MISSILE DEFENSE AGENCY (MDA)
12.A Small Business Technology Transfer (STTR)
Proposal Submission Instructions

INTRODUCTION

The MDA STTR Program is implemented, administrated, and managed by the MDA SBIR/STTR Program Management Office (PMO), located within the Advanced Technology (DV) Directorate. Specific questions pertaining to the administration of the MDA STTR Program should be submitted to:

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Additional information on the MDA SBIR/STTR Program can be found on the MDA SBIR/STTR home page at http://www.mdasbir.com. Information regarding the MDA mission and programs can be found at http://www.mda.mil.

Proposals not conforming to the terms of this Solicitation will not be considered. MDA reserves the right to limit awards under any topic, and only those proposals of superior scientific and technical quality and that offer potential benefit to the BMDS prioritized technology gap areas will be funded. Only Government personnel will evaluate proposals.

Questions about STTR and Solicitation Topics
Refer to Section 1.5 of the DoD Program Solicitation at www.dodsbir.net/solicitation.

Federally Funded Research and Development Centers (FFRDCs) and Support Contractors
The offeror's attention is directed to the fact that non-Government advisors to the Government may review and provide support in proposal evaluations during source selection. Non-government advisors may have access to the offeror's proposals, may be utilized to review proposals, and may provide comments and recommendations to the Government's decision makers. These advisors will not establish final assessments of risk and will not rate or rank offeror's proposals. They are also expressly prohibited from competing for MDA SBIR or STTR awards in the SBIR/STTR topics they review and/or on which they provide comments on to the Government.

All advisors are required to comply with procurement integrity laws. Non-Government technical consultants/experts will not have access to proposals that are labeled by their proposers as "Government Only." Pursuant to FAR 9.505-4, the MDA contracts with these organizations include a clause which requires them to (1) protect the offerors' information from unauthorized use or disclosure for as long as it remains proprietary and (2) refrain from using the information for any purpose other than that for which it was furnished. In addition, MDA requires the employees of those support contractors that provide technical analysis to the SBIR/STTR Program to execute non-disclosure agreements. These agreements will remain on file with the MDA SBIR/STTR PMO.

Non-Government advisors will be authorized access to only those portions of the proposal data and discussions that are necessary to enable them to perform their respective duties. In accomplishing their duties related to the source selection process, employees of the aforementioned organizations may require access to proprietary information contained in the offerors' proposals.

Conflicts of Interest

Refer to Section 1.4 of the DoD solicitation at www.dodsbir.net/solicitation.

PHASE I GUIDELINES

MDA intends for the Phase I effort to determine the merit and technical feasibility of the concept. Only UNCLASSIFIED proposals will be entertained. Phase I proposals may be submitted for a base amount not to exceed $100,000 and a base period of six months. A list of the topics currently eligible for proposal submission is included below, followed by full topic descriptions. These are the only topics for which proposals will be accepted at this time. The topics originated from the MDA Programs and are directly linked to their core research and development requirements.

Please ensure the mailing address, e-mail address, and point of contact (Corporate Official and Principal Investigator) listed in the proposal are current and accurate. MDA cannot be responsible for notification to a company that provides incorrect information or changes such information after proposal submission.

USE OF FOREIGN NATIONALS

See Section 2.4 of the DoD Solicitation for the definition of a Foreign National (also known as Foreign Persons.)

ALL offerors proposing to use foreign nationals MUST disclose this information regardless of whether the topic is subject to ITAR restrictions. See Section 3.5, b., (7) of the DoD Solicitation for required information.

Proposals submitted with a foreign national listed will be subject to security review during the contract negotiation process (if selected for award). If the security review disqualifies a foreign national from participating in the proposed work, the contractor may propose a suitable replacement. In the event a proposed foreign person is found ineligible to perform proposed work, the contracting officer will advise the offeror of any disqualifications but may not disclose the underlying rationale.

ITAR RESTRICTIONS

The technology within some MDA topics is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. You must ensure that your firm complies with all applicable ITAR provisions. Please refer to the following URL for additional information: http://www.pmddtc.state.gov/compliance/index.html.

Proposals submitted to ITAR restricted topics will be subject to security review during the contract negotiation process (if selected for award). In the event a firm is found ineligible to perform proposed work, the contracting officer will advise the offeror of any disqualifications but may not disclose the underlying rationale.

