in the NIMA SBIR program would create a conflict of interest, then the vendor will not be allowed to participate in NIMA's SBIR program.

PHASE II GUIDELINES

Phase II proposals are invited by NIMA from Phase I projects that have demonstrated the potential for commercialization of useful products and services. The invitation will be issued in writing by NIMA.

NIMA typically provides a cost plus fixed fee contract as a Phase II award. The type of contract is at the discretion of the Contracting Officer.

Phase II proposals shall be limited to $500,000 over a two year period, with a $250,000 base proposal (first year) and a $250,000 option period (second year). Phase II base and Phase II option costs shall be shown separately in the proposal. A work breakdown structure that shows the number of hours, labor category and name of each person that will work on the SBIR to be assigned to each task and subtask, as well as the start and end dates for each task and subtask, as well as the start and end times for each task and subtask, shall be included. The option shall be included with the base proposal at the time of submission.

Selection of Phase II proposals will be in accordance with the evaluation procedures and criteria discussed in the DoD solicitation (refer to Section 4.3). Those SBIR participants that are selected to submit Phase II proposals will receive a detailed package of NIMA submission requirements, which will include the relevant importance of the evaluation criteria and also may include additional evaluation criteria. Any additional NIMA requirements for Phase II awards will be included in the Phase II invitation.

NIMA PROPOSAL CHECKLIST

This is a Checklist of Requirements for your proposal. Please review the checklist carefully to ensure that your proposal meets NIMA SBIR requirements. Failure to meet these requirements will result in your proposal not being considered for review or award. Do not include this checklist with your proposal.

_____1. The Proposal Cover Sheet along with the full Technical Proposal, Cost Proposal, and Company Commercialization Report were submitted using the SBIR proposal submission system, which can be accessed directly at http://www.dodsbir.net/submission. The Proposal Cover Sheet clearly shows the proposal number assigned by the system to your proposal.

_____2. The proposal addresses a Phase I effort (up to $100,000 with up to a nine-month duration).

_____3. The proposal is limited to only ONE NIMA solicitation topic.

_____4. The Project Summary on the Proposal Cover Sheet contains no proprietary information and is limited to the space provided.

_____5. The Technical Content of the proposal includes the items identified in Section 3.5.b of the solicitation.

_____6. The Company Commercialization Report is submitted online in accordance with Section 3.5.d. This report is required even if the company has not received any SBIR funding (This report does not count towards the 25-page limit).

_____7. The proposal is 25 pages or less in length (excluding the Company Commercialization Report). Proposals in excess of this length will not be considered for review or award.

_____8. The proposal contains no type smaller than 11 pitch or 10-point font size (except as legend on reduced drawings, but not tables).

_____9. The Cost Proposal has been completed for the Phase I costs. The Cost Proposal has been filled in electronically or included as the last page of the uploaded technical proposal. The total cost should match the amount on the cover pages.

_____10. The proposal must be electronically submitted through the online submission site (http://www.dodsbir.net/submission) by January 15, 2003.

NIMA 03.1 Topic List

NIMA03-001 Steganography Applications

NIMA03-002 SAR Tomography for Target/Feature Detection in Foliated Regions

NIMA03-003 Identification of Vertical Obstructions from Imagery Sources

NIMA03-004 Algorithms to Produce High Accuracy Bathymetry in Littoral Denied Areas

NATIONAL IMAGERY AND MAPPING AGENCY
SBIR 03.1 TOPIC DESCRIPTIONS

NIMA03-001 TITLE: Steganography Applications

TECHNOLOGY AREAS: Information Systems

OBJECTIVE: This research program will provide knowledge and technology to facilitate the embedding of information into digital imagery sources. This research will provide means for NIMA to provide license and copyright data with imagery sources including secondary dissemination products. It may also provide means to create new products with imagery and embedded ancillary information. Knowledge and models for predicting impacts to ability to do mensuration, spectral classification, and image interpretation will also be derived and delivered with this research.

DESCRIPTION: Steganography means "covered writing". In its present incarnation it involves embedding information in digital data. Digital Watermarking involves embedding copyright information that is robust from attack that would destroy it. The digital watermark is to protect the owner of the imagery by allowing proof of ownership if the imagery is copied or distributed inappropriately. Commercial products for steganography and digital watermarking exist, but no products on the market today can meet NIMA's stringent requirements. There are two main issues, the ability to detect the embedded data or watermark, and the effect of the embedded data or watermark on the imagery quality (metric, spectral thematic, and interpretability (for example using the National Imagery Interpretation Resolution Scale - NIIRS)). Other issues include complexity of the technique, vulnerabilities to attack.

