Small Business Innovative Research (SBIR) Projects

The SBIR program is administered by 11 federal agencies to help provide early-stage research and development (R&D) funding to small businesses to explore their technological potential and provide incentive to profit from its commercialization. CPI has been quite successful in winning 11 SBIR Phase I and 4 SBIR Phase II contracts over the past 20 years and is constantly seeking partners from the private sector, or non-SBIR government funding sources, interested in Phase III commercialization of our technology concept into a product for sale in the private sector and military markets. We welcome parties with any interest in our current SBIR projects below to contact us regarding opportunities for partnering for commercialization or for technology use. Our current and recent SBIR projects are listed below.

Accurate Scene Generation of Target Characteristics Incorporating Dynamic Atmospheric Conditions using GAIA™ and OCEANUS™

Missile Defense Agency (MDA), Phase I (concluded)

The Ballistic Missile Defense System's ability to detect and track enemy missiles against space, ocean, or terrain backgrounds, including any intervening clouds as well as atmospheric turbulence, requires prior knowledge of the environmental radiance conditions to support the development of optimal airborne sensors and detection approaches. To support sensor development there is a need for an accurate infrared scene generation capability that fully incorporates the impact of the background on the target signature. CPI has demonstrated a state-of-the-art capability for simulating UV/VIS/IR imagery for terrains and clouds with its Global-scene Architecture for Integrated atmosphere, terrain, and cloud Analysis (GAIA™) model, as well as for oceans with the Ocean Universal Scene Model (OCEANUS™). For this project, CPI proposes to enhance GAIA™ and OCEANUS™ to incorporate cloud motion, star backgrounds, far-field atmospheric turbulence, and accelerate scene generation using a graphics processing unit (GPU). The feasibility of modeling these atmospheric effects will be demonstrated using real-world airborne and satellite mission scenarios, and validated against satellite imagery. This will include error/uncertainty estimates using well-defined statistical measures. GAIA™ and OCEANUS™ will implement an architecture that can be efficiently and consistently interfaced with existing computer modeling environments, such as the Fast Line-of-sight Imagery for Target and Exhaust-plume Signatures (FLITES) or Synthetic Scene Generation Model (SSGM) codes.
First-Principles Earthshine and Skyshine Models (SHINE)

Missile Defense Agency (MDA), Phase II (concluded)

CPI expanded its robust prototype earthshine/skyshine architecture, named Shine, into a fully functional, first-principles model that facilitates the assessment of the impact of infrared, visible, and ultraviolet earthshine and skyshine on missile defense systems. CPI developed and integrated terrain and cloud components into Shine that take advantage of widely available satellite imagery. Models of the moon, bright planets, and bright stars were included as skyshine components, and a first-principles auroral oval radiance scene model was developed. CPI incorporated into Shine improved versions of the standard atmospheric radiation transport models SAMM2 and AURIC. The Shine architecture incorporates the use of fast running algorithms developed within the computer graphics community and takes advantage of massively parallel computing hardware. In order to enhance its earthshine capabilities and to better support the stimulation of MDA optical sensors, Shine was integrated into the FLITES code. FLITES is the next-generation optical signature code that will be used throughout the DoD to support targeting algorithm development programs and measurement and signature intelligence activities. Its improved capabilities will be of great benefit to the missile defense community.

Generalized geophysical Retrieval & ANalysis Tool for planetary atmospheres (GRANT)

National Aeronautics and Space Administration (NASA), Phase I (concluded)

CPI proposes to develop an innovative, generalized retrieval algorithm and analysis tool (GRANT) that will facilitate analysis of remote sensing data from both terrestrial and planetary atmospheres, and that is applicable to a wide range of NASA's remote sensing missions. GRANT will be based upon a generic and flexible implementation of the optimal estimation inversion technique for atmospheric retrievals (OPT), and be driven by a state-of-the-art far-ultraviolet (FUV) to near-infrared (NIR) atmospheric radiance model (AURIC) for its forward model. GRANT will possess a flexible, user-configurable sensor model for generating realistic simulated data that tailors the retrieval algorithm to a specific sensor and measurement system.

Global-scene Architecture for Integrated atmosphere, terrain, and cloud Analysis (GAIA™)

Missile Defense Agency (MDA), Phase II (concluded)

The Ballistic Missile Defense System’s (BMDS’s) ability to detect and track enemy missiles against earth terrain backgrounds, including any intervening clouds, requires prior knowledge of
the environmental radiance conditions to support the development of optimal sensors and detection approaches. There is a need for an architecture that efficiently and seamlessly unifies terrain and cloud models in a consistent and fully integrated computer environment. Computational Physics, Inc. (CPI) demonstrated in Phase I an architecture for simulating terrain and cloud UV/VIS/IR imagery called the Global-scene Architecture for Integrated atmosphere, terrain, and cloud Analysis (GAIA™). In Phase II, CPI proposes to evolve the GAIA™ prototype into a fully implemented model that incorporates terrain altitude and land cover, terrain material optical and thermal properties, cloud structure and microphysics, and ingestion of satellite imagery and data products, with a state-of-the-art capability for representing scene observables in the UV/VIS/IR portions of the spectrum. GAIA™ will include error/uncertainty estimates using well-defined statistical measures. GAIA’s capability and feasibility will be demonstrated using real world airborne and satellite mission scenarios, and validated against satellite imagery. GAIA™ will implement an architecture that can be efficiently and consistently interfaced with existing computer modeling environments, such as the FLITES or SSGM codes.