TECHNOLOGY DEVELOPMENT AND POTENTIAL FOR INVENTIONS

The DoD and MDA SBIR/STTR program includes goals of improving current known technology and developing new and novel technology leading to applications as BMDS improvements. Therefore, there is a potential for contractor generation of inventions during Phase I and Phase II contracts. In order for each contractor to understand DoD reporting requirements for inventions created with U.S. Government funding, it is encouraged that each contractor submitting a Phase I proposal, should become

familiar with the requirements of Federal Acquisition Regulation (FAR) 52.227-11 (include web link), and DoD FAR Supplement (DFARS) 252.227-7018 (include web link).

PHASE I PROPOSAL SUBMISSION

The DoD SBIR/STTR Proposal Submission system (available at http://www.dodsbir.net/submission) will lead you through the preparation and submission of your proposal. Read the front section of the DoD solicitation, including Section 3.5, for detailed instructions on proposal format and program requirements. Proposals not conforming to the terms of this solicitation will not be considered.

MAXIMUM PAGE LIMIT FOR MDA IS **20 PAGES**

Any pages submitted beyond the 20-page limit, will not be evaluated. Your cost proposal and Company Commercialization Report DO NOT count toward your maximum page limit. Proposal coversheets, which will be added electronically by the DOD submission site as page 1 and page 2, DO count toward your maximum page limit.

PHASE I PROPOSAL SUBMISSION CHECKLIST

All of the following criteria must be met or your proposal will be REJECTED.

____1. The following have been submitted electronically through the DoD submission site by 6 a.m. (ET) 28 March 2012.

_____ a. DoD Proposal Cover Sheet

_____ b. Technical Proposal (**DOES NOT EXCEED 20 PAGES**): *Any pages submitted beyond this will not be evaluated. Your cost proposal and Company Commercialization Report DO NOT count toward your maximum page limit. Proposal Coversheets DO count toward your maximum page limit.*

_____ c. If proposing to use foreign nationals; identify the foreign national(s) you expect to be involved on this project, **the type of visa or work permit under which they are performing,** country of origin and level of involvement.

_____ d. DoD Company Commercialization Report (required even if your firm has no prior SBIRs).

_____ e. Cost Proposal **(Online cost proposal form is REQUIRED by MDA)**

MDA PROPOSAL EVALUATIONS

MDA will evaluate and select Phase I proposals using scientific review criteria based upon technical merit and other criteria as discussed in this solicitation document. MDA reserves the right to award none, one, or more than one contract under any topic. Due to limited funding, MDA reserves the right to limit awards under any topic and only proposals considered to be of superior quality, that offer potential benefit to the BMDS prioritized technology gap areas, and that have the ability to transition the technology into an identified BMDS will be funded. MDA is not responsible for any money expended by the proposer before award of any contract.

MDA will use the Phase II Evaluation criteria in Section 4.3 of the DoD solicitation in inviting, assessing and selecting for award those proposals offering the best value to the Government. Only proposals considered to be of superior quality, that offer potential benefit to the BMDS prioritized technology gap areas, and that have the ability to transition the technology into an identified BMDS will be funded.

In Phase I and Phase II, firms with a Commercialization Achievement Index (CAI) at or below the 20th percentile will be penalized in accordance with Section 3.5d of the DoD solicitation.

When combined, the stated evaluation criteria are significantly more important than cost or price. Where technical evaluations are essentially equal in merit, cost or price to the government will be considered in determining the successful offeror.

It cannot be assumed that reviewers are acquainted with the firm or key individuals or any referenced experiments. Technical reviewers will base their conclusions on information contained in the proposal and their personal knowledge. Relevant supporting data such as journal articles, literature, including Government publications, etc., should be contained or referenced in the proposal and will count toward the applicable page limit.

Qualified advocacy letters will count towards the proposal page limit and will be evaluated towards criterion C. Advocacy letters are not required for Phase I or Phase II. Consistent with Section 3-209 of DoD 5500.7-R, Joint Ethics Regulation, which as a general rule prohibits endorsement and preferential treatment of a non-federal entity, product, service or enterprise by DoD or DoD employees in their official capacities, letters from government personnel will NOT be considered during the evaluation process.

A qualified advocacy letter is from a relevant commercial procuring organization(s) working with MDA, articulating their pull for the technology (i.e., what BMDS need the technology supports and why it is important to fund it), and possible commitment to provide additional funding and/or insert the technology in their acquisition/sustainment program. This letter should be included as the last page of your technical upload. Advocacy letters which are faxed or e-mailed separately will NOT be considered.