PHASE I: Demonstrate the feasibility of applying steganography or digital watermarking to a NIMA application..

PHASE II: Do a prototype demonstration to show impacts are acceptable for the application selected.

PHASE III DUAL USE APPLICATIONS: In addition to the above military applications, there is a wide commercial need to protect the copyright, license, and ownership of commercial digital imagery products.

FIT WITH TECHNOLOGIES: Mathematical tools for image compression and decompression and image quality assessment are related, and must be considered because of their impacts on the embedded data.

REFERENCES:
Voyatzis, George and Ioannis Pitas, "Protecting Digital-Image Copyrights: A Framework", IEEE Computer Graphics and Applications, January/February 1999

Johnson, Neil F., Zoran Duric, and Sushil Jajodia, "Information Hiding Steganography and Watermarking - Attacks and Countermeasures", Kluwer Academic Publishers, Boston, 2001.

Katzenbeisser, Stefan and Fabien A. P. Petitcolas, "Information Hiding techniques for steganography and digital watermarking", Artech House, Boston, 2000

KEYWORDS: Steganography, embedding, digital data, Digital Watermarking, imagery

NIMA03-002 TITLE: SAR Tomography for Target/Feature Detection in Foliated Regions

TECHNOLOGY AREAS: Air Platform, Sensors, Electronics, Battlespace, Space Platforms

OBJECTIVE: Identify key technology shortfalls and develop innovative SAR tomographic processing methodologies to support target/feature detection and identification in foliated regions.

DESCRIPTION: A critical hard problem for the DoD is the ability to detect and identify man-made targets or features under foliage. This SBIR effort addresses the application of the principles of mathematical tomography to Synthetic Aperture Radar (SAR) data to support target/feature detection and identification in foliated regions. Tomography involves the mathematical combination of images or other data acquired from many directions in order to reconstruct cross-sectional maps or plots of observed objects. Tomography is most commonly applied in medical imaging to construct 3-D images from x-rays. Tomographic principles have also been applied to other data sources such as SAR. The goal of this effort is to further the work already accomplished in feature detection using tomographic techniques with SAR imagery and/or phase history data. The end goal should be to demonstrate detection of man-made features under foliage and finally feature mapping through the use of SAR tomography from an airborne platform.

PHASE I: Within the first month, the current state of the art in tomographic processing techniques for the automated/computer assisted detection and identification of features from SAR imagery and/or phase history data should be summarized and provided to NIMA. Research should then address identifying the shortfalls in current methods and the investigations necessary to address these shortfalls. In particular, shortfalls should address any constraints in collecting and processing the data and variations that occur between airborne and spaceborne collection scenarios in order to identify the feasibility of implementing various approaches. Research should then consider the promising approaches and undertake the development of an innovative concept to extract features data from currently available image sources, for example, sources such as Radarsat or various airborne SAR platforms. This phase should also include a demonstration of the technology from an airborne platform over two small sites selected by NIMA. Minimizing the need for ground control is highly desirable and will be a factor in assessing the feasibility of the concept.

PHASE II: The technique demonstrated in Phase I should be developed to a prototype capability, including an ability to rapidly and accurately detect man-made features. A prototype demonstration from an airborne platform should be performed over several large test areas selected by NIMA to illustrate that the concept meets the requirements for accuracy (high probability of detection to low false alarm rate), seamless/homogeneous coverage, and cost effectiveness. Another goal in this phase is to demonstrate the ability to map all features in the scene.

PHASE III DUAL USE APPLICATIONS: The feature detection and extraction capabilities developed in this SBIR initiative can be applied to numerous civil applications (e.g., support to search and rescue operations by detecting downed private aircraft in foliated regions) and can be transitioned to commercial software systems.

KEYWORDS: SAR, tomography, target, features, foliage, extraction, data, collection, detection

NIMA03-003 TITLE: Identification of Vertical Obstructions from Imagery Sources

TECHNOLOGY AREAS: Information Systems, Sensors, Electronics, Battlespace

OBJECTIVE: Develop a capability to identify specific types (dams, buildings, bridges, etc.) of vertical obstructions from optical imagery. This capability would eventually be incorporated into an "Upstream Processing" environment for National Technical Means (NTM) and Commercial imagery.