**Model-Driven Optimistic Modeling Language (MODOL™)**

*Missile Defense Agency (MDA), Phase I (concluded)*

Optimistic modeling techniques are being exploited in modeling and simulation architectures that model the complete Ballistic Missile Defense System. Optimistic modeling allows event based simulations to take full advantage of parallel processing by distributing models across all available processors and allowing them to run at full processing speeds while maintaining correct sequencing of events and truth states. However, this efficiency comes at the cost of reconstructing prior model states when straggler events arrive at a logical processor. The simulation is forced to roll back to a prior known state, and reapply events up to the current simulation time. This process can be time consuming and error prone thus defeating the initial intent of the optimistic model. CPI and Monument Software propose to reduce the effort required to write optimistic codes and eliminate the difficulty in finding rollback errors by defining a domain specific language for the representation of optimistic simulation features. We will also develop a code generation capability to generate optimistic code components from the metadata representations. Features such as checkpoint and rollback will be abstracted at a sufficiently high enough level to allow implementation details to be code generated, thereby reducing manual labor and programming errors.

**Ocean Universal Scene (OCEANUS™) Model**

*Missile Defense Agency (MDA), Phase II (Concludes in September 2013)*

Next generation ballistic missile warning, defense and surveillance systems need to anticipate, through modeling and simulation, the background radiation of the battlespace environment,
including geometries that intercept the ocean background. This objective requires prior knowledge of the environmental radiance conditions for development of optimal sensors and detection approaches. Much work has been done to create ocean background models, but what is needed is an innovative architecture that efficiently and seamlessly unifies existing, improved, and/or new computer code, along with access to satellite measurements of ocean parameters, in a consistent and fully integrated computer environment that can be utilized in a plug-and-play fashion by state-of-the-art background radiation codes, such as SAMM®, FLITES, and the Strategic Scene Generation Model (SSGM) code to meet missile warning and defense surveillance needs. This proposed effort will result in an innovative software product called the OCEANUS™ (Ocean Universal Scene) Model. OCEANUS™ will provide MDA with an innovative ocean scene model that incorporates ocean composition, ocean dynamics, the marine boundary layer, the land-sea interface, and the ocean observables in the ultraviolet, visible, and infrared portions of the spectrum.

Resident Space Object Characterization Using Natural Illumination

Air Force, Phase I (concluded)

Space situational awareness (SSA) and the passive detection and analysis of resident space objects (RSOs) from either space-based sensors or ground-based sensors require a detailed knowledge of the radiative environment surrounding the RSO: earth shine from terrain, oceans, atmosphere (including aurora and air glow), and clouds, as well as skyshine from localized space sources (i.e., Sun and Moon), point space sources (e.g., planets, stars), and diffuse space radiation (e.g., zodiacal light, mean star irradiance, galactic irradiance, extra-galactic irradiance), plus man-made sources (e.g., nighttime city lights). The creation of the Integrated Sphere Irradiance Software (ISIS) is designed to provide a detailed simulation of the natural and man-made radiative environment for an RSO for use by sensor designers, algorithm developers, and satellite developers. The innovative design of ISIS provides a high spatial resolution (i.e., pixels on the earth as small as 5 arc-minutes) at moderate spectral resolution (i.e., the standard 2 cm-1 resolution of SAMM2 and MOSART) for the ultraviolet, visible and infrared, that is a validated operational model capable of fully supporting the SSA and RSO detection and analysis missions.

Visible and Infrared Scenes for Tactical Environments (VISTE)

Missile Defense Agency (MDA), Phase I (concluded)

Higher resolution optical sensors are driving requirements for highly detailed representations of natural background surfaces and man-made objects for real-time scene generators used in development of Ballistic Missile Defense Systems (BMDS). New methods are critically needed to represent such structures that are computationally efficient enough for scene generators to support the high frame rates and physical accuracy required by the MDA mission. CPI believes
this can be achieved through careful selection of key physics elements and contributors to scene signatures, as well as judicious choice of the spatial-spectral resolution for the scenario of interest. CPI proposes to accomplish this by developing Visible and Infrared Scenes for Tactical Environments (VISTE), a software product for generating background scenes using these ideas, and that seamlessly interfaces with existing scene generation tools such as FLITES. VISTE will support a user-friendly application programming interface to generate background scenes and run BMDS simulations for defined use case scenarios. The innovative aspect will be a robust integrated run-time framework that intelligently selects the resolution needed to generate high speed and high fidelity representation of complex scenes given user-supplied inputs. VISTE will be a stand-alone background scene generator and scene simulator controller, with visualization of the simulation results.