INFORMATION ON PROPOSAL STATUS

The Principal Investigator (PI) and Corporate Official (CO) indicated on the Proposal Coversheet will be notified by e-mail regarding proposal selection or non-selection. If your proposal is tentatively selected to receive an MDA award, the PI and CO will receive a single notification. If your proposal is not selected for an MDA award, the PI and CO may receive up to two messages. The first message will provide notification that your proposal has not been selected for an MDA award and provide information regarding the ability to request a proposal debriefing. The second message will contain debrief status information (if requested), or information regarding the debrief request. **Small Businesses will receive a notification for each proposal submitted. Please read each notification carefully and note the proposal number and topic number referenced.**

IMPORTANT: We anticipate having all the proposals evaluated and Phase I selection and non-selection notifications distributed in the June 2012 timeframe. All questions concerning the evaluation and selection process should be directed to the MDA SBIR/STTR PMO.

All communication from the MDA SBIR/STTR PMO will originate from the sbirsttr@mda.mil e-mail address. Please white-list this address in your company's spam filters to ensure timely receipt of communications from our office.

MDA SUBMISSION OF FINAL REPORTS

All final reports will be submitted in accordance with the Contract Data Requirements List (CDRL) of the resulting contract. Refer to Section 5.3 of the DoD Solicitation for additional requirements.

PHASE II GUIDELINES

This Solicitation solicits Phase I proposals. For Phase II, no separate solicitation will be issued and no unsolicited proposals will be accepted. Only firms that were awarded Phase I contracts, and have successfully completed their Phase I efforts, may be invited to submit a Phase II proposal. MDA makes no commitments to any offeror for the invitation of a Phase II proposal. Phase II is the prototype/demonstration of the technology that was found feasible in Phase I. Only those successful Phase I efforts that are **invited** to submit a Phase II proposal will be eligible to submit a Phase II proposal. MDA does encourage, but does not require, partnership and outside investment as part of discussions with MDA sponsors for potential Phase II invitation. Invitations to submit a Phase II proposal will be made by the MDA SBIR/STTR PMO.

Please Note: You may only propose up to the total cost for which you are invited. Contract structure for the Phase II contract is at the discretion of the contracting officer after negotiations with the small business.

The MDA SBIR/STTR PMO does not provide "debriefs" for firms who were not invited to submit a Phase II proposal.

PHASE II PROPOSAL SUBMISSION

Follow Phase II proposal instructions described in Section 3.0 of the Program Solicitation at www.dodsbir.net/solicitation and specific instructions provided in the Phase II invitation. Invitations for Phase II proposals are generally issued at or near the Phase I contract completion, with the Phase II proposals generally due one month later. In accordance with SBA policy, MDA reserves the right to negotiate mutually acceptable Phase II proposal submission dates with the Phase I awardees, accomplish proposal reviews expeditiously, and proceed with Phase II awards. If you have been invited to submit a Phase II proposal, please see the MDA SBIR/STTR Web site http://www.mdasbir.com for further instructions.

MDA FAST TRACK DATES AND REQUIREMENTS

Introduction: For more detailed information and guidance regarding the DoD Fast Track Program, please refer to Section 4.5 of the solicitation and the Web site links provide there. MDA's Phase II Fast Track Program is focused on transition of technology. The Fast Track Program provides matching SBIR/STTR funds to eligible firms that attract investment funds from a DoD acquisition program, a non-SBIR/non-STTR government program or private sector investments. Phase II awards under Fast Track will be for $1,000,000 maximum, unless specified by the Director, Advanced Research.

- For companies that have never received a Phase II SBIR/STTR award from DoD or any other federal agency, the minimum matching rate is .25 cents for every SBIR/STTR dollar. (For example, if such a company receives interim and Phase II SBIR funding that totals $750,000, it must obtain matching funds from the investor of $187,500.)
- For all other companies, the minimum matching rate is 1 dollar for every SBIR dollar. (For example, if such a company receives interim and Phase II SBIR/STTR funding that totals $750,000, it must obtain matching funds from the investor of $750,000.)

Submission: The complete Fast Track application along with completed transition questions (see note below) must be received by MDA within 120 days from the Phase I award date. Your complete Phase II proposal must be received by MDA within 30 days of receiving approval (see section entitled "Application Assessments" herein for further information). Any Fast Track applications or proposals not meeting this deadline may be declined. All Fast Track applications and required information must have a complete electronic submission. The DoD Electronic Submission Web site www.dodsbir.net/submission/SignIn.asp will lead you through the process for submitting your application and technical proposal electronically. Each of these documents is submitted separately through the Web site.