DESCRIPTION: NIMA currently maintains a database, Digital Vertical Obstruction File (DVOF) of man-made obstructions that present a hazard to Air Navigation. The Military requirement is to maintain a Worldwide database of vertical obstructions (VOs) 125 feet above ground level (AGL). The database supports NIMA charting and extraction programs, Service preparation of Instrument Approach Procedures for landing at airfields and Low level flight operations. Additionally, the VO data is provided to FEMA, USGS and other non-DoD Agencies. Vertical Obstruction data is important to the US Services to support operations such as low level operations, avoiding radar detection and performing precision targeting and surveillance.

PHASE I: The software prototype will automatically process digital imagery files and report coordinates, type, and AGL of all VOs in the area of coverage of the images. The accuracy and completeness of the processing will be evaluated against NIMA provided ground truth information.

Photo identification of some VOs is very difficult, even for Imagery analysts, due to size, shadows and other factors. As such, to demonstrate the capabilities of the prototype software, certain VO types will be targeted for identification. In addition to the type of VO, the position and height (AGL) will also be derived by the software.

A variety of conventional photo-grammetric processing techniques, i.e. edge detection, gray scale mapping, etc., as well as any new and innovated techniques, will be used in the prototype to increase the identification potential capabilities of the software.

The concepts and the design of the software should allow for rapid processing of each image. This will better suit a future "Upstream Processing" capability where large numbers of images will be processed at the Ground sites in a timely manner.

PHASE II: Future development during Phase II will include adapting the software to process National Imagery Transmission Formatted (NITF) imagery for use with NTM source. It will also increase the processing speed and the types of VOs that can be identified.

Future development could also include the identification of other feature data that would allow automated collection of feature data to support the Regional Databases. These features would include roads, railroads, hydro features, city outlines, and Intelligence type targets.

PHASE III Dual Use Applications: This application could be of value to city planners to identify infrastructure changes and to identify new construction activities. Local Government property taxing bodies could adapt the software to reassess taxes on construction activities. Additionally, the base feature identification capability will allow State and local Governments to economically map their areas of responsibility for use in GIS presentations.

KEYWORDS: Upstream Processing, Vertical Obstruction, detection, data, Imagery, precision, targeting

NIMA03-004 TITLE: Algorithms to Produce High Accuracy Bathymetry in Littoral Denied Areas

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace, Space Platforms

OBJECTIVE: To develop and validate against accurate truth data a new approach with algorithms designed to approximate bathymetry from high-resolution commercial satellites in waters that vary in optical penetrability. To be judged successful, this capability must be capable of…(1) generating and metrically verifying state-of-the-art results; (2) hierarchically reducing broad areas to smaller areas for bathymetric LIDAR, and/ or acoustic surveying, (3) showing promise in transitioning the capability to NAVOCEANO and NIMA for international applications; (4) providing rapid after storm assessment in areas affected by severe weather events, and abnormal sediment loads due to river discharges.

DESCRIPTION: The Office of Naval Research has funded attempts to approximate bathymetry for more than a decade. Two of these procedures are generally considered to be state-of-the-art. However, a number of practical impediments have limited the versatility of these approaches for the following reasons: (1) optical penetrability to the bottom varies seasonally, and is not always possible; (2) aircraft platforms are not likely to be used in denied areas; (3) these approaches are based either on surface wave kinematics, or the physics of bottom reflectivity; but not both. A rapid satellite enabled bathymetric estimation capability producing state-of-the-art results will be of considerable military to NAVOCANO, NIMA, the Marine Corps, SOCOM, and civil agencies/contractors in countries without rapid response hydrographic response capabilities.

LITERATURE SURVEY (Preliminary):

PHASE I: This "proof of concept" effort will include a critical review of the recent history of overhead remote sensing of bathymetry. This will include current, but unclassified military technologies. The proposed research design will incorporate (1) an innovative conceptual formulation and research design; (2) a scientifically based choice of five study areas with available and accurate bathymetry; (3) an algorithmically driven collection and processing plan; (4) an ability to demonstrate an ability to numerically compare predicted with actual bathymetric data surfaces.