Firms who wish to submit a Fast Track Application to MDA MUST utilize the MDA Fast Track Application Template available at http://www.mdasbir.com (or by writing sbirsttr@mda.mil). Failure to follow these instructions may result in automatic rejection of your application.

Firms who have applied for Fast Track and are not selected may still be eligible to compete for a regular Phase II in the MDA SBIR/STTR Program.

Current guidance and instructions may be found at http://www.mdasbir.com.

MDA SBIR/STTR PHASE II TRANSITION PROGRAM

Introduction: To encourage transition of SBIR and STTR projects into the BMDS, the MDA's Phase II Transition Program provides matching SBIR and STTR funds to expand an existing Phase II contract that attracts investment funds from a DoD acquisition program, a non-SBIR/non-STTR government program or private sector investments. The Phase II Transition Program allows for an existing Phase II SBIR or STTR contract to be extended for up to one year per Phase II Transition application, to perform additional research and development. Phase II Transition matching funds will be provided on a one-for-one basis up to a maximum amount of $500,000 of SBIR or STTR funds in accordance with DoD Phase II Enhancement policy at Section 4.6 of the DoD Solicitation. Phase II Transition funding can only be applied to an active DoD Phase II SBIR or STTR contract.

The funds provided by the DoD acquisition program or a non-SBIR/non-STTR government program may be obligated on the Phase II contract as a modification prior to or concurrent with the modification adding MDA SBIR or STTR funds, OR may be obligated under a separate contract. Private sector funds must be from an "outside investor" which may include such entities as another company or an investor. It does not include the owners or family members, or affiliates of the small business (13 CFR 121.103).

Background: It is important that all technology development programs in MDA map to a BMDS improvement and, after a period of development and maturity, are transitionable to targeted BMDS end users. End user is defined as the element, component or product manager to which it is intended to transition the technology. Because of this, it is important that your Phase II contract be at or approaching a Technology Readiness Level of either 5 or 6.

Current guidance and instructions may be found at http://www.mdasbir.com.

2012 12.A PHASE I KEY DATES (PROJECTION)

12.A Solicitation Pre-release……..……...……January 26 – February 26, 2012
12.A Solicitation Opens ……..……...February 27 – March 28, 2012
Phase I Evaluations……..…….....April – June 2012*
Selection and Non-Selection Notifications Distributed.……June 2012*
Contract Award Goal……...……..……....…….....September 2012*

Phase II Transition Program Solicitation is ***generally*** announced via http://www.mdasbir.com in the Spring/Summer timeframe.

*This information is listed for GENERAL REFERENCE ONLY at the time of publication of this solicitation. This date is subject to update/change.

MDA STTR 12.A Topic Index

MDA12-T001	Combined RF/IR Data Correlation
MDA12-T002	RF-IR Data Fusion
MDA12-T003	Innovative Technologies for High Performance Infrared Detectors

MDA STTR 12.A Topics by Research Area

AB (Aegis BMD)

MDA12-T001	Combined RF/IR Data Correlation

CR-C2BMC (C2BMC)

MDA12-T002	RF-IR Data Fusion

CR-IR (CR-Infrared)

MDA12-T003	Innovative Technologies for High Performance Infrared Detectors

MDA STTR 12.A Topic Descriptions

MDA12-T001 TITLE: Combined RF/IR Data Correlation

TECHNOLOGY AREAS: Information Systems, Sensors, Battlespace, Human Systems, Weapons

ACQUISITION PROGRAM: MDA/AB

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 3.5.b.(7) of the solicitation.

OBJECTIVE: The purpose of this STTR is to advance correlation, association, and lethal object selection against threats containing countermeasures, decoys, debris, and other objects of interest. At the end of the effort, algorithms that leverage novel features, feature combinations, and/or sensor fusion schemes will be selected based on performance assessments of within theatre scenarios. By cooperatively exploiting the strengths and weaknesses of RF and IR sensors, the Department of Defense (DoD), Missile Defense Agency (MDA), and the Navy will be provided with analyses that support defining and setting performance requirements against future systems. The resulting approach will drive improvements in Ballistic Missile Defense (BMD) capabilities by identifying advanced algorithm designs and proposing judicious yet insubstantial modifications to radar and seeker hardware specifications (i.e. bandwidth, beam pointing, engagement CONOPS, application of IR/Visible Sensors, etc.).

DESCRIPTION: The sea-based component of the Missile Defense Agency's Ballistic Missile Defense System (BMDS) is Aegis Ballistic Missile Defense (BMD), which builds upon the Navy and joint forces' command, Control and Communication systems, the Standard Missile, and the Aegis Weapon System. In response to its proven flight test record and associated 80 percent successful intercept rate, the Aegis BMD/SM-3 system is a vital element in the Phased Adaptive Approach (PAA) for missile defense in Europe. With the use of the Standard Missile-3 (SM-3), BMD is designed to defeat short- to intermediate-range, unitary and separating, midcourse-phase, ballistic missile threats. The SM-2 missile is used by the weapon system to defeat short-range ballistic missiles in the terminal phase.

BMD Flight tests are designed to demonstrate capability against targets and scenarios of increasing complexity. Aegis ships on patrol detect and track a wide range of ballistic missiles and report track data to the missile defense system. This allows other missile defense sensors to be cued and provides fire control data to land-based firing units, other Navy BMD ships, and Ground-based Midcourse Defense interceptors. . As a result, this topic seeks to improve target discrimination by exploiting the strengths and weaknesses of RF and IR sensors for enhanced reporting of track data.

Requirements for future builds of the Aegis Weapon System and Standard Missiles are set prior to an established design of record. As a result, engineering judgment and medium fidelity modeling are used to drive assumptions regarding possible system limitations and capabilities. This process is an R&D technical risk as it can lead to BMD design assumptions that limit the system's potential capacity to take on more complex future threats. A more rigorous approach to requirements setting for future systems involves understanding the fundamental physical limits of radar, seeker, and EO/IR technologies that are and can be associated with the BMDS, C2BMC, Standard Missile and the Aegis Weapon System. Another technical risk is that system capability is not fully fleshed out until multimillion dollar flight tests have been performed. An expectation of this RFP is that the aforementioned risk can be mitigated through rigorous HWIL testing and/or by evaluating flight test data derived from non-BMD sensors.

The questions addressed by this RFP include the degree to which sensor hardware, algorithm approaches, and overall system designs can be collaterally optimized to ensure that future systems requirements are set to support achievement of maximum performance capability.

Through development of innovative algorithms, sensor fusion schemes, features and/or feature combinations, the work performed herein must improve upon the state-of-the-art in ballistic missile defense capability. Extensive work has been performed on RF and IR feature data, but the focus here is on what is common and different between

RF radar and EO/IR sensor data that can be used to make advancements in tracking, target acquisition, and object selection. It is expected that the research will advance the capability of next generation systems; while, supporting development of performance requirements.

The successful RFP will describe: the physical and algorithmic limitations of BMD sensor technologies; threat geometries that bound acquisition, tracking, correlation, and object selection algorithms/approaches; multi-sensor (RF/IR) data fusion and target tracking approaches that mitigate any system limitations while augmenting current capabilities; and the degree to which the resulting BMD is robust against an evolutionary threat space. In addition, successful RFPs will describe how Hardware-in-the-loop (HWIL), flight test data, and/or simulations will be used to support analyses.

PHASE I:
A. By assessing the state of the art in the Aegis Weapon System, the SM Missile requirements, and where practical the BMDS, perform gap analyses to identify limitations and capabilities in radar, seeker, and other sensor hardware to assess information content of data produced by the sensors either with hardware-in-the-loop (HWIL) testing or field data. Consider potential capability against BMD/SM and 5.0 CU threats.
B. Comprise list of features, feature combinations and algorithm techniques, which show promise for major object detection and lethality. These should address limitations found in "A" above.
C. Identify and describe the merit of data/sensor fusion schemes that will address performance gaps.

PHASE II:
A. Using at least one new feature combination and novel algorithm, analyze a sample set of threat data to identify features derived from radar and infrared sensors, which are useful for lethal object selection.
B. Design, develop, and test data fusion and/or sensor fusion algorithms that leverage radar and infrared sensor data to provide performance against stressing threats identified in Phase I.
C. Identify novel features and feature combinations that support robust lethal object selection against stressing threats. Quantify the degree to which performance is enhanced by the features and/or feature combinations.
D. Specify threats most suited to novel algorithm designs and feature combinations.
E. Assess algorithm performance against stressing ship positions, threats, and/or theatres via comprehensive evaluation against all stressing cases identified in Phase I.
F. Demonstrate and Validate improvements in performance gaps as gleaned by fusion schemes, algorithms, and feature combinations.

PHASE III: Further develop the concept for transition to BMDS Weapon Systems.

COMMERCIALIZATION: The technology is applicable to air traffic control, security systems and other tracking applications.