PHASE II: This phase will implement and critically evaluate the proposed theoretical formulations of Phase 1. Once a physical assay of the physical conditions of each study site is completed, six calculations will be undertaken: (1) the accuracy of depth via sea bottom reflectivity; (2) depth accuracy via surface wave kinematics; (3) depth accuracy via both bottom reflectivity and surface wave measures, (4) an analytical comparison of predicted against actual depths for each study site; (5) use of a rigorous technique of the spatial analysis of errors, or displacements, using state-of the-art methods; (6) interpretation of results at each site; (7) modification of the algorithms as appropriate.

PHASE III: This phase is intended to commercialize the innovations developed, tested and validated in the previous phases. Two simultaneous means of deriving improved bathymetry are expected to be as, if not more effective, and versatile than currently operational unclassified remote sensing procedures. Commercial satellite-based sensors with the required imaging characteristics is likely to be attractive to a wide range of users in developed and less developed nations, This alone represents a significant international market for the innovation sdescribed here. There are other economies of scale that will be attractive to users in developed and less developed alike. Prominent among these is theability to begin by imaging widely, then reducing the zones of interest until LIDAR or acoustic techniques could be used economically in limited areas. In the United States organizations such as the NOAA, the Bureau of Commercial Fisheries, the U.S. Army Corps of Engineers, and NASA represent prospective markets. Commercially the world over, manufactures and users of aircraft sensors, contractors to governments for navigation safety, and other users of remote sensing also constitute substantial commercial markets for
the cost of relatively inexpensive software and that of high resolution satellite imagery.

LITERATURE SURVEY (Preliminary):
Wave and ocean bottom visibility with high resolution satellite imagery. There are of course many papers on satellite imagery of oceans. However the following is the first, and as far as I know the only published papers on using high resolution satellites. The main conclusions are: good ocean wave visibility down to 10 m waves even in less than optimum viewing geometry. Bottom reflectance can be measured to depth of 20-30 m in clear coastal waters such as Hawaii.

REFERENCES:
Abileah, R. "High-Resolution Imagery Applications in the Littorals," Proc. SPIE/EOS Conf. Remote Sensing, Toulouse, France (September, 2001).
State of the art in bathymetry from ocean waves kinematics in the linear waves regime. The Dugan papers, Farber, Hoogeboom, and van Halsema, are the state of the art. All use long sequences of imagery (about 100 frames, 1/s) to measure the wave kinematics and invert to bathymetry through a Fourier transform analysis of the data. The spatial resolution is ~250m. The are good techniques but not suitable for satellite imagery since satellites will not provide the long imagery sequence. Bennett and Kasischke et al. are methods based on wave refraction and one image. The spatial resolution is ~1 km. Abileah's formulation is a new method that requires only two images and obtains resolution on the ~50m. Abileah (1992) reports work under NRO sponsorship demonstrating the technique on simulated data. The NRO study also demonstrated fusion of wave kinematics and multispectral bottom radiance.
Abileah R., "Coastal bathymetry based on fusion of multispectral and LIDAR imaging," Final Report, NRO 000-01-C-0210, SRI Report No. ITAD-11235-FR-02-013, 1992
Bennett, J. R. 1986. "An improved method for the determination of water depth from surface wave refraction patterns," Proc. of IGARSS'86 Symposium, Zurich (8-11 September).
Caruthers, J.W., R.A. Arnone, W. Howard, C. Haney, and D.L. Durham. 1985. "Water depth determination using wave refraction analysis of aerial photography," Report 110, Naval Ocean Research and Development Activity.
Dugan, J.P., G.J. Fetzer, J. Bowden, G.J. Farruggia, J.Z. Williams, C.C. Piotrowski, K. Vierra, D. Campion, and D.N. Sitter. 2000. "Airborne Optical System for Remote Sensing of Ocean Waves," J. Atmospheric and Oceanic Technology.