REFERENCES:
1) Raol, J.R., Multi-Sensor Data Fusion with MATLAB, CRC Press, Boca Raton FL, 2010

2) Hall, D., and James Llinas, "An Introduction to Multisensor Data Fusion," Proceedings of the IEEE, 85 (No. 1) 1997

3) Bar-Shalom, Y., and W.D. Blair, Editors, Multi-Target/Multi-Sensor Tracking: Applications and Advances, Vol. III, Artech House, Norwood, MA, 2000

KEYWORDS: Discrimination Algorithms, Sensor Fusion, Algorithm, Track Fusion, Multi-sensor

MDA12-T002 TITLE: RF-IR Data Fusion

TECHNOLOGY AREAS: Information Systems, Sensors

ACQUISITION PROGRAM: CR-C2BMC

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 3.5.b.(7) of the solicitation.

OBJECTIVE: Determine signatures and characteristics of an object that can be identified by RF and EO/IR Sensors to enable multi-sensor data fusion and correlation. This topic is in support of the ballistic missile defense system in its ability to recognize and characterize different objects utilizing multiple sensor sources in the battlespace.

DESCRIPTION: With new EO/IR sensors coming online in the BMDS, it is critical that C2BMC is able to correlate objects between sensors of disparate phenomenologies. A major challenge will be to 1) enable persistent surveillance and identification of a track across radar and EO/IR sensor fields of regard and 2) enhance the characterization of the object under evaluation.

Currently, sensors communicate target information using metric track states and covariance information, regardless of the widely differing biases and uncertainties associated with EO/IR, satellite or UAV, and radar data. If the threat scene is too dense for these metric correlations to be successful, there can be no useful information exchange between sensors. Attempts to utilize measurement information to enable track correlation and target identification have not provided clear improvements.

The first subtask, correlation of objects between sensors, is a very important handover function in multi-sensor data fusion, particularly when sensors are sparse and overlapping coverage may not occur.. This can become complicated when different types of systems (RF versus EO/IR) are viewing the same objects. For this application, it is critical to quickly determine specific identifying characteristics of a target that a follow-on sensor may be able to utilize to determine target matching. Success in this subtask will be a demonstration of improved handover, compared with a metric only procedure, from EO/IR to RF sensors and from RF to EO/IR, when multiple objects are in the respective scenes.

RF and EO/IR sensors occupy distinct wavebands in the electro-magnetic spectrum which are useful for measuring different target characteristics; these distinct characteristics can be combined in a complementary fashion to better characterize a target in track. However, the heterogeneous sensing environment can complicate track correlation efforts. An essential capability in data fusion and correlation is to recognize common characteristics from the objects which the sensors can identify so the BMDS is able to verify that multiple sources are looking at the same object. Radar signal returns allow an analyst to infer attributes about the object under surveillance, providing a set of measurements that depends on numerous target properties. Similarly, infrared sensors provide target irradiance measurements which depend on various target factors. Additionally, two (carefully selected) wavebands, can provide a richer set of potentially useful features than a single band for target characterization. The IR features then allow a unique set of inferences about the target.

The second subtask, to adequately reason with the information from the disparate sensors, it is necessary to understand the appropriate contributions to target identity from the various sources. In particular, what specific physical attributes of the target can be inferred from the combination of information from the two phenomenologies (RF and EO/IR)? Using the radar and optical feature equations, the physics that give rise to the features, and an inferencing system, for example, a Bayes Network or an influence diagram, one can model the physical target characteristics and their representations in feature space. This can enable a meaningful interpretation of the target in real time from the observed features, once the objects have been correlated. Success will be a demonstration of target characterization in RF, In EO/IR, then together, to demonstrate how a target can be more accurately characterized using a combination of RF and EO/IR measurements.

Analysis needs to be performed on the various components of characterization, as to whether the information contained is supporting between sensors (useful for correlation) or orthogonal, and combine appropriately to insure robustness. Ultimately, we want to know what target information can be obtained from RF-IR data fusion and corresponding sensor characteristics that would enable optimal exploitation.

The researcher may include multiple EO/IR bands as well as several radar frequencies, if desired in their analysis. However, targets will be at ranges that will cause them to appear on, at most, one pixel for the EO/IR focal plane.

Technical risk is significant, since this is a new area of investigation for the BMDS and its suite of sensors. However, researchers can use a standard set of cones, spheres and cylinders from a range of known geometries, and material properties, to reduce risk for Phase 1.

PHASE I: Develop and demonstrate through proof-of-principle tests target correlation improvements using measurement data from disparate sensors. Also, develop and demonstrate enhanced target characterization procedures. The small business and the research institution need to demonstrate coherent and mutually supporting goals and plans.

PHASE II: Refine and update concept(s) based on Phase I results and demonstrate the technology in a realistic environment using data from RF and EO/IR sensors sources. Demonstrate the technology's ability real-time in a stressed environment, a dense scene.

PHASE III: Demonstrate the new technologies via operation as part of a complete system or operation in a system-level test bed to allow for testing and evaluation in realistic scenarios. Market technologies developed under this solicitation to relevant missile defense elements directly, or transition them through electro-optical/infrared sensor vendors.

COMMERCIALIZATION: The contractor will pursue commercialization of the various technologies and EO/IR components developed in Phase II for potential commercial and military uses in many areas including automated target and threat recognition, battle space surveillance, robotics, medical industry, and in manufacturing processes.

REFERENCES:

1) Bar-Shalom, Y & Blair, W.D., Editors. (2000). Multi-Target/Multi-Sensor Tracking: Applications and Advances, Vol. III, Norwood, MA: Artech House.

2) Cowley, D.C. & Shafai, B. (June 1993). Registration in Multi-Sensor Data Fusion and Tracking. Proceedings of the American Control Conference.

3) Friedman, N., Gieger, D. & Goldszmidt, M. (1997). Bayesian network classifiers. Machine Learning, vol. 29, 131-163.

4) Hall, D. & Llinas, J. (January 1997). An Introduction to Multisensor Data Fusion, Proceedings of the IEEE, vol. 85(1), 6-23.

5) Jensen, F.V. (1996). An Introduction to Bayesian Networks. London: UCL Press.

6) Liggins, M.E., et. Al., Editors. (2009). Handbook of Multisensor Data Fusion: Theory and Practice (2nd edition), Boca Raton, FL: CRC Press.

7) Neil, M, Fenton, N.E., Forey, S. & Harris, R. (2001). Using Bayesian belief networks to predict the reliability of military vehicles. IEE Computing and Control, vol. 12(1), 11-20.

8) Palmer, J. M., and Grant, B.G. (2010). The Art of Radiometry, SPIE

9) Pearl, J (1988), Probabilistic Reasoning in Intelligent Systems: Networks of Plausible Inference, Morgan Kaufmann

10) Skolnik, Merrill (2008). Radar Handbook, Third Edition, McGraw-Hill Professional

11) Skolnik, Merrill (2002). Introduction to Radar Systems, McGraw-Hill Science

12) Tenenbaum, J.B, Griffiths, T.L. & Kemp, C. (2006). Theory-based Bayesian models of inductive learning and reasoning. Trends in Cognitive Science, vol. 10, 309-318.

13) Wolfe, William L. (1985), The Infrared Handbook, Environmental Research Institute of Michigan

14) Yang, Jie, Lu, Zheng-Gang and Guo, Ying-Kai. Target Recognition and Tracking based on Data Fusion of Radar and Infrared Image Sensors. Institute of Image Processing and Recognition, Shanghai University

KEYWORDS: Data Fusion, Track Correlation, RF-IR Fusion, Sensor Exploitation

MDA12-T003 TITLE: Innovative Technologies for High Performance Infrared Detectors

TECHNOLOGY AREAS: Sensors, Electronics

OBJECTIVE: Improve infrared sensor performance by developing next generation infrared detectors and focal plane arrays (FPA) through fundamental study and innovation on new infrared material and detector structures, material characterization, device etching, passivation, minority carrier lifetime anti-reflection coating for multiple layer structures. Successful implementation of these innovations will lead to a new generation of III-V superlattice infrared detectors and FPAs with their performance approaching theoretical limit.

DESCRIPTION: Infrared focal plane arrays are critical to military sensing systems and also have many civilian applications such as security surveillance, medical imaging and environmental monitoring. Traditional infrared material HgCdTe has very high performance, but is very expensive and limited to small format due to small substrates. A new class of infrared material using Antimony (Sb) based III-V superlattice material has theoretical performance better than HgCdTe, and has potential to be much lower in cost. Recent development in this technology has shown significant progress in demonstrating FPA performance approaching that of HgCdTe. However, in order to achieve the theoretically predicted performance and make further breakthroughs, innovations must be made to solve issues specifically affecting III-V semiconductor materials.