Dugan, J. and C. Peiotrowski. 2000. "Developmental System for Maritime Rapid Environmental Assessment Using UAVs," Oceanology International 2000 Conference (7-10 March).
Farber, M., H.H. Suzukawa, Jr., and J. Dugan. 1995. "Long range airborne IR detection of ocean waves," Proc. Targets and Backgrounds: characterization and Representation, Vol. 2469, pp. 526-536 (17-19 April).
Fuchs, R. A., "Depth estimation on beaches by wave velocity methods," Institute of Engineering Research Wave Research Laboratory, 1953.
Hoogeboom, P., J. C. M. Kleijweg, and D. van Halsema. 1986. "Seawave measurements using ship's radar," Proc. IGARSS Symp. (8-11 September).
Kasischke, E.S., G.A. Meadows, and P.L. Jackson. 1984. "The use of synthetic aperture radar imagery to detect hazards to navigation," ERIM Report 169200-2-F, for Defense Mapping Agency.
van Halsema, D., and J.C.M. Kleyweg. 1986. "The measurement of wavefields with a simple ship's radar," Fysisch En Electronisch Laboratorium, TNO, Report FEL 1986 (20 April).
Weiss, J.W. 1997. "Three-Dimensional Linear Solution for Wave Propagation with Sloping Bottom," IEEE J. Oceanic Engineering, Vol. 22, No. 2, pp. 203-210 (April).
Wave kinematics in the non-linear regime. The previous references (Duggan, Abileah, etc.) on assume linear wave propagation, which is generally valid for water depths >2 m, and not bad to depth of 1 m. Shallower waters (i.e., surf zone) requires the Boussinesq formulation. The following are relevant and the Kirby group at U of Delaware is very active in this area.
Biesel, F. 1952. "Gravity Waves," in Proc. NBS Semicentennial Symp. Gravity Waves at NBS, National Bureau of Standards Circular, Vol. 521 (28 November).
Misra, Shubhra, Andrew Kennedy, and James Kirby, "Determining Nearshore Bathymetry from Remotely Sensed Ocean Surface Images," publication reference unknown.
Thornton, E.B., and R.T. Guza. 1983. "Transformation of Wave Height Distribution," JGR, Vol. 88, No. C10, pp. 5925-5938 (20 July).
The following investigated fusion of multispectral radiance with LIDAR depth (as in SHOALS).
Kappus, M.E., C.O. Davis, and W.J. Rhea. 1998. "Bathymetry from Fusion of Airborne Hyperspectral and Laser Data," Proc. SPIE., Imaging Spectrometry IV, Vol. 3438, No. 40.
Lyzenga, D. 1985. "Shallow-water bathymetry using combine LIDAR and passive multispectral scanner data," Int. J. of Remote Sensing 6.
References on bathymetry using multispectral ocean bottom reflectance. There are numerous papers on this subject. The classics are Bierwirth et al (1992, 1993), Lyzenga (1978), and Ji (1992). All point to the need for independent calibration of the water optical properties.
Bierwirth, P. N., T. Lee, and R.V. Burne. 1992. "Shallow Sea-Floor Reflectance and Water Depth Derived by Unmixing Multispectral Imagery," First Thematic Conference on Remote Sensing for Marine and Coastal Environments (15-17 June).
Bierwirth, P. N., T. Lee, and R.V. Burne. 1993. "Shallow Sea-Floor Reflectance and Water Depth Derived by Unmixing Multispectral Imagery," Photogrammetric Engineering and Remote Sensing, Vol. 59, No. 3, American Society for Photogrammetry and Remote Sensing (March).
Borsdtan, G. and J. Vosburg. 1993. "Combined active and passive optical bathymetric mapping using the Larsen LIDAR and CASI imaging spectrometer," Proc. Canadian Symp. on Remote Sensing (May).
Huguenin, R.L., E.R. Boudreau, and M.A. Karaska. 1997. "An adaptation of the AASAP Subpixel analysis software for automated bathymetry mapping," 4th International Conference on Remote Sensing for Marine and Coastal Environments, Orlando, Florida (17-19 March).
Ji, W., D. Civco, and W. Kennard. 1992. "Satellite remote bathymetry: a new mechanism for modeling," Photogrammetric Engineering & Remote Sensing 58, pp. 545-549 (May).
Lyzenga, D. 1978. "Passive remote sensing techniques for mapping water depth and bottom features," Applied Optics 17, No. 3, pp. 379-383 (February).
Stuffle, L.D. 1996. Bathymetry from Hyperspectral Imagery, thesis, Naval Postgraduate School (December).
Walker, C.L., R.K. Clark, and T.H. Fay. 1990. "Shallow water bathymetry models using multispectral digital data," Imaging Technology, Vol. 16, No. 5, pp. 170-175 (October).

KEYWORDS: Algorithms, littoral, sensors, bathymetry, zones, imaging, high resolution