In the material processing area, innovative ideas leading to effective superlattice material passivation are solicited. The median dark current density of superlattice FPAs is currently an order of magnitude higher than that of single element large area detectors. This is mostly due to the relatively large amount of surface leakage current associated with small pixel size and mesa structure. Passivants such as SiO2, polyimide, and sulfur have been applied with various etching, cleaning, and passivation protocols. Semiconductor overgrowth was also experimented. However, further developments in passivant and passivation are solicited. Improvements in application of anti-reflection coating to detector arrays to increase quantum efficiency without adding stress and dark current are also solicited.

Research in the area of detector architecture can lead to new ways for suppressing various noise sources and further improving detector performance. New detector structures that can simplify material growth and device passivation are desired. The new detector architecture should help to maximize detector quantum efficiency and minimize dark current noise. For single color detector design, ideas for shallow etched or planar detector structure should also address the possible consequences of spatial crosstalk, which should not exceed 5% ideally. For multi-color design, ideas are solicited to minimize spectral crosstalk to less than 10%, and at the same time minimize spatial crosstalk and maintain high performance at each color.

Although the quality of MBE-grown superlattice materials has improved greatly in the past few years, further understanding of material defects and ways for improvement are desired. Novel ideas are solicited for the identification of carrier lifetime limiting defects. Modeling and theoretical calculations, as well direct measurements can enhance the understanding of underlying physics that controls superlattice minority carrier lifetimes and give good guidance for mitigating lifetime killing sources. The relationship between the lifetimes of a superlattice and its component layers is not clear at the moment. New growth technologies or procedures for reducing defect occurrence and ways to mitigate defect influence are requested, with a goal of achieving minority carrier lifetimes in the order of 1µs. Systematic investigations are necessary to reveal the predominant defect types, e.g., point defects, interfaces, and dislocations, and the quantitative contribution from each component. This requires clever use of many semiconductor characterization tools, such as advanced tools including scanning electron microscopy (SEM), transmission electron microscopy (TEM), cross-sectional scanning tunneling microscopy (XSTM), cross-sectional transmission electron microscopy (XTEM), time-resolved and position-resolved photoluminescence, electron beam induced current (EBIC), and deep level transient spectroscopy (DLTS). Experimental data should be systematically correlated to help gain a complete understanding of material properties and devise ways for their improvement.

Novel ideas of instrumentation for testing and characterizing superlattice materials and detectors are strongly encouraged.

Technologies leading to high-quality epitaxial growth-ready GaSb substrate wafers larger than 3 inch in diameter and with flatness <5 um are also solicited. Innovative ways of building test stations to test this new class of infrared material and related read-out-circuitry is also included.

Any proposed idea that addresses one or more areas discussed above should be demonstrated through detector or detector array fabrication and characterization. The quantitative detector performance goal for Phase I and Phase II program is listed as following.

PHASE I: Preliminary experimental and modeling study showing the feasibility of proposed novel ideas. The small business and the research institution need to demonstrate coherent and mutually supporting goals and plans. A comprehensive study on a selected focus area is expected to show good understanding of the issue and examine it at a single device level. The results from phase I should show strong ability to carry out expansive work in Phase II.

The single-band detector performance goals are quantum efficiency exceeding 70% and dark current density less than 50% of that calculated using Rule 07 at long wavelength infrared (LWIR). For dual-band pixel-co-registered detectors at long-infrared spectral bands, the quantum efficiency and dark current density goals for each band is the same as the goals for the corresponding single band detector. The goal for spatial cross talk is less than 5%. The goal for spectral cross talk is less than 10%. Close collaboration between research institutions and small businesses with coherent goals and work plans are strongly encouraged.

PHASE II: Design and implement comprehensive and systematic scientific investigation on the proposed research topic. Demonstrate consistent and robust performance of detector arrays or small format (320x256) FPAs. Various sources of experimental data and modeling data should be analyzed and correlated in order to establish links to detector performance. Methods for improving detector performance should be derived and subsequently executed, preferably demonstrated at a FPA level.

PHASE III: Marketing technologies developed under this solicitation to relevant missile defense elements directly, or transition them through infrared sensor vendors.

COMMERCIALIZATION: The contractor will pursue commercialization of the various technologies and EO/IR components developed in Phase II for potential commercial uses in many areas, including semiconductor manufacturing, scientific and educational instrumentation, and infrared detection and imaging

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KEYWORDS: quantum efficiency, spatial crosstalk, spectral crosstalk, dual-band infrared detectors, lifetime measurement, minority carrier lifetimes, semiconductor characterization, Rule 07, superlattice interfaces, antimonide superlattice, semiconductor